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Multivariate Money

A statistical analysis of Roman Republican coin hoards with special reference to material from Romania

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Abstract

The aim of this thesis is assess the usefulness of the statistical analysis of coin hoards for the examination of aspects of ancient societies including coin use and exchange. Special attention was paid to various aspects of 'formation processes.' The thesis was divided into three parts.

Part I — Background. This Part initially reviews the history of the project and then goes on to examine the concept of money in the light of anthropological and economic work. A brief discussion of types of exchange (gift, barter, commodity exchange) in societies is offered. The Part is concluded with a review of previous statistical analyses of coin assemblages.

Part II — Analysing Hoards A large database of Roman Republican coin hoards was collected for this project. The problems with this type of data, its storage and retrieval are discussed. The database is then analysed in great detail in order to answer a series of numismatic, archaeological and statistical questions.

Correspondence analysis was used on twenty-two subsets of the data to reveal patterning in the data-set which is discussed. A new variant of cluster analysis was developed to subdivide the data set whilst minimising the time series element. The results are compared to principal co-ordinates and detrended correspondence analyses. The analyses reveal aspects of the use and supply of Roman coinage over Europe and show clearly the unique nature of the Romanian data.

An attempt is made to estimate the speed of circulation of coin in Italy. It is shown that the nature of coin supply leads to variation between periods which is the result of simple probability and sampling theory, not changes in the speed of circulation of coin as has been suggested by other authors.

Simulation studies are used to examine the validity of estimates of coin production and annual coin loss.

The results are summarised. The usefulness of the techniques used is discussed. In the light of the formation processes examined, the patterns in coin hoard data are tentatively interpreted.

Part III — Romania. It is argued that to attempt a detailed interpretation of the patterns revealed above the material must be seen in its archaeological context. This case study is offered as one such attempt. Romania was chosen for two reasons: 1) the exceptional quantity of hoards found in an area outside Roman control; 2) the unique evidence for the copying of coins. After reviewing various aspects of Romanian archaeology, a detailed analysis of the problem of copies is offered including the results of a large scale archaeometallurgical study conducted under the direction of the author. Estimates of the quantities of coins copied are given. A brief review of the settlement evidence in the counties of Sibiu, Alba and Hunedoara, of special settlement and structure types, and of hoards of silverware is presented. The thesis concludes by discussing the nature of Dacian society and its use of coin in the light of the theoretical discussions in Part I, the evidence for coin supply discussed in Part II and the results of the analyses in Part III in the context of the wider archaeological evidence.

Pentru Adrian, prieten şi cărturar

Consequently whether we are speaking of money in simple, so-called primitive communities or in much more advanced, complex and sophisticated societies, it is not enough merely to examine the narrow economic aspects of money in order to grasp its true meaning. To analyse the significance of money it must be broadly studied in the context of a particular society concerned. It is a matter for the heart as well as for the head: feelings are reasons too.

Glyn Davies, *A History of Money*

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Cuvînt Înainte

Whilst working on this thesis, friends and colleagues have often asked, why Roman coins? Why use statistics? Why the Roman Republic? My interest in Roman coins stems from the teaching of John Casey at Durham, particularly his coinage course which I took in 1986–7. My interest in coins, however, is not the interest of a collector—I am interested in what coins can tell us about the societies which used them, not in the individual objects as such. In this regard, the numerical work of Richard Reece appealed greatly. During 1988–9 I undertook the M.Sc. course in archaeological computing at the University of Southampton. It became quickly obvious that the most efficient method for handling large quantities of coinage data was the construction of a relational database. As part of the M.Sc. I also took courses in statistics taught by Stephen Shennan, during which I was taken with the beauty of multivariate statistics, and their applicability to coinage studies. For my M.Sc. dissertation Richard Reece suggested that I examine the so-called Crawford-Buttrey debate, a topic which had the advantage that a body of good quality data was available in the form of Table L in *Roman Republican Coinage*. At the end of this dissertation, it was clear that further work would be profitable, and thus the present work. Whether I have been successful in using computing and statistical techniques to study coins in order to examine past societies is the privilege of the reader.

For those interested in such matters, this thesis was typeset in 11pt Times-Roman using the LaTeX 2$_\varepsilon$ typesetting system and the BibTeX bibliography system. The UKTUG distribution of Eberhart Mattes' EMTeXsystem for DOS machines was used, mainly running on a 50mhz 486 PC. The final top-copy was printed on a Hewlett-Packard 4MP PostScript printer from files generated by Thomas Rockiki's DVIPS. The primary editor was Ulrich Jahnz's Eddi4TeX, and the BibTeX files were manipulated using Eyal Doron's BIBDB for DOS. A large number of packages were down-loaded from the Cambridge CTAN archive. Those used in this thesis were: doubles2 (double spacing), moreverb (extended verbatim environments), times (PostScript Times-Roman font), vmargin (page layout), chicago (Harvard bibliography style), epsfig (PostScript graphics inclusion), longtable (multipage tables), xspace (elegant space handling), fancyheadings (page headers and footers), rotating (rotating figures and text), calc (calculation in TeX), lgreek (full Greek fonts), afterpage (inclusion routines), dcolumn (decimal point justification in tables), amstext (text in maths), amssymb (maths symbols), multicol (multiple columns), caption (customise figure and table captions) and a slightly modified version of the subfigure package (subfigures and tables) called subfigkl. A number of custom-written packages were also used. All the figures in this thesis were stored in PostScript format and included using the epsfig package. All the `.tex`, `.bib`, `.dvi` and non-standard `.sty` files have been placed on the attached CD-ROM. Additionally, all the figures, and the PostScript files used to print this thesis, are on the CD.

Funding for this thesis was primarily provided by the Science and Education Research Council to whom my thanks are due. The metallurgical project, which was conducted as a result of my doctoral research, was funded by the Fund for Applied Science in Archaeology, the Royal Numismatic Society, and the UK Numismatic Trust.

In conducting the research for, and the writing of this thesis, I have incurred many debts of gratitude and I would like to take this opportunity to acknowledge the help I have received. Firstly, I would like to thank my supervisors, Clive Orton and Stephen Shennan for all their help and encouragement. I would also like to thank: Michael Crawford for allowing me to use his archives and data, now stored in the British Museum; the staff of the Dept. of Coins and Medals, primarily Andrew Burnett and Roger Bland, for allowing me such easy access both to those archives and to the library of the Department, and for allowing samples to be taken from silver *denarii* in the Museum's collection; Richard Reece, who kindly provided the original idea for my M.Sc. dissertation and spent much time discussing my ideas and work; Matthew Ponting for so enthusiastically agreeing to undertake the metallurgical analyses, including accompanying me to Romania in May 1992 to collect the samples; John Merkell for allowing the analyses to be conducted on the Institute's equipment; Peter Guest for discussing my ideas and sharing his own with me; Christopher Howgego for allowing me to sample coins from the Ashmolean; Terrence Volk and Ted Buttrey, both from Cambridge, for providing off-prints and discussing my work; Warren Esty for a long and highly productive conversation in Oxford and subsequent discussions by e-mail; Mike Baxter, Christian Beardah, Richard Wright and Morven Leese for discussing and helping with the statistical aspects of my work; Nick Ryan for his help with the database and for so promptly sending me copies of his article and book, and Sebastian Rahtz for acting as my unpaid, unofficial but willing LaTeX guru. Frank Martin printed the photographs from my rather poor negatives, for which I am immensely grateful.

In Southampton, I would like to acknowledge the Department of Archaeology at the University for kindly allowing me access to both their hardware and software upon which much of the work was undertaken. I would particularly like to thank: Timothy Sly for all his help and patience, especially in matters regarding computing; Dale Serjeantson for proof-reading almost everything, and for her patience; Sophie Jundhi for pasting-up the plates and Kathryn Knowles for her help in this matter; and Keith Westcott for digitising the maps. I also wish to express my deepest gratitude to Jenny Coy for allowing me to continue to use my room in Southampton as an office until the completion of my thesis.

Many people have helped me cope with the large numbers of languages involved in this work, including Federica Massagrande (Italian, Spanish), Rosemary Burton (Spanish), Dale Serjeantson (French), Genevieve Stone (Russian) and Doina Whitaker (Romanian).

My work in Romania could not have taken place, and certainly would not have been so pleasant, without the kind help and co-operation of a great many people to whom my thanks are willingly given, foremost of whom are Gh. Poenaru Bordea and Adrian Popescu of the Institutul de Arheologie "Vasile Pârvan" in Bucureşti, and Virgil Mihăilescu-Bîrliba of the Institutul de Arheologie, Iaşi. I would particularly like to thank Adrian's and Virgil's families for their repeated hospitality over the years. I would also like to thank: Constanţa Ştirbu (Muzeul de Istorie al România), Radu Ocheşeanu (Severeanu Museum, Bucharest), Catalin and Geta Borţun (Muzeului Judeţean Teleorman, Alexandria), Ecaterina Ţînţăreanu (Muzeului Judeţean Teleorman, Alexandria), Aniko Mitruly, Lili Ardea and Doina Comşa, (Mediaş Museum), Ioan Caproşu (Universitatea Al. I. Cuza, Iaşi), Dan Gh. and Silvia Teodor, Victor Spinei, Costel Chiriac, Ion Ioniţa, and all the researchers and staff at the Institutul de Arheologie, Iaşi, and Nicu Bolohan and Marius Alexianu and their families (Piatra Neamţ).

The events of 1989, both in Romania and the rest of eastern Europe, have changed the lives of many millions of people in often unexpected ways. Much of the work contained in this thesis would not have been possible but for the dramatic and historical events of that year. In 1991–2, as part of my research, I attended an evening class in the Romanian language taught by Doina Whitaker, now a close friend. At that course I met my future wife, Sally Markwell. My last, and most heartfelt thanks go, therefore, to Sally and her children Jonathan and Lindle, whose patience I have stretched further than I had any right to hope, and whose love I have come to rely upon so much.

Part I

Background

Chapter 1

Introduction

1.1 Aims and content

Archaeology is an interdisciplinary subject. Although it is usually classed as one of the human or social sciences it uses in large measure techniques and methods developed both in the hard sciences and in the arts. This aspect of the subject has been its strength and its weakness. One weakness is that it has created a plethora of specialists, and while this is not in itself a problem, it becomes one when communication and mutual understanding is poor.

A second weakness is to lose sight of the discipline's aims. Defining archaeology is probably impossible. Wheeler wrote:

> What in fact is archaeology? I do not myself really know. Theses have been written to demonstrate that it is This or That or not the Other Thing. . . (Wheeler 1954, p. 16)

He did know, however, that:

> . . . the archaeological excavator is not digging up *things*, he is digging up *people*; however much he may analyse and tabulate and desiccate his discoveries in the laboratory, the ultimate appeal. . . is from mind to intelligent mind, from man to sentient man. Our graphs and schedules mean nothing if they do not ultimately mean that. Of our scraps and pieces we may say, with Mark Antony in the market place, 'You are not wood, you are not stones, but men.' (Wheeler 1954, p. 17)

If the soil micromorphologist or the hermeneuticist does not show the importance of their particular piece of work for the understanding of the human past, then they are not 'doing' archaeology, although we must be aware that identifying what we cannot say is also an important contribution.

How is the archaeologist to overcome this weakness? One possibility is to have generalists, as well as specialists; synthesisers who combine the diffuse threads of evidence to weave them into their own tapestry, their own broad picture of the past. Another solution is to become a middle man. In statistics, Clive Orton (1992) has suggested a model of practice whereby an archaeologist with training in statistics — a parastatistician — acts as communicator between 'real' statisticians and other archaeologists, and this is the approach followed here.

This thesis is an attempt to look at the concept of money and the function of coins in past societies, but in the following pages a number of seemingly disparate subjects will be discussed.

Why is a chapter containing descriptions of the various ‘money-objects’ in various societies in the same volume as a discussion of 20th century political history in Romania? What has either to do with the statistical analysis of Roman Republican coin hoards? It would have been easy to have written this thesis from the narrow perspective of the analysis of coin hoards but I felt the necessity of standing back and examining what I was trying to do. Starting from the point I had reached in my masters dissertation (Lockyear 1989) I firstly looked at the broader themes: what is money? What sorts of economies are there? How does money function in different societies? From these broad themes, I then examined one type of money: Roman Republican coins, and primarily silver *denarii*. What can we learn from hoards of such coins? Can we identify the causes of variation in coin hoards? Can we develop valid statistical techniques for the analysis of this material? Further, I felt a need to put flesh back onto the subject, to situate the analysis in an archaeological and social context. Therefore, a case study was chosen: Republican coins as found in Dacia, approximately modern Romania. This case study uses the insights gained from the wider background research presented in Part I, and the results of the research presented in Part II. However, to put the coins into their archaeological context, that context has to be understood. To understand the archaeology of Dacia in the present in turn requires an understanding of the study of Dacia in its modern context, *i.e.*, in the 20th century, and even the history of the area from late antiquity. I hope that the reader will see, despite the seeming vastness between topics, that they are all relevant to the overall task.

I have often felt inadequate to the task I have set myself. Specialists may find my forays into their fiefdoms naïve and simplistic. Statisticians could argue my techniques were not optimal; anthropologists may ask why I chose this society and not that; Romanian archaeologists may argue that I have not examined all the available evidence. In a project such as this, comprehensiveness is not an obtainable goal. For example, a published bibliography of the La Tène in Romania up to 1981 contained 4890 entries (Comşa 1993). Consulting a fraction of these references, almost entirely in languages other than English, has been extremely time consuming. I have, therefore, used the techniques, examples and data available to me, and make no apologies.

To summarise, this thesis contains three parts: Part I contains this general introduction (Chapter 1), Chapter 2 contains a discussion of the nature of money, and some of the debates that surround it, including anthropological and ancient historical perspectives, and Chapter 3 contains a detailed discussion of numerical and statistical techniques as applied to coinage studies. Part II (chapters 4–12) is the analytical section of this thesis, including two case studies examining specific problems. Part III contains the principal case study: it starts with an overview of many relevant aspects of the problem and presents a discussion of some aspects of the archaeological evidence for this period (Chapter 13). This is followed by a more detailed discussion of the coinage (Chapter 14) which includes an attempt to solve the problem of copies (section 14.4). Chapter 15 attempts to join the many threads of evidence from all three Parts to create a coherent picture of the late Iron Age of Romania. There then follows a series of Appendices.

What is not presented, at least in printed form, is a detailed listing of the data used in Part II. This data is detailed information of the contents of coins hoards of the Roman Republic dating from 211 BC (the start of the *denarii* coinage) to 2 BC. This information, in the form of comma delimited ASCII files, dBASE data files, and an Access 2 database, are included on the CD-ROM affixed to the rear cover of this thesis. It would be a huge task for anyone to re-input the data used in this thesis from printed lists in order to assess or re-analyse the data sets. By including the data in digital format this enables future scholars to use and re-examine the data without needless replication of work already undertaken. The CD-ROM also contains tables with the results of various queries (primarily the data sets referred to in Part II), files for input to various statistics packages, the graphs in POSTSCRIPT format, and dBASE programs, or other files which might be of use including the text of this thesis in LaTeX 2_ε format, and as `.dvi` and POSTSCRIPT files. Updated versions of the primary *coin hoards of the Roman Republic* (CHRR) database, which forms the core of this work, will also be available from sources over the InterNet, initially from the University of Southampton's WWW server (http://avebury.arch.soton.ac.uk/Lockyear/chrr.html), and hopefully in the near future from the Humanities Data Service.

1.2 The theoretical perspective

This thesis is not, primarily, theoretical in that it does not explicitly examine theoretical issues with a view to the advancement of archaeological theory. However, it is impossible to be atheoretical — whatever we do is influenced by our theoretical stance, or to put it another way, what we believe is the correct or best way to 'do' archaeology. In the development of archaeology over the last 150 years a number of different schools of thought have emerged (Trigger 1989), some of which could be classed as significant paradigm shifts (Kuhn 1970). In the initial stages of each development, the 'new' school often adopts a combative stance (*e.g.,* Shanks & Tilley 1992) which leads to conflict, stalemate and eventually stagnation; a classic example in economic anthropology being the formalist-substantavist 'debate' (Plattner 1989), and a more recent example in archaeology being the processual/post-processual debate (Preucel 1991b; Yoffee & Sherratt 1993). Such conflict is counter-productive. An example is *site formation processes* (Schiffer 1987). The Schiffer school of thought gives primacy to the investigation of these processes and see an understanding of them as a bridge between the archaeological record and the past (Schiffer 1987). In contrast, Shanks & Tilley (1992), argue that as the past is constructed in the present, there is no one 'true' past', and a research program centred solely on formation processes is misguided:

> However, we would strongly criticise the view that there is a mechanical, albeit indirect, relation between material culture and the contexts of its production. The aim of a science of material culture, a science of the archaeological record, is a mistaken one, a futile search for scientific objectivity. As we hope to show, there can be no *objective* link between patterning in material culture and processes which produced that patterning. (Shanks & Tilley 1992, p. 10).

Recently, many have recognised that the conflict between processual and post-processual archaeology is counter-productive, and that if not co-operation, at least tolerance would be more fruitful (Preucel 1991a).

I refuse to declare myself an adherent of any one school, preferring to remain open minded and to extract from each insights which appear to me useful, whilst remaining free to jettison the less useful ideological baggage which often accompanies those insights. I have attempted to follow what I see as a constructive middle road. Firstly, the archaeological record is the result of a complex interaction of past human behaviour, physical processes, and the recovery and recording of that record by archaeologists. An investigation of the processes which lead to the formation of the record (in which I would include the training and beliefs of the archaeologists involved) can only enhance and improve the interpretation of that record. However, there is never only one possible interpretation of the record, and this is not only a result of imperfect data — there can be multiple versions of the past (Shanks & Tilley 1992, p. 11).

To clarify this, a good example would be a recent televised discussion examining the effect of the Second World War on the class structure of Britain, primarily the idea that the war brought the people together in a common purpose. This debate included historians, and people involved at the time. No consensus was reached — one discussant who had worked in the east end of London during the war clearly showed that the Government was slower to provide suitable shelters here than elsewhere, whereas another involved in looking after evacuees had a somewhat different perspective. Neither was 'wrong', in that their individual experiences were true, but nor was either 'right' in that their experiences could not be generalised to the whole population. In this case, neither version of the past is correct or false, in that each individuals' experiences have validity. We can argue that each version is *incomplete*, which is another matter. We can contrast this with attempts by contemporary right-wing extremists to show that the holocaust did not happen but was an enormous Jewish fraud. We can easily demonstrate that this version of the past is false. Generalising this to the archaeological debate, we cannot prove that one particular version of the past is 'true', and in some ways even ostensibly conflicting versions of the same past can both be valid, but we can reject a particular version of the past as being demonstrably untrue.

The fact that there are demonstrably false pasts does not, however, mean that we must adhere to an empiricist or positivist form of interpretation. To use the catch-phrase of the 1989 Newcastle TAG, we can be 'empirical without being empiricist.' If, within archaeology, we only present interpretations or conclusions that we can 'prove' from the available evidence, our versions of the past will be impoverished. The schema presented by Shennan (1993), following the sociologist Runciman, has much to merit it. Runciman makes a distinction between *reportage*, explanation, description and evaluation. Shennan sums this up succinctly as follows:

> Reportage corresponds in certain respects to the concerns of "middle range theory." It refers to the process of reporting an event, process or state of affairs as having occurred. Such reports are not, of course, presuppositionless, but they should as far as possible be theory-neutral, in the sense that holders of rival theories should be able to agree on them; reports should not imply or pre-empt particular theoretical positions at the level of explanation. (Shennan 1993, p. 54)

In this work, I have tried to make clear the distinction between items of reportage, and items of explanation, although the boundary between the two is not always clear-cut. The former can be demonstrated from the archaeological evidence; the latter cannot and it would not be difficult to construct alternative explanations based on the same data, although perhaps with a different theoretical perspective. Here I would like to introduce a principle which I call *concordance*. If we accept that reportage is possible, and thus we can have items of information which can be generally agreed upon ('facts'), we can admit explanations of the past which are *concordant* with those 'facts' and reject those which are not. Which of the admissible versions of the past we *prefer* is dependent on our theoretical perspectives, our own preoccupations, and even our non-archaeological, perhaps political, aims. If, however, we wish to work towards a holistic view of a particular past society, essential insights can often be gained from different explanations based on different perspectives of the same set of data, an approach which is similar in spirit to the *Annales* school of history (Bintliff 1991, especially n. 1, pp. 26–7). For example, whilst as a discipline we might reject crude environmental determinism, this is not to say that environment has *no* influence on the development of past societies: environment without the social is as misguided as social with the environment.

The majority of Parts II and III of this work can mainly be classed as reportage, whereas Chapter 15 is primarily explanation, which I have attempted to make concordant with the data previously presented.

Within this work, and primarily within Part III, a number of topics which have generated a large literature have been encountered. For example, the assertion that the polity controlled by Burebista was a state leads to the question: what is a state? The assertion that part of the evidence for this state was the appearance of towns leads in turn to the debate concerning urbanism. The explicitly marxist evolutionary schema within which the late Iron Age of Dacia has usually been examined (Stahl 1992) presents one with the problem of social evolutionism (*cf.* Sanderson 1990). The most thorny question of all is the identification of certain elements of material culture as being evidence of ethnic groups, the Dacians, the Celts, the germanic Bastarnae, and so on (*cf.* Shennan 1989). As the aim of Part III of this work is primarily to examine the function of coinage in one particular society, no detailed discussion of these topics has been presented. For example, rather than defining what a 'town' is, and then looking for archaeological correlates for this in the excavated evidence (and incidentally running the risk of affirming the consequent; Shennan 1993, p. 54), I have attempted to characterise the settlements from the evidence, and have used the neutral term 'settlement.' Likewise, when referring to, for example, a 'Dacian cup' (*ceaşca dacică*) this should be understood as a label for a particular ceramic form, and no ethnic attribution should be inferred. By using this 'bottom-up' approach, I hope to be able to discuss the problems in hand without, at least at this stage, becoming overly embroiled in topics which have commanded theses in their own right.

The only broad topic which has been extensively examined is that of the nature of 'money', see Chapter 2. Even in this case, it was found that a top-down theory-to-archaeology approach was difficult to follow, and that a more satisfactory route was to examine the rôle of coinage in a particular society, without pre-judging whether this use was 'monetary' or not.

The use of analogy, particularly anthropological analogies, is also deserving of some comment. Analogies can be divided into two categories: formal and informal. In a formal analogy we state that in society *A* we can observe *x*, *y*, and *z* (this society is likely to have been subject to an ethnographic study); in society *B*, however, we can only observe *x* and *y* (probably archaeologically), but go on to infer *z*. This procedure is fraught with problems especially when *A*, for example, is a contemporary culture from the Pacific, and *B* is a prehistoric European archaeological culture. Informal analogy, however, is more a means of producing ideas. We all exist in a specific culture at a specific time, and many of our thoughts and actions are conditioned by the culture within which we exist. An interesting example comes from organisational theory — organisations within which we work (that is those of use living in a western European capitalist society) can be divided into four organisational cultures Handy (1995). When members of organisations with different cultures meet, without prior warning of the differences in culture, mutual misunderstanding and confusion, and even conflict, arise. The members of each organisation cannot imagine how else an organisation could function. If we generalise this to societies, we can see how easily ethnocentrism can occur. This is particularly true of coinage studies where many scholars presume that we all 'know' how coinage and money operates, whereas in fact we know only how it operates within the narrow confines of our own culture. For example, western European delegates at the *Computer Applications in Archaeology* conference held in Iaşi, Romania, 1996, found the sight of the conference organiser carrying large bundles of notes around in his rucksack in order to pay for various items highly amusing — most delegates had never operated within a cash dominated system.

Use of anthropological and historical studies, therefore, enable us to view the data from other angles, and to produce interpretations that are less ethnocentric, although still confined by our knowledge and experience. An interesting variant of this problem is encountered in studies of the Roman period: a number of scholars work within the belief that we know what the Roman world was like and all we are doing is infilling the details — an approach I would call 'romocentrism.' This could, arguably, be true for late Republican Italy but is an unfortunate straightjacket to which studies of, for example, Roman Britain have been confined (Reece 1988c).

1.3 Archaeology, numismatics, and the study of hoards

Numismatics, especially the use of numismatic evidence for archaeological or historical purposes, is a complex subject. Many general introductions exist for Roman coinage, numismatics and archaeology and it is not proposed to repeat this material here; the reader is referred to Burnett (1991), Casey (1980, 1986), Crawford (1983), Creighton (1992a, chapter 1), Grierson (1975), Haselgrove (1987, chapter 1), Lockyear (1989, chapter 1), Reece (1987a) and Ryan (1988, chapter 1), as well as various papers in *Coins and the archaeologist* (Casey & Reece 1988). A detailed discussion of numerical techniques used in the study of coin hoards is presented in Chapter 3.

1.4 The rôle of statistics in archaeology

The initial introduction of statistics to archaeology was part of a wider paradigmatic shift in the human sciences in which geography, history, anthropology, sociology, and to a lesser extent even literary theory, turned to the use of statistical methods to illuminate problems within their respective disciplines. The 'New Archaeology' was a quantitative archaeology, and one of its main proponents stated that 'the days of the innumerate are numbered' (Renfrew, cited in Shennan 1988, p. 7). Subsequent changes in theoretical perspectives aside, this was to prove a false statement. Although there are more statistically aware archaeologists now, the majority of archaeologists are still uncomfortable and unfamiliar with statistical methods. This has many practical consequences with projects squandering potentially huge resources simply because their sampling strategy, if they have one, is flawed. If we add to this the fact that some current theoretical developments are openly hostile to numerical techniques, what should the rôle of statistics in archaeology be, and why is this not being fulfilled?

Statistics can perform two primary functions: to influence what we do, and to influence what we think. The former includes answering essentially straightforward questions, although the answers may be less than straightforward to obtain. They include: how many radiocarbon dates should I have done to assess if these two phases are contemporary? How many holes should I dig to assess the archaeological potential of this site? How many coins should I sample to estimate the number of copies? This function mainly concerns the collection of data. The second function is the investigation of existing data: are these two phases contemporary? Is the silver content between group A coins and group B coins significantly different? Is there any patterning in the contents of these hoards? Often, these questions form a cycle with the results of the data collection stage being processed by investigative statistics, which in turn lead to fresh questions and more data collection (Orton 1980, pp. 19–24).

Why, then, are statistics not used as much as they might to fulfil these functions? The answer is threefold:

1. there is a misunderstanding of what statistics can and cannot do and say;
2. statistics have been misused in the past;
3. there is a mistaken association of statistics with a particular theoretical standpoint.

A common complaint voiced is that statistics can be used to 'prove anything.' This is wrong: statistics cannot *prove* anything. Many statistical techniques provide one with further information, often in the form of a statement of probability, which influences one's beliefs and decisions. Decisions, for example, will often be based on non-statistical criteria as well, usually the consequences of making a mistake (Shennan 1988, pp. 51–3). As an example, the probability of winning the National Lottery is 1 in approximately 14,000,000. These are huge odds, so why does anyone bet on it? They bet because the consequences of being wrong, losing £1, are negligible, whereas the consequences of being right, winning in excess of £8,000,000, are substantial. If we reverse the situation and analyse the odds of the O-ring seals on the fuel tanks of a space shuttle failing, we would probably wish to reverse the acceptable odds to 14,000,000 to 1 as the consequences of being wrong would be the death of the astronauts.[1] In archaeology, and in the human sciences generally, the odds used are usually 1 in 20; there is nothing magical in this figure and in every case one needs to assess the consequences of being right or wrong.

If one moves away from the idea that statistics can prove something right or wrong, and perhaps towards the use of statistics in an exploratory, investigative way, a way of playing with ideas, or simplifying complex patterns, as being part of an investigative cycle, then many of the misunderstandings of what can be achieved are dissipated.

Secondly, there are two ways in which statistics have been misused. Statistics have often been used as a weapon to be used to 'prove' or 'disprove' another's theories: 'application of the χ^2

[1] As happened, the statistical analysis of O-ring failure in the case of Challenger was flawed as only the data about failed rings was input to the analysis, not data about all the rings.

test demonstrates that no such relationship exists.' In fact, the test probably demonstrated that at a probability level of 1 in 20, two samples were not statistically significantly different, which is not the same statement at all. Secondly, statistics sometimes appear to be used to obfuscate: after a general introduction, pages of complicated formulæ and graphs are followed by: 'as can be seen. . . ' Few question the conclusions, if they even get that far.

Finally, the association of statistics with a particular archaeological theoretical standpoint is a result of the association between processual archaeology and statistics (Shennan 1988, pp. 1–6). In response to Orton's (1980, p. 13) belief that mathematics can be used as 'a tool for organising one's thoughts and data', Shanks & Tilley (1992, pp. 59) argue that:

> Here reason is explicitly reduced to instrumentalism. It is an organ of calculation, of coordination, of planning. Reason becomes detached from decision as mathematical reason itself decides the means of approach to the past. The purpose, the aims of a study of the past are attributed to the calculating subject. Reason is detached from the decision to apply reason, the electronic calculator or computer from the creative impulse behind model building, from justifications. The latter can only be detail, subjective and arbitrary. As mathematics is purely formal, it can only become meaningful when meaning itself has been discarded. . . . Yet the self-contained formalism of mathematical explanation is related to its totally opposite, totally and equally meaningless empiricism, the attempt to merely record all facts without any subjective content or bias.

This is utterly to misunderstand Orton's position and the rôle that statistics and mathematics can play. 'Mathematical reason' does not replace human reason, it can only influence it; mathematical models may *describe* aspects of the past, but the archaeologist must *interpret* them. A statistical technique has no (archaeological) theoretical stance[2] — the software for correspondence analysis on my hard-disk is not inherently 'processual' or 'post-processual' but, as soon as I (the researcher) select data for analysis by CA, and even more so when I interpret the results, the analysis gains a theoretical aspect. The technique is atheoretical in terms of archaeology; the analysis, particularly the interpretation of the results, is inherently theoretical. Despite their criticisms of the use of mathematics in archaeology, when faced with a mass of data, *e.g.*, in their study of beer cans, they turn to exploratory statistical methods such as Principal Components Analysis and Principal Co-ordinates Analysis, for help in simplifying that data (Shanks & Tilley 1992).

Statistical methods do, however, have a statistical theoretical basis. To grossly oversimplify, there are two main schools of statistical thought: classical statistics and Bayesian statistics. In the former, the analysis usually proceeds from the position that we know nothing except for the data input into the analysis. If we do know something, perhaps from having plotted a graph, we can be accused of 'data-snooping', a grievous sin. Bayesians, however, argue that we do know something in the vast majority of cases, and that this prior knowledge should be incorporated into the analysis, to produce posterior knowledge (Litton & Buck 1995). The practicalities of this were such that Bayesian analyses of any usefulness have only really been possible in recent years with the advent of high-power computers.

[2] There are some exceptions, primarily 'social status analysis'.

In theory, therefore, we could take the ‘expert’ knowledge of a number of archaeologists, and use them as the prior knowledge in the analysis, and obtain a series of possibly different posterior knowledges. Even the ultimate sceptic who would deny validity of either any prior knowledge, or even the validity of the procedure of including such knowledge, can be accommodated. The analysis can be run from a position of ‘great prior uncertainty’, *i.e.*, our prior knowledge is that we do not have any! Such a way of working should appeal to many adherents of the newer theoretical schools.

Given the attractiveness of the idea, why has Bayesian statistics not seen widespread application? Firstly, the mathematical procedures are non-trivial and Bayesian analyses have to be run in collaboration with specialists in the field. Secondly, as noted above, only recently have technological and theoretical advances been made which enable worthwhile analyses to be undertaken. Lastly, a great majority of statisticians are of the classical school, and of these many view Bayesian methods with some scepticism. Despite this, there has been a recent growth in the application of these methods in archaeology (Litton & Buck 1995).

Given these problems, what future has statistics in archaeology? It is unrealistic to expect every archaeologist to have a good working knowledge of statistics. What would be more useful is if archaeologists had at least some idea of what could be achieved through statistics, and when it would be useful to consult either a parastatistician, or a ‘real’ statistician. Archaeologists innate inability to ask for advice, and to attempt to do things alone, at best results in the re-invention of the wheel, or at worst poor statistical analyses which have had huge financial implications. A similar situation exists, for example, in the design and implementation of databases.

In this thesis, I have used statistics in an investigative way to examine the problems of the formation of, and patterning within, coin hoards in order to illuminate aspects of the use of these artefacts in antiquity. Discussions with ‘real’ statisticians have formed an important part of the research process, and I believe that the results justify the method.

Chapter 2

Money

> Underlying a rich diversity of form, money is a single phenomenon. But its nature is not easy to understand, for money gives no information about itself, except that it *is* money. In revealing itself as money, it is nothing more than a cultural tautology. (Crump 1981, p. 1)

2.1 Introduction

The stimulus for looking at the theory of money, and at anthropological work on money, was two discussions in *Coinage and Money under the Roman Republic* (Crawford 1985). It is worth citing them at length here. The first discussion occurs in Chapter Two on the early Republic. It begins promisingly:

> Absence of coinage, however, does not mean an absence of money, and much of what I have to say here relates to the role of money in the early Republic. But any attempt to discuss the subject must face the problem of the sources. Relentlessly modernising, they persistently discuss the Republic in terms of the monetary conventions of their own times, including, of course, the use of coinage. . . (p. 17)

Crawford then goes on to discuss some of the sources and the use of anachronistic monetary terms and conventions in them. He then states:

> It is as true for the Roman world as for the Greek that the most important stage in the early history of money is the designation by the state of a fixed metallic unit. . . (p. 18)

He then states:

> As far as the designation of a fixed monetary unit is concerned, there is an alternative tradition, at first sight of considerable plausibility. Romans of the late Republic and after believed that wealth in Rome in early times consisted largely of cattle, whence the word *pecunia*. . . it was believed that fines in early times were in cattle and sheep and that two laws in the course of the fifth century provided for their conversion into fines of bronze.
>
> . . . There is no agreement about the content of the *suprema multa* — two cows and thirty sheep according to Dionysius of Halicarnassus. . . two sheep and thirty cows according to Gellius. . . thirty cows only according to Festus. . . (p. 19)

Crawford then discusses some more inconsistencies in the historical record concerning the various laws before going on to state:

> Quite apart from all the incoherences, I find it incredible that fines were ever levied in Rome in cattle and sheep. Just as in the Homeric world the fact that wealth was thought of as consisting in part of cattle and evaluated in terms of cattle does not mean that cattle were ever *used* as money for purposes of payment, so for Rome it does not follow from the existence of wealth in the form of cattle that cattle were ever levied as fines. (p. 20)

Crawford then goes on to discuss the creation of a metallic unit designated as ‘a certain weight of bronze’ (p. 20), and for a ‘state designated metallic monetary unit [that] existed at Rome from the middle of the sixth century.’ (p. 21).

It is interesting to contrast this with his discussion of the various large bronze bars such as those with the ‘ramo secco’ pattern found in Eturia, the Po valley and elsewhere in Italy during the late archaic and classical Eturian periods. Here he states:

> Yet despite the spread and duration of the fashion, these bars were never more than bullion passing by weight. (p. 6).

Before commenting on this I would like to contrast these statements with his discussion of coinage in modern Romania, roughly ancient Dacia. Crawford reveals his preconceptions in the first paragraph:

> It is time to turn from the slave-using to the slave-producing areas of the Balkan peninsula. One of the most remarkable phenomena within the pattern of monetary circulation in antiquity is the presence of large numbers of Roman Republican denarii… on the soil of present day Romania… the total comes to something like 25,000 pieces. (pp. 226–7)

This total is made more remarkable by the lack of coin hoards in neighbouring areas although in Bulgaria this is more likely to be due to the lack of publication. Crawford (1980) dismisses the possibility of large numbers of these coins being copies despite the cast coins from Breaza and the dies from Tilişca and Ludeşti known at that time (Lupu 1967; Stoicovici & Winkler 1971; Chiţescu 1980; Chiţescu 1981). Crawford believes that the presence of these coins in this area is due to the slave trade (here he summarises Crawford 1977a). He goes on to state:

> If one turns to consider the social and economic significance of these finds, it seems likely that the presence of a variety of coinages… has little to do with the operation of a money economy…
>
> The virtual absence of any small denominations means that none of the coinages… can have functioned very effectively as a means of exchange in a market economy. And the readiness… to use coins of… differing weight standards without any consistent attempt to produce its own suggests that the coinages functioned perhaps only in a rather rough and ready way as a measure of value.
>
> The answer lies… with coinage being used rather for the exchange of gifts… its function was presumably to define and enhance the status of a local aristocracy…
>
> Coinage is in fact to be envisaged as for the most part a fashionable form in which to hold and display wealth… the origin of the fashion perhaps lies in a perception of the power of money in the *civilised* world… there of course the power derived from a *real economic function*. (p. 229, emphases mine)

Crawford then contrasts this view with that of some Romanian scholars (such as Chiţescu) who would like to see the existence of a unified state under Burebista with a monetary economy. Most of the last quotation is entirely plausible, perhaps more so than the opposing views expressed by Romanian scholars before the fall of Ceauşescu.[1] It is interesting to note that throughout this discussion no reference is made to the large amount of work on 'gift economies', including Mauss' seminal work *The Gift* originally published in 1925 (Mauss 1990). Crawford's one reference is to a numismatist's warnings about the difficulty in interpreting coin evidence (Grierson 1959). His arguments about the slave trade are entirely dependent on his assertion that all but a few of the coins are genuine, and that there were no other imports into Italy from Romania. His real prejudices are revealed in footnote 43 (p. 233) which it is worth quoting at length:

> I note in passing that, *grosso modo*, amphoras and pots (and their imitations) predominate outside the mountains which surround Transylvania, silver-ware, bronze-ware and coins (and their imitations) predominate within; there is not enough evidence for glass-ware and other assorted objects to detect a pattern;... I suppose the difference to correspond to a difference of fashion; within the mountains one threw silver around, without them one got drunk. Burebista eventually attempted to ban wine, Strabo vii, 3, 1 (303–4), and he may have also tried to stop or reduce the slave trade. (n. 42, p. 233, emphases Crawford's)

In a work entitled *Coinage and Money* it is surprising that there is no discussion at all as to what money is; no definition is offered, nor are there any references that this author can find to the literature on the theory of money. In the first discussion quoted above it is hard to see the difference between his 'money as weights of metal' concept, and the 'ramo secco' bars he discusses earlier.

His discussion of the rôle of cattle in the ancient world is fascinating. Only two reasons are really given for dismissing them as money:

1. that the sources are contradictory

2. his own incredulity

There is a considerable literature on the cattle economies of Africa (*e.g.*, Neale 1976, pp. 41–44), and good evidence for the use of cattle in payments in early Medieval Ireland. This topic will be discussed in more detail (section 2.3.1). Most definitions of money include its function as a store of value and a unit of account (see below), as well as a means of payment. Crawford seems at this point to believe that money's primary rôle is as a means of payment but it is not discussed here.[2] As to the contradictory sources, it would be more worrying if they were in total agreement as this would suggest one common source.

With the Romanian evidence Crawford plays lip service to more sophisticated interpretations of the rôle of value items in societies but does not attempt to analyse them at all. In the footnote quoted above he is seemingly unaware of some of the problems of using archaeological data. It is

[1] It is clear that the influence of the modern Romanian state has led to work being constrained to fit Party ideology. The question of Burebista and his 'state' is one of these. For example, see Crişan (1979). Conversations with Romanian scholars have revealed their acute awareness of this problem (Mihăilescu-Bîrliba 1994a; Mihăilescu-Bîrliba 1994b).

[2] Crawford (1970) does argue that coinage primarily represents a means of payment in the Republican period, and that it was struck solely for the purpose of making state payments, *cf.* Howgego (1990).

not surprising that amphoræ do not cross the Carpathians into Transylvania as the chances of them reaching their destination in one piece are remote. If we could contrast the distribution pattern of wine skins or barrels with that of amphoræ we would no doubt have a very different pattern. As to the distribution of coins, it does not seem, on superficial examination of the distribution maps, to be true that most silver coins occur within the Carpathian ring (see Fig. 14.2, page 390), although there is a predominance of hoards of silverware within the mountain ring (Fig. 14.4, page 402; Mărghitan 1976, pp. 69–71).

It should obvious from the above that any work that investigates coinage has to be aware of the theory of money and exchange in societies, and the debate that surrounds this topic. In the following section I will attempt to discuss the nature of money with reference to the anthropological evidence on money in non-western, non-capitalist societies. It cannot be emphasised too strongly that I am not intending to suggest that any of the societies can form a direct analogy with Rome, Dacia, or any other area from where Republican coins are found. The aim is to provide an informed background to the investigations that follow in the analytical section of this work so that interpretations of the evidence need not be constrained by ethnocentric preconceptions of the nature of money and the functions of coinage.

2.2 What is money?

A discussion as to 'what is money' is hampered by the lack of consensus both within academic disciplines, and between them. The problem is further complicated by disagreement as to whether 'money' is a type of object with specific functions, a theoretical concept, or system of measurement analogous to centimetres or inches. The arguments surrounding money are often part of wider arguments concerning paradigms for the study of the economy either in economics or anthropology (Dalton 1975). As a starting point, a 'neo-classical' (or 'formalist') economic viewpoint will be presented, as can be found in many standard economics textbooks.

One such textbook is that by Crockett (1979). The first chapter concerns us here. Crockett starts by explaining the theory of exchange stating, it is one of the 'earliest contrivances of organized society' (p. 3). The origins of exchange are logically deduced and a simple example given which is worth examining. In the example there are two primary products: sheep and corn. Every member of society attempts to produce 'that combination of sheep and corn which maximises his satisfaction.' The combination produced will be determined by two laws, the 'law of diminishing marginal returns in consumption' and the 'law of increasing marginal costs in production' (p. 3). A contrast is drawn between two persons, one who is in a situation which makes raising sheep easy and growing corn difficult, and the other who is in the reverse situation (p. 4). The first person will attach less value to sheep than to corn (the law of diminishing marginal returns in consumption); the reverse being true for the second person. However, the first will find it more expensive, in terms of sheep, to produce more corn (law of increasing marginal costs in production), and will therefore find it advantageous to exchange sheep for corn with the second person. Thus, the origins of exchange are seen in the concepts of the costs of production and satisfying wants.

Similarly, the origin of money is seen in exchange. The direct exchange of goods in the manner discussed above is only possible when both parties wish to exchange at the same time — there is a dual coincidence of wants (p. 5). In reality, Crockett notes, there are problems. Firstly, the person wanting corn in exchange for sheep must not only find someone who wishes to exchange at that time, but also someone who has corn and wants sheep. A situation may arise when the person who wants corn has to exchange his sheep for an intermediate commodity that the final exchange partner desires (pp. 5–6). This is extremely inconvenient, and Crockett suggests that one particular item will rapidly gain general acceptance as a 'vehicle commodity', and that the price of other commodities will be expressed in terms of that commodity, and holdings of that commodity will then represent future purchasing power (p. 6).

Crockett summarises the uses of vehicle commodities as follows (p. 6):

1. as a medium of exchange
2. as a unit of account
3. as a store of value
4. as a standard for future contacts

These functions of vehicle commodities are the well known functions of money often cited. Crockett (p. 7) then notes that many types of money have been used including cattle, ornaments and craftwork, and even cigarettes in prisoner of war camps.

Crockett then goes on to discuss the final function of money: as a means of payment (p. 7–8). He notes that the physical existence of money as an object is necessary in order to minimise the uncertainty of payment. He then proceeds to discuss the characteristics which enable a particular commodity to emerge as money. The primary characteristic of early money where no power exists to enforce a particular value, is that it must have some intrinsic value — a value-in-use. This could be as food, a tool, or an object which satisfies some psychological desire and must be scarce in the technical sense of their being insufficient to satisfy everyone's wants. Once the item is used as a vehicle commodity, however, it gains value-in-exchange which may exceed its value-in-use. An ideal vehicle commodity is durable, has a stable supply, and stable rate of demand, it needs to be homogeneous, divisible and portable (pp. 9–12). It is these ideal characteristics which are seen as the logic behind the dominance of precious metals as money.

This standard description of the origins and nature of money, ultimately derived from Adam Smith's *Wealth of Nations*, suffers from several weaknesses. The primary weakness is that the logical deduction of the origins of exchange is no more than that (Gregory 1982, p. 11). The diachronic perspective that archaeology could provide, or a comparative perspective from anthropology, is not considered. Although the use of the comparative method in social evolutionary studies has been long discredited (Sanderson 1990), the fact that exchange in many recent or existing societies did not function in the manner outlined surely casts strong doubt on the model presented. Indeed, the application of concepts such as the 'law of increasing marginal costs in production', part of neo-classical economic theory, are of doubtful use in their pure form in the analysis of non-capitalist societies.

In 1957 the landmark volume *Trade and Markets in the Early Empires* was published (Polanyi *et al.* 1957). This volume was the foundation of a new paradigm in economic anthropology (Dalton

1975), in which the substantive approach to the economy was defined by Polanyi (1957); a paper which is the ultimate origin of the so-called substantavist-formalist debate. This debate, often conducted in vituperative language, lasted almost twenty years (Plattner 1989). The arguments were not new and can be seen as a continuation of the contrast between the political economy and neo-classical paradigms within economics (Gregory & Altman 1989). The substantavist-formalist debate is of interest here because one facet of the argument was the nature of money, how it may be both defined and studied, and how it functioned in various societies. What follows is a brief outline of this debate, particularly those parts of that debate that relate to the concept of money.[3]

Polanyi argued that the word ‘economic’ had two meanings which had become compounded:

> The substantive meaning of economic derives from man’s dependence for his living upon nature and his fellows. It refers to the interchange with his natural and social environment, in so far as this results in supplying him with the means of material want satisfaction.
>
> The formal meaning of economic derives from the logical character of the means-ends relationship, as apparent in such words as “economical” or “economizing.” It refers to a definite situation of choice, namely, that between the different uses of means induced by a insufficiency of those means. . .
>
> The two root meanings. . . have nothing in common. The latter derives from logic, the former from fact. (Polanyi 1957, p. 243)

The uncompromising language with which Polanyi started his paper was to set the tone for the majority of the subsequent debate. Polanyi went on to argue that only the substantive approach to economics is “capable of yielding the concepts that are required. . . for an investigation of all the empirical economies of the past and the present” (Polanyi 1957, p. 244). He argued that formal economics, developed under a western European market system, was only capable of analysis within that system, and that the application of its analytical tools to non-western, non-capitalist societies, would result in a misunderstanding of those societies. Formal economics centres attention on the rational choice of the use of scarce means, be those means food, money, time, friendship, love or whatever, in the satisfaction of various, graded, wants. Polanyi points out that there can be choice without scarcity, and scarcity without choice (p. 246). He argues that formal economics concentrates on the price-making market and how that market integrates all aspects of the economy (p. 247), and how prices can be used in a series of “acts of economizing” in order to make rational choices about the uses of scarce means. He concludes:

> The relation between formal economics and the human economy is, in effect, contingent. Outside of a system of price-making markets economic analysis loses most of its relevance as a method of inquiry into the working of the community. (p. 247)

In contrast to this, the substantive concept “is the empirical economy” (p. 248). This was defined as “an instituted process of interaction between man and his environment, which results in a continuous supply of want satisfying material means.” Process was defined as the movement of material means either in location or ownership, which includes the production of those means. Social actions which form part of this process may be called economic, and institutions are concentrations of such

[3] Overviews of this debate can be found in Dalton (1975), Gregory & Altman (1989) and Plattner (1989), although the first reference is heavily biased in favour of substantavism.

activities (p. 249). The institutional aspects of the economy are of utmost importance, forming as they do a fundamental part of all societies and "vests that process with unity and stability".

> The human economy, then, is embedded and enmeshed in institutions, economic and noneconomic. The inclusion of the noneconomic is vital. For religion or government may be as important for the structure and functioning of the economy as monetary institutions or the availability of tools and machines themselves that lighten the toil of labor. (p. 247)

Polanyi then went on to define three major types of economic process: reciprocity, redistribution and exchange. These categories have gained quite wide acceptance in the literature although with inevitable additions and modifications. The first category of economic process had already been explored by Mauss (1990) and the study of gift exchanges has formed an important part of economic anthropology. Redistribution "designates appropriational movements toward a center and out of it again" whereas exchange requires price-making markets (p. 250).

After discussing these types of economy Polanyi gives the substantive definition of money:

> The substantive definition of money... is derived from definite uses to which quantifiable objects are put. These uses are payment, standard and exchange. Money, therefore, is defined here as quantifiable objects employed in any one or several of these uses (Polanyi 1957, p. 264).

This is contrasted with the "catallactic definition of money is that of means of indirect exchange" (p. 264). Polanyi gives primacy, especially in early communities, not to exchange, but to payment; a view supported strongly by Crump (1981). Polanyi sees the exchange use of money as being a relatively late development. Extensions to the meaning of money included the definition of money as a unit of measure (p. 265). Early money was seen as 'special purpose money' with different kinds of objects having different money uses.

The substantive definition of money was expanded by Dalton (1965) where he turned the question around. Rather than asking were cattle, goats or whatever ' "really", "money" ', he asked "how are the similarities and differences between such items and dollars related to similarities and differences in socio-economic structure?" (p. 45). Dalton expanded upon Polanyi's definition of western money as being "all purpose money" which can fulfil all money uses (p. 46). He showed how modern money can have non-commercial uses despite the inherently commercial description of money by formalist economists (p. 47), and how modern, all-purpose money could be used in all three types of process defined by Polanyi (1957): money collected as taxes is a redistributive process, money given as a birthday gift forms part of a reciprocal process (p. 47). The fact that most contemporary societies have elements of all processes was noted by Polanyi (1957). Davis (1992), for example, notes that in the late 1960s 4.3% of the UK consumer expenditure was on gifts.

In contrast Dalton (1965, p. 48ff.) argued that "primitive economies — *i.e.,* small-scale economies not integrated by market exchange" (p. 48) — had limited purpose money with different monetary objects being used to fulfil different functions. He argued that limited purpose money also exists in contemporary capitalist societies, but that its importance is less than in small-scale societies without general purpose money. Also, in small-scale economies, there is often little conscious control over money by the political authorities which must be a reflection of different economic systems (p. 49).

Dalton demonstrated that "the uncritical use of our general purpose money as the model of true money" (p. 51) would hinder the understanding of money in other societies by imposing upon it functions it did not perform. To illustrate the point he discussed at length the Rossel Island shell money system (pp. 52–59). In this case, the original ethnographer, Armstrong, had proposed that the shell-money was analogous to modern money, with different types of shell representing different denominations which he ranked 1–22, and that a basic form of interest on loans existed. Dalton effectively demonstrated that Armstong's analysis was incorrect. The Rossel Islanders had never ranked their shells in this way, and as far as Dalton could reconstruct from Armstrong's published evidence, there were in fact three groups of shells, each capable of performing different functions and *not* capable of performing the function of another group. Shells in groups 18–22, for example, were especially venerated treasure items used in exchanges linked to important social events.

Dalton summarised his arguments in five main points (pp. 59–61):

1. Anthropologists should not hesitate to define different types of money based on their function. The "money-ness" of these objects "consists in their being required means of (reciprocal or redistributive) payment".

2. Primitive 'money-*stuff*' need not be 'portable' and divisible, attributes often assigned to general purpose money. This is a reflection of their restricted functions.

3. Economists make the mistake of equating primitive money as a crude version of western all-purpose money, *i.e.*, a crude media of commercial exchange.

4. The interaction of western money and societies can lead to:

   (a) the use of special-purpose money in commercial transactions, especially with members of outside groups;

   (b) the use of general purpose money in rôles formerly fulfilled by special-purpose money.

5. That the quest for a single all-embracing definition of money hides the fact that money fulfils many different rôles, and that those differences are a reflection of the underlying social and economic organisation.

He finally concluded that:

> In sum, money has no definable essence apart from the uses money objects serve, and these depend upon the transactional modes that characterize each economy: as tangible item as well as abstract measure, "money is as money does" (p. 62).

Although this primary distinction between special-purpose and general purpose moneys was an important one, the argument that no further theorising about money was worthwhile was limiting. Codere (1968) examined the problem from a new angle. She argued that money should be seen as a symbolic system. As such, money-stuff is the physical realisation of those symbols, just as mathematicians use Σ as a symbol to represent 'the sum of.' The physical form of money is therefore related to its ability to fulfil its symbolic function. Although perhaps not impossible, a mathematician would find two-foot high Greek letters rather difficult to work with. Similarly, in the present

M-system	$\mathrm{M} \to \mathrm{G}_n$
MN-system	${}_n\mathrm{M} \to_n (\mathrm{G}_n)$
MNA-system	${}_n\mathrm{M} + \frac{\mathrm{M}}{n} \to_n (\mathrm{G}_n) + \frac{1}{n}(\mathrm{G}_n)$
MNAW-system	same as MNA system but practicable

KEY:
G = good(s)
M = money-stuff
N = number or counting system
A = amounts system or system of weights and measures
W = writing system
$\to$ = 'symbol for' or 'rewrite as' or 'exchanges for'
V = 'either–or'

Figure 2.1: Money as a symbolic system with co-ordinate subsystems. From Codere 1968.

context, the use of silver *denarii* in the Roman world reflects the function that these *denarii* would have fulfilled, which was presumably different from the function that the first, very large and heavy, *asses* would have fulfilled.

Codere went on to show that different types of money-system are linked to the development of other systems within society, namely good(s), money-stuff, a number or counting system, an amounts system or system of weights and measures, and a writing system. By combining these systems four possible money-subsystems are possible, to which should be added a money-less society. These were summarised in a diagram, reproduced here as Fig. 2.1.

The M-system is where a single money-stuff only symbolises, and can be exchanged for, a single good, or choice of good, but "*without any numerical or amounts quantifications*" (p. 563); Codere cites the *Kula* exchange ring as an example.

The MN-system is where the number system of a group has been applied to money-stuffs so that "multiples of the money-stuff in its natural unit can be exchanged for various multiples of good in their various units" (p. 563); Codere cites the example of the Yorok where a string of teeth could be used to buy, for example, a fishing place, or two strings two fishing places, or one fishing place of better quality.

The MNA-system is where the money exchange system reaches, in theory, its full symbolic powers where units of goods and units of money-stuff can be compared using arbitrary symbolic units which can, though need not be, physically represented by money-stuff, *cf.* the use of *sestertii* as a unit of account in the later Roman period long after the coin itself ceased to exist. Although this system is theoretically possible, it is limited by human cognition until a writing and recording system is available which forms the *MNAW-system* (pp. 564–565).

Codere also allowed for the existence of plural moneys where a society has more than one type of money. She argued that in this case it is likely that all the different moneys are likely to have the same symbolic system except at periods of rapid change or outside influence. She then compares her schema with a number of societies, including the Rossel Island example mentioned above, and with the development of money among the Kwakiutl. In the latter case an imported good, woollen blankets, became both a money-stuff and a unit of account. The numeral system was expanded to cope with the thousands of these blankets that were distributed at potlatches. Eventually, Canadian dollars replaced the use of blankets and other goods at these potlatches. Codere's final example, the Tiv, will be discussed further below (section 2.3.2).

Codere, therefore, presented a method of describing different types of money which whilst going beyond the strictures imposed by Dalton and Polanyi, were still firmly within the substantivist camp.

The substantavist attack on formalist economics was not left unanswered. Schneider's (1974) *Economic Man* is a representative example. In the first chapter of his book, Schneider contrasted and compared the two paradigms, but from the outset he misrepresented and ridiculed the substantive position. In his first example, that of a transaction at a local store, he stated that a substantavist would say that:

> The grocer gives food to the customer because he obligated to do so; it is a moral act. Any profiting from the transaction is a by-product (p. 3).

Although he immediately admitted that this example was inappropriate as it was drawn from a western, capitalist society, the very type of society that Polanyi and others stated formal economics was suited to study, he used it as a device to immediately lure the reader into a feeling of disbelief. He went on to claim that substantavism is relativistic and inductive whereas:

> ... formal technique is deductive, utilizing logic and laws of the mind—theory in the proper sense. Inductivism glorifies the particular, and Polanyi's claim that there are two meanings of economic—substantive and formal—merely confuses a science with its subject matter. (p. 8)

Schneider did, however, provide a useful overview of the three schools of formal economic anthropology, as he saw them. These schools were unified by a "partial or total acceptance of the cross-cultural applicability of formal theory" (p. 9). To simplify, the first school "were not really interested in formal thinking" but believed that economic relations "involved prestige and social position as well as material exchange" (p. 13); the second school, the materialists, applied formal theory in a traditional way to markets and transactions; and the third school attempted to extend formal theory to 'social exchanges.' This last school is perhaps the most interesting. It attempted to apply formal laws, such as maximisation, to exchanges of non-tangibles such as prestige, self-worth and happiness. Happiness, for example, is seen as a type of good which one attempts to obtain by deployment of one's scarce resources. Schneider later provides a more detailed overview of the work of this school (pp. 117–156). Theoretical considerations aside, the problem with this approach is the difficulty in applying the fundamentally quantitative methodology of neo-classical economics to problems with unquantifiable variables such as prestige.

Schneider provides an extended discussion on the subject of money (chapter 5), largely following that of Melitz (1970). Melitz's critique primarily concentrates on what he sees as the substantavists misunderstanding of western all-purpose money. Firstly, he argues that they conflate and confuse money as a unit of account and money as an object which is exchanged. Secondly, he argues that all-purpose modern moneys are in fact special purpose:

> First, our coins are *mainly limited* to the payment of petty sums. Otherwise, they are too cumbersome to carry and too time-consuming to count... Our paper currency is also *unsuitable*

> for payments above moderate levels—say not exceeding several hundred dollars in the United States... Also, all our currency, whether paper or coin, is *inconvenient* for mail payments. (Melitz 1970, p. 1022, emphases mine)

Here, Melitz misses the point: although it is *inconvenient* to pay a large sum in coin, it is not prohibited and there are no 'moral' overtones, as there would be, for example, if a Tiv managed to obtain brass rods in exchange for staples (see below). Melitz makes the valid point that our 'all-purpose' money cannot buy everything. For example, there are distinct moral overtones to the purchase of political office or sex in western societies (p. 1022).

After an account of the history and nature of money, Melitz "advocate[s] restricting the term [money] to media of exchange and means of payment and letting the unit of account stand for itself" (p. 1026), and "as goods held, in significant measure, for purposes of settling transactions" (p. 130). In discussing the application of monetary theory to primitive societies, Melitz makes the interesting observation that:

> If money is a means of economizing on transaction costs, as economists conceive, such a tie [monetary evolution to external trade] plainly follows, because in a primitive context little could magnify the significance of transaction costs as much as does contact with foreign cultures. (p. 1031)

The effects of contact with other cultures with their own money-stuff and their own money-uses is an important but difficult field for study. By definition, we are unable to study, in an ethnographic sense, cultures who have not been in contact with other money-using cultures.

One problem for Melitz is the presence of token moneys among "primitive societies with a narrow market base" (p. 1030). He resolves this in the following manner:

> We may define a money as token to the extent that its nonmonetary value is below its monetary one. Accordingly, a fully token money is worthless except as money. (Such a type of money is a limiting case rarely even approximated in primitive societies where token monies ordinarily possess substantial ceremonial or prestige value.) It follows then, on economic rationality assumptions, that all resources devoted to tokens or tokenness are entirely absorbed in improving the quality of monetary services... (p. 1031)

The confusion that Melitz sees between money as an object, and money as a unit of account, has its origin in the historical perception of money. Until very recent times, money-units either had to have a physical equivalent, or a recognised conversion rate into a physical equivalent, which had an 'intrinsic worth.' Galbraith (1995) illustrates how early attempts at paper currencies failed when public confidence in the issuers ability to convert notes to these physical equivalents, usually coins, was lost. The problem arises as to why anything has an 'intrinsic worth.' Schneider (1974, p. 163) neatly side-steps the problem by stating "the reason for the valuation is of no concern for economic analysis." I will return to the problem of value below.

By the early 1970s there was a growing dissatisfaction with the substantavist/formalist debate (*e.g.,* Panoff 1970). Sahlins, who was largely aligned with the substantavist camp, concluded his introduction to *Stone Age Economics* as follows:

> In the meantime, we cultivate our gardens, waiting to see if the gods will shower rain or, like those of certain New Guinea tribes, just urinate upon us. (Sahlins 1972, p. xiv)

Gregory & Altman (1989, p. 5) were to later argue that:

> At the centre of this debate [substantavist/formalist] is a distinction between 'theory' and 'empirical evidence': different protagonists argue the case for their particular theory on the grounds of applicability and explanatory power. But the distinctions that need to be drawn, we argue, are those between primary, secondary and tertiary methods of analysis, not those between 'formalist', 'substantavist', and 'neomarxist' theory.

The heart of the problem, I believe, is the relationship between data and theory, not between levels of data analysis. Substantavists work from data towards a theory, formalists work from theory towards data. The explanation why the schools do not meet in the middle lies in the fundamental foundations of economics:

> Truly important and significant hypotheses will be found to have 'assumptions' that are widely inaccurate descriptions of reality, and, in general, the more significant the theory, the more unrealistic the assumptions... To be important, therefore, a hypothesis must be descriptively false in its assumptions.' (Milton Friedman cited in Gregory & Altman 1989, p. 26)

By negating any necessity for the data to fit the theory, "neo-classical economists have rendered their paradigm virtually immune from empirically based criticism" (Gregory & Altman 1989, p. 26). *Principles of economics: some lies my teachers told me* (Boland 1992) presents a detailed critique by an economist of the neo-classical paradigm, especially the work of Alfred Marshall. The critique proceeds almost entirely on theoretical grounds with little or no reference to actual data.

We can see from this debate, therefore, that there is no consensus on how to define money, primarily because 'money' is not a static concept. As Hart (1986, p. 638) notes:

> If we want to make sense of such phenomena, it will not do to stick to a restrictive definition of money which explains more the preindustrial roots of modern civilisation than its continuing evolution and potentialities.

Similarly, however, we should avoid a teleological perspective such as that of Goldsmith (1987) who examines a series of historical periods looking for the first appearance of various monetary institutions defined in terms of what they later became.

In an investigation of money in past societies, it is obviously not productive to accept a particular definition of money and then to look for correlates of that definition and perhaps commit the error of "affirming the consequent" (Shennan 1993, p. 54). Money as a concept is defined by the society within which it operates, its functions are circumscribed by that society.

2.2.1 Value

A fundamental trait of money-stuff is that it is 'intrinsically valuable.' What, however, makes an item intrinsically valuable? The two main competing explanations are the labour theory of value and the utility theory of value; the former is essentially the Marxist standpoint, the latter the neo-classical economic view (Dobb 1973). It is not proposed to review these here.

As Appadurai (1986a) noted, however, a more useful examination of this problem is contained within the first chapter of Georg Simmel's *The Philosophy of Money* (originally published 1900, English translation 1990). Simmel rejected the idea that objects have a natural or inherent value:

> The value of objects, thoughts and events can never be inferred from their mere natural existence and content, and their ranking according to value diverges widely from their natural ordering. (p. 59)

He went on to state that:

> Value exists in our consciousness as a fact that can no more be altered than can reality itself. (p. 63)

He saw value as a measure of desire and stated that "we desire objects only if they are not immediately given to us for our use and enjoyment" (p. 66), and thus:

> Objects are not difficult to acquire because they are valuable, but we call those objects valuable that resist our desire to possess them. (p. 67)

Simmel believed that the question as to what value "really" is was unanswerable (p. 62). He went on to show, however, how money can act as a measure of value, and how that measure may initially have a physical manifestation which is valuable, but that this was not an inherent necessity of money. He predicted the development of money as a "mere symbol" which would be "neutral as regards its intrinsic value" (p. 152).

If we cannot usefully identify what value 'really is', we can make some observations about objects which have been regarded as valuable. Clark (1986) shows how objects and materials which have been valued vary from society to society. For example, gold, of highest value in the West, is not a traditionally sought after metal in Japanese culture. In recent years, however, the western tradition of wedding rings has become popular in Japan, but nine out of ten brides have platinum rings rather than gold. In China, jade was considered more valuable than gold or silver. A second observation from Clark's book is that often valuable materials and items come from outside the society that values them. To return to the example of China, there were no jade deposits within ancient China and this material had to be imported from Khotan and Yarkand, which are up to 3,600km. from some of the places where it was being worked. This last observation cannot be promoted to the status of a cross-cultural law, but it is a common phenomenon.

2.2.2 Gifts and commodities

In the above I have had occasion to refer to 'gift' exchange and to contrast this with commodity exchange. The literature on this subject is extensive and it would be inappropriate to do more than provide an outline of some of the main points.

Gregory (1982) provides us with a succinct overview:

> … gift exchange is an exchange of inalienable things between persons who are in a state of reciprocal dependence.
>
> … commodity exchange establishes a relationship between the objects exchanged, whereas gift exchange establishes a relationship between the subjects. In other words commodity exchange is a price-forming process, a system of purchase and sale. Gift exchange is not… An inalienable thing that is given away must be returned. Thus a gift creates a debt that has to be repaid…
>
> The gift economy, then, is a debt economy. The aim of the transactor in such an economy is to acquire as many gift-debtors as he possibly can and not to maximise profit, as in a commodity

> economy. What a gift transactor desires is the personal relationships that the exchange of gifts creates, not the things themselves.

Although the processes of gift exchange had been observed by early anthropologists such as Morgan, it was Mauss' *Essai sur le Don*, written in 1925, which drew the observations together into a theoretical framework (Mauss 1990). One of his main aims was to counter the prevalent concept of a natural economy which produced solely for consumption rather than exchange (Gregory 1982, p. 18). He demonstrated that not only was this not the case in contemporary 'primitive' societies, but also there is a great deal of evidence to show the existence of gift-based economies in historical contexts. Samson (1991a) discusses, for example, the rôle of gifts in Viking society as shown by the sagas, and Morris (1986) looks at the evidence for archaic Greece.

The term 'gift economy' masks, however, a large degree of variation both in form and function of gift exchanges. There is no consensus whether there is a continuum of variation between unreciprocated gifts, reciprocated gifts and commodity exchange, or whether they should be distinct classes. Davis (1992) has shown how gift exchanges in contemporary western society still act to define and mediate social relations, although perhaps on a lesser scale than some other recent and contemporary societies.

Although in many gift-based exchanges there is a moral obligation to return a gift, there are exceptions. Parry (1989) discusses an example where gifts of money are used to pass ones 'sin' onto a priest, and in this case it is absolutely imperative that the gift is not returned. The morality of money forms a complex topic both in western society (Frankel 1977) and in other cultures (Parry & Bloch 1989).

From an archaeological veiwpoint, two types of gift-exchange economy are of extreme interest. This first is the prestige goods economy, a model which has been applied, for example, to the Iron Age of south-western Germany (Frankenstein & Rowlands 1978). In this model the élite rulers of a group maintain their position of power by controlling access to prestige goods in two ways, by controlling the import and/or manufacture of those goods, and by controlling to whom they are given. The application of this model to the early Iron Age of southern Germany has been criticised by Gosden (1985) who sees the control of the means of production as being more significant.

The second type of economy is based upon the giving of gifts to gods (Gregory 1980; Bradley 1982). In competitive gift-economies each gift has to be reciprocated with a counter-gift, preferably one which is greater than the gift received. This can lead an ever increasing spiral in the size and complexity of the gifts and, according to Gregory, eventually to social instability. Conversely, the advantage of giving of a gift to a god is that it is not returned, and therefore there is no direct competition between the doner and the recipient. This model is particularly attractive to archaeologists as it has potentially recognisable archaeological correlates of which the deposits of rich finds such as the Battersea Shield in the Thames are a good example (Champion *et al.* 1984; Collis 1984). In this model there is still competition between members of the élite in terms of conspicuous consumption, but, again according to Gregory, the resultant competition can be more stable.

2.3 Some anthropological examples

Having examined the various theories of money and the economy, it would be useful to take a short look at some examples. There are many possibilities in the anthropological and historical literature which can act as informal analogy, in the sense defined in Chapter 1, and it would be inappropriate here to list them in great detail. I have, therefore, chosen three examples: cattle-as-money, the Tiv and the Huaulu.

2.3.1 Cattle as money

The concept of using livestock as a form of money, one which Crawford (1985) found so hard to accept, can be found in both historical and anthropological examples. In early Irish history, for example, the ransom paid for the release of Amhlaimh to Mathgamain Ua Raigain in AD 1029 contained some 1,200 cows as well as other items (Lucas 1937–1957). Perhaps the most widely known anthropological examples of cattle-as-money are those of central and eastern Africa (Neale 1976, pp. 41–44). Here they were used as payments from the groom's kin to the bride's kin as part of the marriage contract, as a means of paying compensation to prevent blood-feuds, and as a means of securing alliances. More recently they have been used for commercial payments.

As regards cattle in marriage contracts, though cattle were used as a unit of account the final payment could be in other items, such as goats. It is important to realise that the payment of bridewealth was *not* seen as buying a woman, but was conceptualised more along the lines of purchasing the rights to offspring, as a guarantee that the wife would stay with her husband, and as the symbolic formation of political alliances. The bridewealth was paid by the groom's kin, not the groom himself.

For murder or manslaughter compensation could be paid in cattle to prevent a blood-feud, although in some societies it would be possible to pay in advance (Neale 1976, pp. 42–3). Similar arrangements often existed for adultery.

The possession of cattle in these societies was a significant social marker. Wealthy persons, in Ireland as in Africa, would lend their cattle to inferiors who would look after them in exchange for milk, blood and a share of the offspring. The creditor would have the advantages that his cattle were looked after, and division of his herd would be a safeguard against disease. Primarily, however, it increased his social status by placing the borrower in a position of debt.

Cattle were, therefore, money in the sense that they were used as a standard of value and a means of payment. They were not usually used as a means of exchange; it "did not mean… I could sell sisters and daughters in order to acquire cattle with which to pay for my sadistic rampages" (Neale 1976, p. 44).

In the case of British central Africa, a lack of understanding of the rôle of cattle in the economy caused great suffering and hardship (Neale 1976, pp. 77–81). In the 19th century the area was conquered by colonial settlers from the west. The local Bantu had a social structure based on family and kinship within which cattle formed the primary status marker. The colonists required labour, but could not resort to slavery. Conversely, the Bantu had no use for western all-purpose money. The settlers tried to force Bantu males to perform waged labour by imposing a poll tax, but this was not very successful, and gradually more and more coercion was employed. What the settlers had failed to appreciate was that for the Bantu agriculture was woman's work, and Bantu males felt insulted at being required to farm. Eventually, the Bantu were forced to become part of the monetary economy but by that stage they were excluded from all but the lowest wage earning groups.

2.3.2 The Tiv

The Tiv (Bohannan 1959; Bohannan & Bohannan 1968) form one of the most discussed groups in the debate regarding money (*e.g.,* Codere 1968; Neale 1976). The reason for this is the combination of their relatively well-documented 'monetary' system and the impact of western all-purpose money on that system.

The economy of the Tiv was 'multicentric' (Bohannan 1959, p. 492), *i.e.*, an economy in which exchangeable goods fell into mutually exclusive spheres. In the case of the Tiv there were three such spheres. The first, called *yiagh*, was a subsistence sphere where everyday goods were exchanged at markets using barter. The second, prestige, sphere was called *shagba*. Within this sphere cattle, slaves, ritual 'offices', large white cloths called *tugudu*, medicines, magic and brass rods could be exchanged for each other (p. 493). These items never entered the market. Within the group, however, the 'price' of each item was measured in brass rods which became a type of all-purpose money but only within this sphere of exchange. This sphere of exchange was "tightly sealed off" from the subsistence sphere. The final supreme sphere was the exchange of human beings other than slaves, primarily rights in women. Within this sphere the only acceptable return for a woman was another woman, although there could be a time lag between the exchanges.

One aspect of this system is that there are moral overtones to exchanges: within a sphere exchange is morally neutral, between spheres exchanges "have a strong moral quality in their rationalization" (p. 496). To exchange upwards, from food to brass rods for example, is considered 'good', whereas to have to exchange downwards, from a ward to brass rods, is considered 'bad' (p. 497). Attempting to improve one's social status by upward exchanges was encouraged; wealth only in subsistence goods was scorned.

The brass rods were, therefore, a limited-purpose money within their sphere. They could not have formed a general purpose money as the value of a single brass rod was too great for most subsistence traders.

With the arrival of the British, a large number of changes occurred which resulted in the breakdown of this system. These changes included the imposition of peace which allowed movement around the country in safety, the linking of the Tiv economy to the wider economy, the introduction of western multipurpose money, and eventually the banning of exchange marriages. Bohannan (1959, p. 500) believed that "no single factor has been so important, however, as the introduction of multi-purpose money." He argued that money formed a "common denominator" between all spheres, even acting as a unit of value in subsistence barter transactions. The introduction of multi-purpose money led to the breakdown of the spheres of exchange, and to the traditional social structure. He concluded:

> Money is one of the shatteringly simplifying ideas of all time, and like any other new and compelling idea, it creates its own revolution. (p. 503)

In an important paper, Kopytoff (1986) examined the concept of spheres of exchange in relation to the concept of commodities. He defined a commodity as:

> A commodity is a thing that has a use value and that can be exchanged in a discrete transaction for a counterpart, the very fact of exchange indicating that the counterpart has, in the immediate context, an equivalent value.

One problem with commodities is how one measures their value given that they encompass all exchangeable items. Kopytoff argues (pp. 72–3) that the Tiv spheres were a mechanism which simplified the process of valuation by subdividing commodities into separate groups with common traits: subsistence items created by labour, prestige items gained by "social manoeuvring", and finally the intimate rights in women. The introduction of multi-purpose money caused a "drive towards commoditization" where the various spheres were no longer separated as a result of the improved exchange technology that western money represented.

The concept that 'money', that is multi-purpose money, can cause change in societies has been strongly challenged by Bloch & Parry (1989). In the case of the Tiv they argued that the introduction of money by itself was insufficient to cause the changes observed. For example, the destruction of exchange marriage cannot be assigned to money, but to British legislation. Although this legislation may have been unpopular with the lineage elders, who lost their mechanism of control over young men, it was popular with the young males who could now negotiate marriage contracts on their own behalf using either brass rods or money.

Bloch & Parry (1989, p. 16) argued that the 'drive towards commoditization' that Kopytoff (1986) believed was inherent in every economy, was not restricted by the available exchange technology, but by changes in exchange relations. In the case of the Tiv, these changes were brought about by the British annexation of the area which introduced a variety of new exchange situations, such as taxation in cash, which were *accompanied* by the introduction of multi-purpose money; the changes were not caused by money *per se*. In support of this contention the case of the Bantu noted above exemplifies the rôle of money: money in itself could not cause Bantu males to farm for they had no use for it. Only by coercion, initially in the form of taxes, did they enter the 'monetary economy.'

2.3.3 The Huaulu

The Huaulu of Seram have an extremely complicated process for 'giving' and 'taking' wives in which they speak of 'buying' wives but not 'selling' them (Valeri 1994). They compare prices of wives, and complain of their 'priceyness', but never talk of selling wives except as a deliberate insult to the wife-givers. This use of language contrasts strongly with the accepted anthropological view that bridewealth payments do not represent 'sale' as the woman 'purchased' cannot be alienated to a third party, at least without reference to her kin. Valeri's paper is an attempt to examine this paradox, and in the process makes some important observations about commodity and gift exchange.

Huaulu society is divided into units called *ipae*, usually translated as 'houses.' Relations between members of Huaulu society are also classed as either between 'non-others' (*lelakisi*) and 'others' (*lelaki*), non-others being primarily members of the same house, and houses in a sibling relationship. Exchanges between non-others is a non-reciprocal gift exchange; to expect a return from a non-other is to turn the relationship between the transactors into one of otherness:

> In sum, to some extent the form of give-and-take is self-fulfilling: it makes the relationship and is not just made by it. (Valeri 1994, p. 7)

Gifts between non-others are usually perishables such as food-stuffs, gifts between others are usually durables such as antique plates or armshells.

Within this system the giving-and-taking of wives is an complicated and long-drawn out process which encompasses aspects both of exchange between others and between non-others. Often the two houses involved in the exchange are initially in a friendly 'joking' relationship (*i akariki*). Once a house decides to ask for a wife, this relationship becomes one strictly of non-otherness. After some negotiation, the wife may be declared off-limits to other potential spouses after an exchange where the wife-takers give antique plates, and the wife-givers give armshells. At the next stage a further exchange takes place where the wife-givers are expected to give rare and valuable strings of glass beads for which they receive small value, usually commercially bought items such as sarongs. After this stage the groom transfers residence to the wife's house. After a period, which may be some years, a further exchange takes place between the two houses at which point the groom, his wife, and probably his children return to his father's house. This last exchange is often a large, public and vociferous affair where the wife-givers insist that they are paid in antique plates, but as soon as they are paid they reciprocate with armshells. At these meetings many other Huaulu, often not related to either of the houses, will arrive and conduct exchanges with others usually for armshells and plates. The whole rite is likened to a market with the collateral exchanges taking place not to 'honour' the alliance, but for personal motives.

At most stages of this process, however, store-bought items and cash are also given and received although they are *not* included in the price of the wife:

> The payment of store-bought items, and even more of cash is often not considered worth mentioning. (p. 14)

Recently, the increasing scarceness of plates caused by the purchase of them by outside antique dealers is leading to an increasing use of cash in these prestations, and make the transactions more like commodity exchange than gift.

The whole process of gift and counter-gift, payment and negotiation never really ceases with relatives from allied houses. The complexities of the balance between the value of the items exchange need not concern us here, what is more important is the mixture of exchanges which are superficially commodity exchanges, unreciprocated and reciprocated gifts. There is no clear division between the two types; nor, Valeri argues, do they represent two poles of a continuum. The objects exchanged are conceptualised as a means of payment for the taking-and-giving of a wife, but the reciprocation of shells for plates is justified as a means of ensuring that the wife-takers will give more plates when they are needed. The process of wife giving-and-taking is primarily concerned with the creation and maintenance of alliances between houses:

> Huaulu marriage exchanges use a property of the monetary or quasi-monetary signs which they employ—namely, the fact that they embody abstract value—for their own symbolic purposes. By reducing the individual women married at each generation by the men of the house to (ideally) the same sum of quantitative value, they do not simply begin as commodity exchange with what must be terminated with a gift, but signify the equivalence of all those women as expressions of the same alliance, itself identified with a specific value. (p. 19)

Ultimately, the whole process of 'buying but not selling' wives is a process of creating and maintaining alliances between houses. Within this process gift and commodity exchange are bound in a complex dialectic which challenges the simple opposition identified in economic anthropology.

2.3.4 Summary

A number of lessons can be learnt from these examples.

1. The huge variety of ways that social relations are mediated through exchange should warn us against simplistic arguments as to function of value items in past societies. To characterise the complexities of gift-exchange as 'differences of fashion' and 'throwing silver around' does not do justice to the sophistication that can be obtained.

2. The presence of coinage does not require one to infer the presence of multi-purpose money used in market transactions. Limited purpose moneys can take a variety of forms, and coinage is only one of them. Coinage, or even banknotes, can be used as a limited-purpose money, and in gift exchange (*e.g.,* Gregory 1982).

3. The introduction of a form of multi-purpose money cannot, of itself, create changes in social relations. These changes are more often the result of other factors, such as a change in political domination, which accompany the arrival of multi-purpose money. It has been suggested that in Roman Britain the embedded late Iron Age economy survived in some form until the third century AD (Hodder 1979; Reece 1979).

4. Imposed multi-purpose money may only be used as a limited purpose money. For example, in some peasant societies the only coinage needed was that to pay rent or taxes. In 19th Ireland households would raise a pig each year in order to sell it to raise cash to pay their rent (Watson forthcoming).

5. Maintenance or improving social status and position may not only be managed through the possession and display of value items, but often also through giving them away, disposing or destroying them, or by controlling access to them by other groups (Bradley 1982; Gregory 1980; Gregory 1982; Rowlands 1980).

6. Gift and commodity exchange are ideal theoretical types; empirically observed economies are more ambiguous in their categorisation of types of exchange. It is possible, as in the case

> of the Huaulu for example, to obtain value items through commodity exchange expressly for the purpose of use in gift exchange. Exchanges may take place with one expressed aim, but perform another more long term function. To take a contemporary example from western society, birthday presents are given with an expressed altruistic motive. However, the giving of birthday presents act to cement relationships. Conversely, failure by the recipient to give a present in return at the appropriate time can lead to a weakening, or even dissolution of those relationships (Davis 1992).[4]

In the above discussions, I have shown how the concept of money is deceptively simple, and how it is not a static phenomenon but one which is constantly developing and mutating. I have also shown the value of looking at the use of money in other cultures, and will go on to use the insights gained here later in this thesis.

2.4 The ancient economy

The use of anthropological perspectives is not new to archaeology, although different parts of the discipline have made varying degrees of use of the material. Prehistory has been at the forefront of the use of anthropologically derived models, but medieval studies have also seen their application (*e.g.,* various papers in Samson 1991b). In Roman archaeology the use of such models has been more limited although by no means unknown (Hodder 1979). Similarly, theories of money have not been entirely ignored either in prehistoric contexts (*e.g.,* Ottaway & Strahm 1975), or within Roman period studies (*e.g.,* Crawford 1970).

The problems, debates and examples outlined above may seem peripheral the study of the Ancient Economy, especially if that economy is defined, as Finley (1985, pp. 27–34) does, as the Graeco-Roman mediterranean world. When, however, we consider that Rome came into contact with, or conquered, large areas which were not directly part of that world, and that the apparent homogeneity of material culture may actually be more illusory than real, then the use of models and perspectives from outside the classical world can contribute usefully to the discussion. In the case of Dacia, discussed in detail in Part III, we have an Iron Age society on the periphery of the Graeco-Roman world for some considerable time which enthusiastically adopted Roman silver *denarii* for its own purposes. An explanation of this phenomenon which uses these perspectives, such as that presented in Part III, would be richer than a simplistic examination in terms of the the stark gift:non-money::market:money debate.

Roman *denarii* were, however, made within 'the Ancient Economy', and the majority of the data analysed in Part II comes from that world. The aims of most of those analyses are, however, limited to an examination of hoard formation processes, and the pattern of supply, distribution and loss. Apart from the contribution to the debate concerning the validity of one small part of the Hopkins' (1980) model for taxes and trade, the results of the analyses are not discussed in detail

[4]This is a substantavist/functionalist interpretation of the rôle of birthday presents. 'Social exchange' theorists would no doubt see the exchange as some form of maximising strategy.

here in terms of the wider debate concerning the Ancient Economy. However, the results could be used to contribute to the current debate.

An excellent overview of some of the current topics within the field have been provided by Harris (1993). Whilst I disagree with his ultimate conclusions, Greene (1986) provides a useful overview of the debate concerning the use of money in the Roman economy, as well as many other topics. Love (1991) has attempted to use the work of Max Weber to examine the Ancient Economy, primarily in terms of what he has termed 'institutional capitalism.' *Structure and Scale in the Roman Economy* (Duncan-Jones 1990) contains a series of essays on various themes including a discussion of Hopkins' *Taxes and Trade* model (Hopkins 1980).

Within the field of monetary studies there are three major but inter-related debates: money for payment only, or money as a means of exchange; the relative monetization of different areas and at different periods; and the 'integration' of the Roman economy. The first debate largely concerns Crawford's (1970) hypothesis that coinage was produced by the state solely for the purpose of state payments and with no regard for trade or commerce, and that coinage was little used outside of the cities. This has been criticised by various authors: Millar (1981) attacks it on the grounds of the evidence of Apuleius' *Golden Ass*; Howgego (1990, 1992) on the basis of other aspects of the literary and numismatic evidence.

The second debate concerning the relative monetization of the economy of various regions has generally been hampered by a lack of definition. Both Creighton (1992a) and Duncan-Jones (1987) have approached the problem through attempting to analyse differences in the speed of coin circulation. Walker (1988) approached the problem by estimating the size of the coinage pool in Roman Britain and certain periods, and then comparing those figures to estimates of the size of the population. This latter piece of work has been strongly criticised by Buttrey (1993); the former two will be reviewed in the next chapter.

Recently, a debate has started over the 'integration' of the Roman economy. Duncan-Jones' publications over the last nine years have been working towards the conclusion that the Roman economy was not an integrated whole, but a series of localised cells. International trade and exchange is seen as relatively unimportant; this view has been challenged by Howgego (1994). To a certain extent, this debate is rather hampered by what the term 'integration' actually means, and what level of inter-regional exchange there has to be to be 'integrated.'

In my opinion, many of the contributions to these debates are weakened by a lack of regional or temporal specificity. Although there is, as Finley argues, much to link the various parts of the Graeco-Roman world together in terms of a common heritage and a basic cultural understanding, this can obscure important regional and temporal differences.

The analyses presented in Part II provide a positive contribution to a small facet of the Hopkins model, and a negative but important contribution the the analysis of the speed of circulation. The identification and description of patterns in the hoard evidence form an explicit and firm foundation for any discussion concerning patterns of supply and loss in the Republican period. The cluster analysis enables cross-period and regional comparisons. The Italian pattern can now be used as a baseline for the comparison of assemblages, and as a model for the working of a continuous input-output system. However, each regional pattern has to be understood in terms of the wider archaeological picture, as I have attempted to show in Part III.

Chapter 3

Statistical and numerical approaches to the study of ancient coinage

3.1 Introduction

Ancient coinage, and Roman Republican coinage in particular, has been a topic for scholarly attention for at least 150, if not 200 years. This chapter could not realistically hope to review all this material, and therefore it concentrates on papers which either have contributed to the methodology of the analysis of coin assemblages, or papers which make observations, or discuss topics, relevant to the analytical part of this thesis. This chapter has, therefore, a number of aims:

- to provide an overview of the development of some aspects of the study of coinage, hoards and assemblages;
- to provide a background to some of the debates examined in Part II;
- to identify and illustrate some of the problems and pitfalls in the analysis of hoards and assemblages;
- to note and discuss some of the important observations which have been made.

The papers reviewed below were chosen with these aims in mind, and in some cases alternative papers could have been discussed. What follows has, on the whole, been arranged by author, although some attempt to link themes has been made. A entirely thematic approach was rejected as some works cover many more than one theme, but would be difficult and undesirable to divide up (*e.g.*, Creighton 1992a), and because this structure allows the illustration of the chronological development of ideas of particular authors, especially Reece (see section 3.4). Where necessary, I have provided cross-references between the various sections. Where I have been critical of any particular work, the criticisms are aimed at illustrating problems, either statistical or numismatic, in order that solutions to these problems can be sought. Other reviews of interest are given by Metcalf (1981), Volk (1986), Ryan (1988, Chapter 1) and Reece (1994).

3.2 Thordeman and the structure of hoards

Thordeman's (1948) paper is an extremely important landmark in the analysis of coin hoards, not only for its relatively early date, but also for the importance and influence of its conclusions.

In 1937 workmen in Stockholm uncovered a hoard of silver coins and objects weighing some 443lb., which has become known as the Lohe hoard after the family who deposited it. The latest coin in the hoard dated to *c.* 1741. After a discussion of the reasons for hoarding in various societies and the correlation of peaks of hoarding with periods of uncertainty, unrest or war (pp. 191–196), Thordeman dates the hoard to 1743, the date of a serious uprising in Stockholm following reverses in the war against Russia (p. 196).

The hoard consisted almost entirely of silver marks of various denominations, and some courant and öre pieces for the period 1738–1741 when production of the mark was suspended (p. 197). Thordeman was curious to discover why the representation of different years of issue varied in the hoard and decided to plot the numbers of coins in the hoards (expressed in marks) against the output from the mint, for which records survive. A high level of agreement was found (p. 198 & Fig. A). Thordeman produced a second graph where the figures for both the mint and the hoard were expressed as a percentage of the largest year (Fig. B) and then the deviation of the find curve from the mint curve by using the mint curve as the abscissa (Fig. C). In doing this he confirmed the general agreement between the two curves, but also showed that the oldest coin in the hoard tended to be under-represented and the newest coin tended to be over-represented (pp. 198–9). This is what would be expected as the oldest coins would have had longer to be lost, exported or melted down than the newest coins. Thordeman then calculated the rate of loss by expressing the "difference between the two curves year by year in percentage of the higher of the two figures" from which he constructed his Figs. D and E, and estimated the average loss rate of coinage at 2% *per annum* (p. 199). He noted that there was still some residual variation (Fig. E) which is either due to chance or to historical and economic factors which might have caused small scale fluctuations in the loss rate.

To confirm the principle that hoards can represent coins as struck, Thordeman examined a further 30 hoards, although he presented the results from only one, the Hakarp (Småland) hoard, and found that in all cases "the agreement was better than I could image one had a right to expect" (pp. 200–201). He noted that this general principle had long been known, but that the precise nature of it had not been demonstrated, nor had its possible accuracy been appreciated. Thordeman suggested that one could estimate the size of issues where the mint figures were missing from hoard finds (pp. 203–4).

An important point which is implicit in Thordeman's paper is that hoards are often a partially random sample of coins in the coinage pool. I use the term 'partially' because many hoards only contain one denomination, and the hoard is in fact only a random sample of that denomination. In the case of the Lohe hoard, only marks were hoarded, with a few öre and courants for the last three years when marks were not struck, whereas other types of money such as plate money, paper money and copper coins, were in circulation. In the *corpus* of Roman Republican coin hoards which will be examined in Part II, the majority of the hoards available for analysis were composed entirely of *denarii*, the main silver coin of the period, despite there also being available silver *quinarii*, bronze denominations and, especially in the later period, gold *aurei*.

3.3 Volk's re-examination of 'Thordeman's Law'

In an expansive paper, Volk (1987) re-examines Thordeman's work discussed above, and then attempts to apply the insights gained to the Roman Republican series. Here, I will only extract a few of the more interesting points.

Volk (pp. 144–5) noted a possible bias in Thordeman's analysis in that the figures that were compared were not counts of coins, but the value of coins expressed in marks. This was because the mint records Thordeman used do not state the quantity of coin, but the value of the coin struck. As a rule, Volk noted, different denominations fall out of circulation at different rates. In this case, I would argue, differences between the high-value silver 1-, 2- and 4-mark pieces are likely to be minimal, but as a general point this should be noted.

Volk discussed the possible 'sinks' (places of loss from the coinage pool) for coinage (pp. 147–149), and the differential rates of coin loss for different denominations with value, size and function all being important (pp. 149–151). For example, the 20th century UK sixpence appeared to 'waste' at about 2.1% *per annum* compared to 0.9% for the half-crown worth five times more. The shilling, however, had a low loss-rate due to its use in gas and electricity meters which resulted in many coins being effectively stored in hoards, and thus involved in fewer transactions, than other denominations (see also Cole 1981).

Volk went on to show (pp. 151–154) how there are exceptions to the gradual, even loss rate seen in the Lohe hoard, but these are often explicable: the low loss rate for the 50-cent piece during the Depression, the high loss rate of pennies in the UK from 1949–1953 due to official recall of those coins, and the pattern of survival of 19th century gold sovereigns. The phenomenon of new coins, or coins of new monarchs, being kept as souvenirs also affects the loss rate. However, despite these variations, a general trend is often observed.

Volk noted that the structure of a particular coinage system may also effect the loss rate because certain types of coin may have a specific function (pp. 155–158). For example, the Swedish *riksdaler*, a coin contemporary with the marks in the Lohe hoard, is not found extensively in domestic hoards as it was a coin primarily designed for international commerce. Volk then questioned whether certain unusual characteristics of the Lohe hoard make it suitable for the construction of a general 'paradigm' (pp. 158–165). These are the completeness of the recovery of the hoard which is rare, its size, especially in relation to the mint output, and the circumstances of the hoard's collection and deposition — it seems fairly clear that the hoard does not represent a single withdrawal from the coinage pool, but a savings hoard collected over an unknown period of time.

Volk applied Thordeman's method to the Heligholm and Stenisholm finds (pp. 165–166). In the latter case, although there was a general agreement between the mint output and the hoard, the deviations are not consistent and do not form the pattern shown by the Lohe hoard. He concluded that the Lohe hoard cannot be used as a general circulation model.

Part II of Volk's paper was an examination of the Roman Republican evidence. This started with a detailed consideration of the manner in which Crawford derived his die estimates (pp. 167–169), which will discussed further below (section 3.13.4) and in Chapter 11.

Volk then discussed (p. 169–173) whether three hoards from Spain 'fit' the pattern of emission suggested by (Crawford 1974). Although there was some agreement between the two, the pattern was not very clear and was somewhat erratic. This analysis, however, suffered from a major problem. The hoards, if they do represent the coinage pool from the period when they were collected, will represent the coinage pool in the Iberian peninsula. They are being compared to coin production estimates largely based on Italian evidence and not including any Iberian peninsula material. The analyses presented in Chapter 8 below clearly show that the supply of coinage to the Iberian peninsula was erratic. For example, the period 61–47 BC is under-represented in the Fuente de Cantos hoard (Fig. 10c, p. 213), whereas the issue for 46 BC is over-represented. My analyses suggest that there was little coinage being sent to the Iberian peninsula in the 60s–50s BC; the main coin issue of 46 BC was struck in Spain leading to a high representation of that issue in hoards from there (*e.g.*, see section 8.3.14, page 211). If one wishes to compare Crawford's estimated output with coin hoards, this should be done in the area which shows fewest distortions due to erratic supply, *i.e.*, Italy (*cf.* Chapter 11).

Volk then looked at the representation of individual issues and here he makes perhaps his most important observation. Reworking Thordeman's figures for the Scania hoards, Volk noted that "it appears that it is volume of output rather than length of circulation that offers the best correlation with the spread of an issue's score" (p. 174). He identified the same pattern in the Roman Republican evidence (pp. 174–5). This feature of hoard structure will be discussed fully and explained in Chapter 9.

Volk then examined the last source of bias in Crawford's die estimates, the fact that the 24 hoards used have an uneven chronological and geographical distribution (pp. 175–178), but could not suggest how this could be avoided. Volk then went on to examine the differential survival of coins in the 24 hoards compared to die counts (pp. 178–187). These differential survivals could be the result of:

- different lengths of circulation (especially for the older coinage);
- dilution of the coinage pool, *i.e.*, the coinage pool is growing;
- accelerated wastage due to:
  - differential fineness[1] (see section 3.6 below);
  - export, *e.g.*, to Romania;
  - official withdrawals (for which there is no real evidence under the Republic).

In this discussion, Volk asserts that the most likely average waste-rate for the Roman Republic is between 2.75% and 3% (p. 181).

He concluded (pp. 187–189) by stating that although Crawford's estimates may ultimately be shown to be incorrect, the debate they have generated has been valuable, and may ultimately lead

[1] Note that the metallurgical analyses presented in section 14.4.3 do not support the idea that the issues of 88–87 BC were debased.

to more accurate models of coinage supply and circulation, and that the way forward lies in the construction of databases of material which will enable fast and accurate analyses to be performed.

The value of Volk's paper lies in the wide-ranging discussion of possible influences on hoard structure and the representativeness of individual hoards. His most valuable observation concerning the variability of individual issues would have merited a more detailed examination, and perhaps separate publication. Had this been done it might have prevented problems encountered in, for example, Creighton (1992a) discussed below. His belief that the way forward lay in the construction of large databases has been, I believe, vindicated in Part II of this thesis.[2]

3.4 Reece and the analysis of hoards and assemblages

Reece's work, spanning thirty years, is perhaps the most prolific source of numerical approaches to the study of ancient coinage, and forms the original inspiration for the current work. Only a small selection of his work has been chosen for review. Much of it is drawn together in *Coinage in Roman Britain* (1987a). His approach to archaeology, particularly Roman Britain and including coinage, can be found in *My Roman Britain* (1988c). Of papers not reviewed here, Reece (1987c) presents some thoughts on the nature of archaeology, especially archaeological method, Reece (1988b) presents some interesting comments on the interpretation of hoards, and Reece (1988e) provides an extremely useful overview of the development of the Roman monetary system.

3.4.1 Numerical aspects of Roman coin hoards in Britain

Numerical Aspects (Reece 1974b) was later reprinted with an afterword (Reece 1988d); here I will use page references from the latter publication.

Reece initially discussed hoards of silver *denarii* from Roman Britain. Firstly he looked at hoards dating to Septimus Severus. He illustrated the 'structure' of the coin hoards by dividing their contents into periods (*e.g.*, Republic, Nero, Galba/Otho/Vitellius, *etc.*), calculating the percentages, and then plotting the results on a scattergram.[3] From this he noted two points (pp. 86–90):

- There appears to be a 'normal' hoard — all the hoards are similar in most respects.
- The period at which greatest variation occurs is the last period (for these hoards, the Severan period).

These were important observations about the structure of hoards which were later also observed in Republican hoards and investigated by Lockyear (1989, 1991, see section 3.5 below).

Reece then went on to show how the proportion that a new issue forms in hoards tends to increase gradually at first so that the peak abundance often occurs sometime after initial issue date, and then declines with time — a phenomenon noted elsewhere in the analysis of archaeological finds and usually called a battleship curve. He illustrated this with coins from Antoninus Pius in

[2] Subsequent to writing, Terrence Volk kindly bought my attention to a further paper (Volk 1994) which uses the Thordeman method to compare hoards from Italy and Spain.

[3] Lockyear 1989, 1991 also used this type of graph.

hoards from AD 138–268 (pp. 90–1, *cf.* Fig. 9.7, p. 277 below). The exception to this pattern is the Republican series (pp. 91–94), which although declining gradually in abundance from Claudius to Nerva, declined rapidly under Trajan and Hadrian, and only formed a very small percentage, if anything, of hoards from Antoninus Pius on. This is clear evidence of the deliberate removal of Republican coins by the state under Trajan, as is suggested by Cassius Dio and the so-called 'restored' Republican coin types issued by Trajan. There is also a suggestion that at the time these coins were being removed by the state, hoarders also preferentially selected these coins due to their relatively high fineness.

Reece then looked at early bronze coin hoards and concluded that "up to the end of the second century new bronze coinage reached Britain with little delay" (p. 94). A more detailed examination of eight hoards from after AD 240, however, suggested that "bronze coinage in third-century Britain was made up of a majority of old and worn coins. . . " (p. 95) and Reece went on to suggest that worn Hadrianic *sestertii* found on sites were probably lost in the mid-third century (p. 96).

Finally, Reece examined late bronze hoards (pp. 96–100). Again, late hoards (post AD 388) can be seen to follow a pattern and a 'normal' hoard structure can be identified, largely consisting of the latest Theodosian coins, often in excess of 80% of the hoard total. As these Theodosian coins are the last to be supplied to Britain, and they form such a large proportion of the hoards, Reece suggested that many of these hoards are deposited after AD 402, perhaps as late as 425 (p. 97).

Of the many insights provided by this paper, the identification of where in a hoard's structure maximum variation is likely to occur was an important observation, and one which led to further work (see Chapter 9).

3.4.2 Analysing coin assemblages I — ratio based methods

From 1965–1970 Reece undertook the collection of data from a number of continental museums and sites (Reece 1967; 1971, 1972a), and along with fourteen sites from Roman Britain (Reece 1972b), produced a detailed analysis (Reece 1973). *Clustering of coin finds* (Reece 1974a, reprinted 1988a) was an extension of that analysis which presented a simple but effective method for clustering coin assemblages. A simpler variant of this technique subsequently appeared in a number of other publications (*e.g.,* Reece 1979; 1980; 1983; 1984).

The first stage of the method was the division of the lists into 21 periods — these periods continue to be used by Reece and others, with occasional minor modifications. These 21 periods were then further aggregated into four main phases. Phase A contains all coins up to AD 259, phase B AD 259–294, phase C AD 294–330 and phase D from AD 330–402. The simpler (and later) method was to plot the percentage of one phase against the percentage of another phase (*e.g.,* Reece 1984, Fig. 1, p. 12). By plotting phase B against phase D it was possible to divide British site lists into two main groups: Group I contained most of the major towns and Group II contained military, religious and rural sites. Group I sites had roughly equal numbers of phase B and D coins whereas Group II had up to three times more phase D coins than phase B (Reece 1984, p. 11). This division has been confirmed by later work, to the extent that Reece now talks of good towns (those that follow the pattern) and bad towns (those that do not; Reece 1993). Fig. 3.1 plots phases B against D for lists published in *140 sites* (Reece 1991b). The pattern is less clear than in graphs of less data published

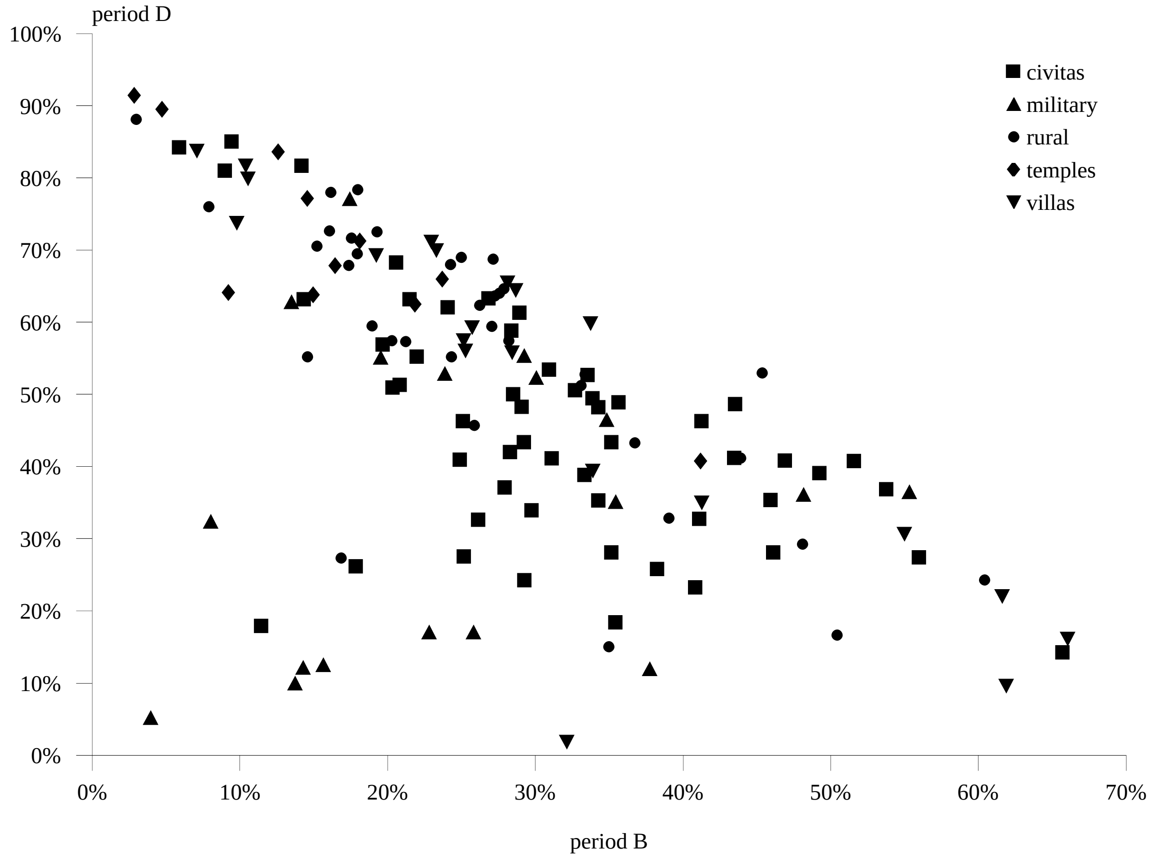


Figure 3.1: Scattergram of Reece period B (AD 259–294) *v*. Reece period D (AD 330–402) for 140 sites from Roman Britain. Data and site classification taken from Reece (1991b).

by Reece. Reece also experimented with triangular graphs where one axis represented period A, the second B and the last C and D (Reece 1987b, Fig. 7). This again showed differences between major Romano-British towns and continental towns, with the exception of Colchester Culver Street which had an abnormally high proportion of phase A coins.

The earlier, and slightly more complex method, plotted the deviation of the percentages from an average rather than the percentages directly (Reece 1988a). In this case, this was either a British average or a European average, dependent on the sites being examined. Most of the plots for the British data showed the two main groups noted above, with occasional outliers. Similarly, continental evidence usually showed clear groups. The exceptions, in both cases, were when phase C was used in the plots — this phase of coinage masked any groupings. Finally, both British and continental sites were plotted on one diagram comparing phases A and D. This clearly showed regional groupings, and divisions within regional groupings. Later papers, with more material, showed that within these groupings there can be less clear trends. For example, a plot of phases B against D, clearly showed the town–rural divide noted above (Reece 1980, Fig. 6.3, p. 121). However, a close re-examination of the 'rural' category also showed a *tendency* for temple sites to have a higher proportion of phase D coins than smaller towns and rural settlements, although I must emphasise this is no more than a tendency. This is in agreement with the Principal Components Analysis performed by Ryan (1988) discussed below, section 3.11.

The importance of this work is that it has clearly demonstrated that there is a definite ‘normal’ British pattern of coin loss, a fact also noted by Casey (1974). The British pattern stands in contrast to the continental pattern, which can also be divided into smaller regional groups. The British pattern can also be divided into clusters which partly correspond to certain types of site. The method used proved to be simple, effective and enduring and continues to be used by other authors (*e.g.,* Davies & Gregory 1991, pp. 75–6, Fig. 5 & Table 3, p. 101).

3.4.3 Britain and the continent

As already noted above, Reece had shown that by using the four major periods and simple plots of ratios, British site lists could be seen as distinctive from continental lists. A second observation, first noted in 1973 (Reece 1973), and expanded upon in *Clustering* (Reece 1974a), and then discussed in some depth in *Coinage in Roman Britain* (Reece 1987a, chapter 6), concerns this variation between Britain and the continental and Mediterranean pattern. Put succinctly, Britain has a very low proportion coins of phase A (up to 259) when compared to other regions. Britain also has a high proportion of coins of phase D (330–402) even if phase A is omitted from the calculations (Reece 1988a). Taking this further, Reece demonstrates that the rate of loss on a ‘normal’ Italian site, such as Rome, is roughly constant over time, whereas the loss rate on Romano-British sites is very low until *c.* 275 (Reece 1987a, Fig. 6.1, *cf.* Fig. 6.2). Furthermore, some continental sites on the periphery of the Empire, such as Conimbriga in Portugal, fit much better with the British pattern than the Mediterranean (Reece 1979, *cf.* Figs. 4–6).

Reece interprets this pattern as perhaps reflecting the degree of monetization of these areas and states:

> The habits of coin using, or else the establishment of a market economy as opposed to an exchange system more dependent on social structure, travelled only slowly so that it was not until the third century that centre and periphery seem to use coins in the same way. (Reece 1982, p. 343)

This is an extremely important observation with consequences for the current work. If coin use in areas such as Portugal was substantially different from core areas of the Empire until the third century, we must assume that there were differences prior to this including areas which could be seen as core under the Empire, but peripheral under the Republic, such as the mediterranean parts of Spain. Also, I would also argue that this places a constraint on the usefulness of texts relating to one part of the Empire, such as Apuleius’ *Golden Ass,* as evidence for coin use outside that area (Millar 1981, *cf.* Greene 1986, p. 50). Any attempt to discuss coin usage in the ‘Roman world’ must be aware that the finds suggest regional and chronological variation and what holds true in Italy, for example, is not necessarily going to hold true for Britain or elsewhere.

3.4.4 ‘The Normal Hoard’ — analysis method II (standard deviations)

The Normal Hoard (Reece 1981) is a development of *Numerical Aspects* (Reece 1974b) discussed above. Reece started by stating that he believed there is a ‘normal’ hoard, and that this can, and should be demonstrable numerically. As an example, he proceeded to examine the large coin hoard from Falkirk which closes[4] *c.* AD 230, but which contains an unusually large number of coins of the first and second century. To illustrate this he compared the Falkirk hoard with six hoards closing AD 193–217 and six closing AD 222–238. To do this he divided the hoards into a number of phases, and then converted the coin counts into 'permilas' (coins per thousand). As the representation of coins in the final phase of each hoard is highly variable, the permilles were calculated excluding that phase. Reece also calculated the mean permille for each phase, and its standard deviation (σ). He then plotted the means and standard deviations for each phase as error bars on two graphs, one for each hoard group. In addition, he plotted the figures for Falkirk on each graph. This clearly showed that the Falkirk hoard is very similar to hoards from AD 193–217, but quite unlike contemporary hoards from AD 222–238. He interpreted this as showing that the nucleus of the hoard was assembled during the reign of Septimus Severus, to which a group of 87 coins was added around AD 230. The Falkirk hoard had "been shown to be numerically atypical of one period of coin use, but completely normal at another period" (p. 303). Similar observations will be made concerning some Roman Republican coins hoards from Romania (see Chapter 10, below).

Reece then went on to illustrate the effect of sample (hoard) size. Reece quantified the deviation of each hoard from the mean pattern by summing the difference between the permille of coins in a hoard for a particular period, with the mean permille for that period, and then plotted this deviation against the square-root of the number of coins in the hoard. Although there are some outliers, of which Falkirk is an extreme example, there was a trend for small hoards to have large deviations, and *vice versa*, or in other words: "the larger the hoard the nearer it comes to representing the actual pool of coinage from which it was drawn, and hence the smaller the errors involved in extracting the hoard from the pool" (p. 305).

Three important points emerge:

1. There is such a thing as a 'normal' hoard, and this demonstrates that most hoards are partially random (as defined above) selections of coins from the coinage pool.

2. Some 'abnormal' hoards can be seen as having a nucleus from an earlier date to which later additions have been made.

3. Sample (hoard) size is important in the interpretation of patterns.

The use of means and standard deviations in this way was also used in the study of site assemblages such as Conimbriga and Ravenna (Reece 1979), Malta and Rome (Reece 1982), Lincoln (Mann & Reece 1983) and Verulamium (Reece 1984). In *The Normal Hoard*, and *Roman coinage in the western Mediterranean* (Reece 1982), the mean was plotted as a series of points and the standard deviation as an error bar, onto which were overlaid the site(s) or hoard(s) of interest. In *Metodos de comparacion* (Reece 1979), and the Lincoln and Verulamium reports, he produced a new type of graph (*e.g.*, Reece 1984, Fig. 2). Firstly, the mean is centred on the *x*-axis, and then the deviation of each point from the mean is plotted as a percentage of the standard deviation for that period. Thus,

[4]The term 'close' refers to the date of the newest coin in a coin hoard. This may not be the same as the date of deposition or loss, and in the case of small hoards is extremely unlikely to be the same.

in the Verulamium report for example, the standard deviation of the period IIa coins is 65 permille, with a mean of 37 permille. Period IIa forms only 28 permille of the Frere coins, which is 9 permille below the mean. This 9 permille deviation can be expressed as 14% of the standard deviation (9/65 $\times$ 100 = 14%) and so period IIa is plotted as -14 on the graph. The graph also includes dotted lines at $\pm 1\sigma$. By standardising the means and standard deviations in this way, Reece managed to give equal weight to all 21 periods, whereas the earlier type of graph was often dominated by the later periods which form the largest overall proportion of Romano-British site lists. A similar form of standardisation is used in statistics, although not on percentages, where the mean is centred to zero and the standard deviation to one.

There is a theoretical objection to this method, whether applied to hoards or sites, which needs to be explored. Perhaps the best explanation of the problem is Reece's own, which is worth quoting at length:

> I used to use the mean and the standard deviation of the values around the mean until ten years after I had first used it, Clive Orton said 'But you can't do that with percentages'... There were three reasons for changing course. First, the mathematical objection did make sense; second, and tactically, few people use their own brains on anything numerical but rely on a few people who can, so those few saying the method was wrong would lead to widespread belief that the results were wrong when they weren't, only the method; and finally and decisively Clive is such a nice person that I could not bear the thought of him continuing to look reproachfully at me over coffee.
>
> As I understand it, the mathematical objection to finding a standard deviation of a set of percentages is that each percentage is a different animal from each other. A percentage of 5% on a sample of 20 coins is one coin, 5% on 2000 coins 100 coins. But it is quite possible that in each sample we are one coin out, one too few or one too many so we usually mean at least ± 1 in each case. In the sample of twenty, minus one coin makes the value nil and the percentage 0%; plus one coin makes the sample 2 and the percentage 10%; so the first 5% really varies between 0% and 10% or 5$\pm$5%. In the second case one coin in 2000 is 0.05%, so the second value is really 5$\pm$0.05%. If we start manipulating these percentages then we have to take account of these inbuilt plusses and minuses, so the whole thing becomes horribly more complicated than it seemed at first sight. (Reece 1988c, pp. 25–6)

Reece went on to state that the method 'worked' — the reason that this is so is because he generally used large sample sizes, normally $\geq$100 coins, which helped to minimize the problems. However, a new technique was developed in response to the problem with standard deviations which is now outlined.

3.4.5 Analysing coin assemblages III — an alternative to standard deviations

The method is outlined in *My Roman Britain* (Reece 1988c, pp. 26–7) and was used in a number of reports (*e.g.,* Reece 1987b; 1989). The method is a simple scaling of the values for each period. In the Colchester report, for example, a mean in permilles was given for 51 sites from 21 major Roman towns (Reece 1987b, p. 17). On the graphs, this mean was plotted as a value of 50%. Another line was then plotted for no coins (0%), and a third for twice the mean (100%). For example, period 1 (to AD 43) has a mean of 10 permille over the 51 sites. For this period then, no coins equals 0%, 10 permille (the mean) is plotted at 50% and 20 permille (2$\times$ the mean) at 100%. The site at

Balkerne Lane, Colchester, has 16 permille of its coins from period 1 which would be plotted at 80% ($16/20 \times 100 = 80\%$). This procedure was then repeated for all 21 periods.

This method has the advantage that it avoids the problems of standard deviations discussed above, but the choice of two times the mean as the divide between acceptable variation, and notable variation, is somewhat arbitrary. It would be interesting to know what proportion of the values from all 51 sites lie outside this limit. Also, the method does tend to emphasise oddness when that is an above average proportion of coins, but does not emphasise oddness when that is a below average proportion of coins.

Perhaps an improvement on the method, especially now that the data from 140 sites including permilles and rank order has been published (Reece 1991b), could be derived from *Exploratory Data Analysis* (Tukey 1977). Although Reece's work is very much within the philosophy of exploratory data analysis, he has not used any of the methods described in Tukey's seminal volume. Tukey provided a number of methods for displaying data, which included fenced letter displays (which will be used later in this volume), and box-and-whisker plots. In the latter, a elongated box is drawn with a cross-bar, usually near the middle. The cross-bar represents the value of the median or middle value, and the top and bottom edges the upper and lower quartiles, that is the value ranked half-way between each extreme and the median. The inter-quartile range is the difference between the value of the upper quartile and the lower quartile. From this elongated box two whiskers protrude to a value, known as a 'step', which is 1.5 times the inter-quartile range from the median. Values which are greater than these whiskers are plotted individually; those greater than 1 step but less than two are said to be 'outside' or outliers, and those greater than two steps are said to be 'far out' or extreme outliers. To illustrate this, I have constructed Fig. 3.2.

In Fig. 3.2a are 13 numbers in rank order. With 13 numbers the fourth number is the lower quartile (or hinge) and the tenth number the upper quartile or hinge; the seventh number is the median, and the first and thirteenth numbers the extremes. Fig. 3.2b gives the 13 ranks and from these two figures we can see that the median is 30, the lower-quartile 25 and the upper quartile 37. The inter-quartile range is, therefore, 12 (*i.e.*, $37-25$), and one step is 18 (*i.e.*, 1.5×12). From this, we can define values which are greater than 48 or less than 12 (*i.e.*, median $\pm$ 1 step) as 'outside' and values which are greater than 66 or less than -6 as 'far out.' The values which are nearest to, but inside $\pm$ one step of the median, are known as the 'adjacent' values. The names for the various values are given in Fig. 3.2c. The boxplot of these values is given in Fig. 3.2d.

If we wished to produce a revised Reece-style graph based on this method, we could standardise the median to 0%, $\pm$ 1 step as $\pm$100%, 2 steps as 200% and so on. These could be plotted as various styles of horizontal line, and the individual points then plotted.

3.4.6 Portchester, 140 sites, and the use of rank ordering (method IV)

Reece's original analysis of the finds from Portchester (1975) was criticised by two authors (Casey 1986, pp. 98–9; Brickstock 1987, pp. 106, 253–5). They argued that the pattern of variation within the Portchester coinage was within the normal range of variation and therefore no special interpretation need be placed on the evidence. Reece's original article had compared the Portchester data to 14 sites from Roman Britain (the same sites discussed in Reece 1972b) and six sites from

E			LQ			M			UQ			E
11						30						67
	17				28		31				52	
		19		27				35		44		
			25						37			

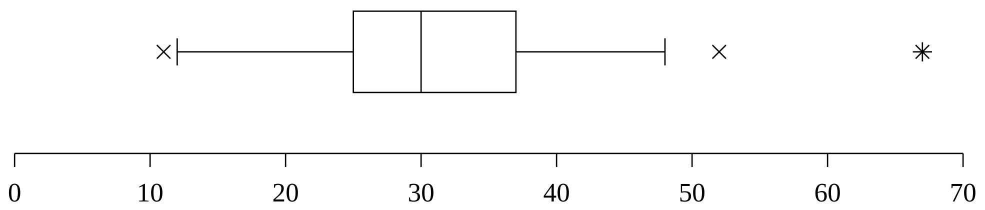
(a) Thirteen observations in rank order.

E			LQ			M			UQ			E
1						7						13
	2				6		8				12	
		3		5				9		11		
			4						10			

(b) The ranks of thirteen observations.

E			LQ			M			UQ			E
f						M						F
	A				v		v				f	
		v		v				v		A		
			H						H			

(c) Status of the values from Table 3.2b: f = outside; A = adjacent; v = a value; H = hinge (or quartile); M = median; F = far outside, or extreme outlier.



(d) Boxplot of the above data

Figure 3.2: Explanation of rank ordering and boxplots — see text for details. The staggered layout is to give a visual aid to understanding. Meaning of top rows: E = extreme; LQ = lower quartile; M = median; UQ = upper quartile.

Europe. *Portchester revisited* (Reece 1991a) is a reply to these criticisms. Reece argued that to say, for example, coinage from AD 348–64 is "perhaps a little below the figure one might expect from an 'average' site" (Brickstock 1987, 106), is too inexact and one should know what an average site looks like, and how much variation around the 'average' is acceptable, and how much is abnormal. Also in 1991, Reece published summary coin lists for 140 sites from Roman Britain (Reece 1991b), in which was also presented a series of tables showing the data as permilles (Table 2), ranked permilles (Table 3) *etc.* for all these sites. The rank method, outlined in *140 sites*, was used to re-examine the Portchester problem.

Reece moved towards the use of a ranking method in order to avoid criticisms concerning his use of the arithmetic mean of percentages. The data in *140 sites* is laid out in such a way that one can assess the position of a new or existing site in comparison to other sites using this method. With

Portchester, Reece had argued that the coinage of 294–330 formed an abnormally large proportion of the assemblage, and the coinage of 348–364 an abnormally low proportion. Looking at the rank position of Portchester in the 140 sites, it has the highest proportion of coins of 294–317 if all the periods are considered, and the fourth highest if only fourth century coins are considered. Similarly, 348–364 is ranked 47th (all periods) or 21st (4th century only). However, Reece also wished to avoid 'the problem of percentages', known in statistics as 'closure.' This problem is that the unit total is constrained to a single figure (1 with proportions, 100 with percentages). In the case of Portchester, 294–317 has such an abnormally high proportion of coins that the other periods will automatically have to have a lower proportion than other sites. To circumvent this, he calculated the ratio of every phase to its previous phase (*e.g.*, 317–300 *v.* 294–317), and then ranked the ratios, providing the rank order for Portchester, as well as the highest, lowest and median ratios. Ratios had been used in a similar way in the discussion of the Uley assemblage where the results had been illustrated graphically (Reece 1980, Fig. 6.7). At Uley he demonstrated the unusualness of the period 348–364 and plausibly interpreted this as the result of a dispersed hoard (Reece 1980, pp. 122-4). At Portchester, Reece clearly demonstrates, by using both the ranked permilles and the ranked ratios, how Portchester is odd, and where.

The 'Portchester' method has two advantages and one disadvantage. Its advantages are firstly, it avoids the problems of calculating means and standard deviations from percentages — there are no statistical objections with the Portchester method that I can see. Secondly, with the use of the data from *140 sites*, the details of any new site can be compared to a large corpus of sites in a meaningful way. The disadvantage of the method is that although it is easy to see how the site one is interested in behaves in relation to the all the other sites, it is difficult, although not impossible, to either identify a site which is similar, or to divide the assemblage into groups based on their coin assemblages alone. The last paper, to be discussed in the next section, is Reece's solution to the latter problem.

3.4.7 Analysing assemblages V — cumulative proportions

Site finds in Roman Britain (Reece 1995) outlined his latest method for the examination of site profiles. After a brief review of past methods and criticisms (pp. 179–181) in which he stated that classical statistics have been unsuccessful in providing the sort of analysis he required, he then outlined his aims and methods. The data used in this paper was that in *140 sites* (Reece 1991a). His aim was to look for groupings in those sites with as few 'presuppositions' as possible, and to let possible groupings emerge by themselves, rather than imposing them. He stated that more formal statistical methods, as applied up to now by students undertaking the numerical methods course at the Institute of Archaeology, London, had been unsatisfactory and were always overly influenced by sample size (pp. 181–2). The aim was to generate pictures which illustrated the variation in the coin profiles clearly, and then to group them manually. He stated that a 'more objective numerical sorting' may be established later.

The method was to construct cumulative permille curves of the site profiles where the categories are his usual 21 periods (pp. 182–185). Plotting these as graphs and comparing profiles was not entirely satisfactory as many lines made the picture unclear, and so Reece subtracted the cumulative mean curve[5] from the cumulative site profile and plotted the difference. Obviously, at period 21 this will always equal zero (pp. 185–188). The profiles of the 140 sites thus portrayed were then grouped manually into 22 groups. Reece rightly noted that although the curves may have looked quite different, the resultant groups would be the same whatever mean profile had been used. There then followed a commentary on these 22 groups with some interpretation.

As a method, this has much to commend it — it is clear, simple to construct, and the diagrams are simple to understand. The main problem lies in constructing the groups. Although the reader may be somewhat overwhelmed by the 22 graphs, the enormity of the task is more apparent when one realises that with 140 sites there are 9,730 possible comparisons. This is a daunting task. Having printed the graphs out, it took two days to divide the sites into groups (Reece *pers. comm.*). Reece's comments regarding the use of more standard statistical methods can be seen as a friendly challenge to produce a formal numerical technique which would produce results he would consider useful and acceptable. This challenge has not been specifically met here, but some form of cluster analysis, such as that presented in Chapter 10 on a different data set, may be the answer.

3.4.8 Summary

Reece's analyses have been in the spirit of *exploratory data analysis*, if not using the methods suggested by Tukey (1977). A number of general points of methodology arise from Reece's work.

- The first step in any analysis is to define what is 'normal', or the 'background' against which any assemblage can then be compared.
- Any individual hoard or assemblage can only be interpreted with reference to this background.
- Large-scale patterns in the distributions of coins do occur and should be looked for.
- The data should be allowed to speak for itself — it should not be pre-judged (*e.g.*, a hoard of 300 coins should not be rejected from an analysis simply because it is only 10% of the original total).
- Patterns within the data should be looked for on their own terms, not within the constraints of other aspects of the archaeology. For example, we should not *only* compare villas with other villas, or towns with other towns. If there are similarities within site classes, or between them, they will become apparent from the data.
- The best way to identify patterns and make comparisons is graphically.

These tenets have influenced the work in Part II of this thesis. A large collection of hoards are analysed, and although no attempt is made to calculate an arithmetic, or other mean, for hoards of any date, comparison of a number of hoards using Correspondence Analysis identifies differences and patterns. Further, I do not exclude hoards on the basis of an externally applied criteria of data

[5] The mean in this case is the mean of the permilles of the 140 sites from (Reece 1991a).

quality, beyond setting a minimum size of identifiable *denarii*. If a hoard is 'odd', it shows as such in the analysis. Only at the stage of interpretation do I return to the publication to see if post-recovery factors may be influencing the result. Given the age of many of the hoard reports from which the data derives, and the fact that very few of the hoards are certainly complete, remarkably few problems are encountered. All the data examined is presented graphically, both as straightforward cumulative percentage graphs, and as maps from correspondence analysis.

Reece prefers to apply what he calls 'numerical' methods to his data, and refuses to call them 'statistical.' His methods are straightforward, have proved robust, are effective in identifying patterns and thus are to be recommended, especially to the mathematically nervous, as effective means of analysis. This stands in contrast to some of the other papers reviewed in this chapter which attempt to apply more formal statistical methods but fail to appreciate some of the complexities.

It could be argued that multivariate methods, such as Principal Components Analysis, Correspondence Analysis or Cluster Analysis can reveal further aspects of the data. Reece (1995) stated that so far these techniques have not been successful, although this is not to say that these methods might not produce useful results in experienced hands (*cf.* Ryan 1988). In the present work, the nature of the data has allowed the extensive application of multivariate methods with, I believe, extremely effective results. It could also be argued that an analysis at a more detailed level than Reece's 21 periods would be desirable. Unfortunately, site-find data is rarely of high-enough quality, mainly due to corrosion and coin wear, to support a more detailed analysis although this has been attempted for fourth-century material (Ryan 1988). Here, I have been able to use very detailed data due to the nature of the coins: silver usually preserves well, especially in hoards, and the highly individual types used during the later Republic make coin identification relatively easy.

The most important of Reece's observations for the analysis of coin hoards are:

- It is possible to identify a 'normal' hoard structure.
- Inter-hoard variability is usually at its maximum in the period immediately prior to the hoard's closing date.
- Many (most?) hoards are a partially random selection of coins in circulation, *i.e.*, a random selection of coins of one denomination.
- Larger hoards usually have a smaller proportional deviation from the coin population than smaller hoards — for samples, this is one of the fundamental results of sampling theory.
- It is possible that a hoard with one closing date may resemble in many details hoards of an earlier closing date (*cf.* Chapter 10).
- The prime determinant of hoard and site-find profiles is the supply of coinage to an area, which is, in turn, dependent on the pattern of striking.
- The evidence strongly suggests that official state supply is the most important single type of supply, but that subsequent movements of coin by trade or private persons can create, or destroy, patterns.
- There appears to be inter- and intra-regional variation in coin loss, and presumably coin use.

All these observations are important in that they are accepted for the remainder of this study.

Reece's work has done much to bridge the gap between 'traditional' numismatics, largely concerned with dates, styles, associations, types and metrology, and archaeology, which too often uses these artefacts as merely a source of dating evidence. It is the aim of Parts II and III to show how numismatic evidence, in conjunction with other archaeological evidence, can shed light on wider aspects past human societies.

3.5 Lockyear's computer simulation and further analysis of hoard structure

In 1989 I analysed 24 hoards using a variety of methods of which two are of relevance here. The regression analysis performed will be discussed below (section 3.13.6, page 101); here I will outline the computer simulation (Lockyear 1989, section 2.5) which was later published (Lockyear 1991).

As discussed above, Reece (1988d) noted that the profile of hoards of the same closing date usually appears similar over most periods until the last. The representation of coin of the last period, or the last few years before the closing date of the hoard, was often erratic, however. This phenomenon was visible in the hoards examined in 1989 (see Fig. 9.1, p. 269 below). Several possible explanations were offered for this pattern: it could represent the difference between 'savings hoards' and 'emergency hoards', between different 'introduction delays', or between different decay (loss, wastage, attrition) rates. Some clarification of these terms is necessary. I define an 'emergency hoard' as one which has been collected at one moment in time and will reflect the coinage pool at that time, and a 'savings hoard' as one which has been collected over a longer period of time, and may, therefore, have less of the most recent coins than the emergency hoard. As these names have interpretational overtones which are undesirable, I attempted to rename these theoretical hoard types Type 1 and 2, but these names have proved unmemorable and thus the original names have been retained here. The 'introduction delay' is a combination of two factors. The first is the distance of the collection point from the points where new coins were released into the pool. The second factor is the speed of circulation of coinage. The last factor, the decay rate, has already been discussed.

Prior to 1989 there had been no attempt to assess how variation in each of these factors would affect the composition of coin hoards. The simulation program, written by myself and described below, was an attempt to do this. The program firstly took a series of die counts per year, an average number of coins struck per die, the introduction delay and the decay rate. From these pieces of information the program calculated battleship curves for each year. From these, the composition of the coinage pool in any year could be calculated. The program then asked the user for the type of hoard to be collected, and the size and closing date of the hoard. If a savings hoard was to be simulated, the program also asked for how many years the hoard was to be collected over. So, for example, if one requested a 1,000 coin savings hoard collected over five years, the program would randomly select 200 coins per year for the five years up to the closing date of the hoard. If an emergency hoard was requested, all the coins would be selected randomly from the coinage pool in one year.

In retrospect, the average number of coins minted per die was irrelevant and would make no difference to the results. It was unfortunate that 30,000 was made an explicit choice as this probably unjustifiable figure has attracted more attention than the results of this analysis (*e.g.,* Buttrey 1994, n. 18). It would also have been perfectly possible to invent a fictitious coin series with an equally fictitious set of die counts and still examine the problems at hand. However, it was felt desirable at the time to compare the results of the simulation with real data. Therefore, die estimates for Republican *denarii*, based on a slight modification of Crawford's original method (see section 3.13.6 below), were used. Again, my decision to use the contentious Republican die estimates has detracted from the results which are independent of them.

Two real hoards were chosen for comparison — Fiesole and San Guiliano Vecchio — and the various simulated hoards had the same closing date and size as these two hoards. The simulated hoards were plotted together with these genuine hoards. It was decided to examine each factor in turn whilst keeping the others constant. Simulated hoards for three decay rates ($\frac{1}{2}$, 3 & 6%), three introduction delays (1 year, 10 years and 20 years), and three periods of hoard collection (1 year, 10 years, and from 156 BC to the closing date) were created, for each of the two hoard sizes/dates.

The results were extremely interesting, but did not allow us to construct a simple picture of hoard formation processes. Varying *any* of the three factors produced a large degree of variation in the final period of the Fiesole type hoards. A very large collection period of over 50 years produced a hoard very unlike the real hoard, but otherwise a remarkable degree of similarity was observed between the simulated hoards and the real hoard over the majority of their profiles. For the San Guiliano hoard simulation, however, changing the parameters produced a much less marked level of variation in the last few years of the simulated hoards.

This simulation clearly showed that to interpret inter-hoard variability on the basis of only one of these factors, such as the speed of circulation, and ignoring other possible and vital sources of variation, was a dangerous procedure. Subsequent to this work, a further cause of inter-hoard variability has been identified and this will be discussed in depth in Chapter 9.

3.6 Carradice and the coinage of Domitian

Carradice's work on the coinage of Domitian includes a survey of hoards containing *denarii* of Domitian (1983, Chapter 3). The prime purpose of this survey was to enable Carradice to estimate the size of the various issues of Domitian from AD 81–96. Carradice began by presenting a useful discussion of the problems of using coin hoards including the effects of debasements, regional publication traditions, the representativeness of hoards as samples *etc.*, and then presented the data which consisted of 51 hoards from Nerva (AD 96–98) to Trajan Decius (AD 249–251). He used coin hoards dating some time after the issue date of the coins he was interested in for two reasons. Firstly, in order to have a suitably large sample of hoards and secondly, so that the distribution of these coins over the Empire would have had time to become even. The later work of Duncan-Jones (1989), discussed below (section 3.10.2), suggests that it unlikely that regional variations will ever even out entirely.

The data was presented as a series of tables and graphs. Firstly, Carradice showed the distribution of the coins of Domitian, divided into seven phases, in hoards grouped by dates, *i.e.*, hoards from Nerva–Trajan, Antoninus Pius *etc.* (Table C, p. 68, Fig. 1, p. 69). Secondly, he presented similar data but with each period divided into three regions which were: north-western Europe including Britain, central and eastern Europe including Romania and Bulgaria, and finally other areas including the East and Africa (Table D, p. 71, Fig. 2, p. 72). His Fig. 1 clearly showed that the relative distribution of the coin phases remains constant across the periods apart from the first two columns. It appeared that there were relatively more phase one coins (AD 81–2) in the latest group of hoards, which date to after the 'great debasement' of Septimus Severus (AD 194/5), than earlier hoards. Also, the second phase of coinage (AD 82–85), rapidly disappears from circulation. Carradice explains this in terms of the relative fineness of the coins. In the reign of Domitian there appears to have been three periods of coinage characterised by different finenesses: the First Period (AD 81–82) was relatively debased, the Second Period (AD 82–85) attempted to return to a previous high fineness and the Third Period (AD 85–96) was a compromise between the two. Gresham's Law, which states that bad coin drives out good, would lead to high value Second Period coins not surviving well in a coinage pool dominated by coins of a lower fineness. After the great debasement of Septimus Severus, even the Third Period coins would have had a relatively high fineness and therefore been driven out of circulation leaving a relatively high proportion of the debased First Period coinage.

Carradice then went on to see if there is a regional pattern. There does appear from his Fig. 2 to be a degree of variability between regions but the smaller sample sizes being plotted should also be noted. Carradice's discussion of these patterns would have been strengthened by the selective use of statistical tests such as the two-sample Kolmogorov-Smirnov test (Shennan 1988, pp. 55–61), or even some form of multivariate procedure, such as Correspondence Analysis on the full data table. This might have revealed regional variations in coin types as observed by Duncan-Jones (1989) which were partly identified by a multivariate statistical analysis (see section 3.10.2 below).

In order to re-examine Carradice's data more fully, I performed a small number of Kolmogorov-Smirnov tests. Firstly, the total numbers of coins of Domitian in hoards from Nerva–Trajan were compared to the total numbers in hoards closing after AD 194/5 (hoards 44–51). In this case, there is a statistically significant difference between the two distributions,[6] and the first phase is mainly responsible for this difference. This, therefore, supports Carradice's interpretations. An examination of the figures for the post AD 194/5 hoards, however, show that there appear to be differences between regions, and that the last period is dominated by the large Réka Devnia hoard (71% of the coins from the last period). Application of the two-sample Kolmogorov-Smirnov test between the hoards from areas A and B (north-western Europe *v.* eastern Europe represented by Réka Devnia) shows no statistically significant difference at the 0.05 level,[7] but comparison between Réka Devnia and the Group C hoards (east and Africa) does show a statistically significant difference at that

[6] $\text{Dmax}_{\text{obs}} = 28.9\%$; n_1 (hoards from Nerva–Trajan): 114; n_2 (hoards from after AD 194/5): 417; $\text{Dmax}_{0.05} = 14.4\%$, therefore reject H_0 at the 0.05 level.

[7] $\text{Dmax}_{\text{obs}} = 13.9\%$; n_1 (Group A hoards): 83; n_2 (Réka Devnia): 296; $\text{Dmax}_{0.05} = 16.9\%$, therefore accept H_0 at the 0.05 level.

level.[8] This re-examination of Carradice's data shows that one should be cautious about accepting a pattern which is largely derived from a single hoard, especially a single very large hoard which is by definition unusual.

Carradice, with caution due to differential survival rates, presented three tables with the relative sizes of the issues of Domitian. Although the earliest group of hoards should have the most accurate relative issue sizes, the sample size was rather small as Carradice noted. He then went on to undertake a die study of a small number of issues. The very controversial nature of such studies will be discussed below (section 3.13). Here we need only note that Carradice used the Lyon equation for die estimates (p. 83) and that he employed Crawford's controversial figure of an average of 30,000 coins struck per die.

The importance of this work in the present context is fourfold:

- One should be cautious in the use of abnormally large hoards.
- The hoards show a consistent representation of coin issues by period confirming that they are random selections of the *denarii* in circulation.
- The relative fineness of different issues has an effect on their relative abundance in the coinage pool due to deliberate removal of the better coins, *i.e.*, the loss rate of a particular coin issue can be effected by its relative value.
- There is some regional patterning which requires further detailed investigation, perhaps at the level of individual types.

3.7 Patterson and the decay rate

As part of a project looking at the history of lead production, Patterson (1972) had the opportunity to examine levels of silver production and loss from prehistory to the present day. He regarded the accidental loss of silver coin to be the prime cause of loss from the silver stock in the ancient to modern period. He estimated the loss rate (called L) from a variety of sources. Firstly, he examined the loss of silver from the American coinage pool in the first half of this century and derived estimates of between 2–4%. This compared well to De Glanville's study which gave loss rates of 1–3.6% for different UK denominations. A second set of calculations based on another set of data provided an estimate of 2% for the period up to 1960 (pp. 211–2) and a third method gave estimates for silver in the range of 1–4% *per annum* (p. 212).

After some discussion as to the relative size of silver stocks and the relative value of silver at different times, Patterson estimates the loss rate for the Roman Empire at *c.* AD 150 at 2% *per annum* (Table 5, p. 220). The importance of this paper is that it is the cited source for the 2% decay rate that Hopkins (1980) used in his analysis of the size of the coinage stock in the late Republic.

[8] $\mathrm{Dmax}_{\mathrm{obs}} = 24.4\%$; n_1 (Group C hoards): 38; n_2 (Réka Devnia): 296; $\mathrm{Dmax}_{0.05} = 23.4\%$, therefore reject H_0 at the 0.05 level.

3.8 Goulpeau and the circulation of coin

Goulpeau (1981) attempted to define a dynamic model for the circulation of coin. He rightly saw that the problem was essentially one which used the concept of battleship curves as had been noted on other occasions (*e.g.,* Collis 1988). He noted that at one location the abundance of an issue of coin will initially increase after that issue has been released into the coinage pool. The speed of that increase is dependent on the distance from the point the new coinage is released into the pool, and the speed of circulation (*cf.* Lockyear 1989; 1991, 1993a). This factor he called τ_1. After that coin issue has reached its maximum abundance in that location (at time t_{max}) it will then decline in abundance as coin is lost or passed onto other locations (my decay rate, Volk's wastage rate, Buttrey's attrition rate, see Lockyear 1989; 1991; Preston 1983; Volk 1987). He called this constant τ_2. It is normally defined as a percentage of the coinage pool lost per year (*cf.* Thordeman 1948; Patterson 1972). The combined battleship curve defined by these two parameters would normally have to be calculated with the use of a differential equation. Goulpeau, however, used Laplace transformations to perform this task (see his Fig. 1 and pp. 288–290).

There were, however, several problems to be overcome. Firstly, a series of curves for the abundance of each coin issue at a location had to be plotted. There are never, however, enough large hoards from one location to allow the plotting of the abundance of a coin issue to produce such a set of curves. Variable hoard sizes and random variations also have to be taken into account. Goulpeau turned the problem around. If the sizes of issues are constant, and the period of time for each issue is constant, the coins in a hoard when plotted as a line graph will form the classic battleship curve but in reverse (see his Fig. 2). It is also vital that τ_1 and τ_2 does not vary between issues. The problem became one of calculating the values of τ_1 and τ_2 for this curve. Goulpeau provided a method of doing this and provided two examples. The first based on coins from modern church collections and the second based on a find of double *tournois* from Rance. In order to meet the vital assumption about the size of issues Goulpeau had to standardise the representation of coin types. For the first example he had the mint records from which to work.

It is this need to standardise the size of issues which is the major problem in applying this idea to another context. For example, in the Republican period, mint records do not survive. The use of estimated production figures is a problem because, amongst other things, they are derived from the hoard evidence in the first place. It is difficult to assess how much of a problem the circularity of using hoard evidence to provide standardisation figures for hoards is, even if the hoards were split into two groups for the purpose. Also, for the Republican period, the accuracy of the dating of issues is highly variable, and there is no certainty that the length of issue is always known.

There are also more general criticisms of this work. Given that various factors will prevent the plotting of a perfect curve from the standardised figures, how does one smooth the curve, and decide on the various points needed which are then input to Goulpeau's main graph (figure 3, p. 292) to estimate τ_1 and τ_2? Also, if one looks at his Fig. 5, it can be seen that the wider the estimation of points derived from the hoard plots, the smaller the possible variation in τ_1 and τ_2; *i.e.,* the more inaccurate your data the more accurate a figure for τ_1 and τ_2 will be…

Although the details are less than ideal, and the assumptions which have to be met are all but impossible, Goulpeau's analysis was a sophisticated attempt to solve the problem of estimating these 'constantes de temp', and provided some very useful insights.

3.9 Rogers and the analysis of coin weights

Rogers (1975) analysed the weight of Roman Imperial gold coins found in the two hoards from Liberchies and Corbridge. For each hoard he plotted two graphs, one with the weight of each individual coin against its date of issue, and a second with the arithmetic mean of a 20 year period plotted against mean date. For Liberchies, this resulted in five points which lay on an almost perfect straight line, illustrating that the oldest coins are the most worn. For Corbridge, the line was much less straight, and the mean weight of all the issues was higher than Liberchies. Rogers claimed that this, in conjunction with the fact that the Liberchies hoard has some clipped coins (*monnaies rognées*), suggests that the Liberchies hoard is a 'market' hoard (*trésor marchand*), whereas the Corbridge hoard is a savings hoard (*trésor de thésaurisation*).

There is one problem with this simple analysis: how sure are we of the accuracy of the published weights (Corbridge was published in 1912, Liberchies in 1972)? There are also alternative possible interpretations; Duncan-Jones and Creighton (see below) interpret the differences in terms of differences in the speed of circulation of coin, not collection method. However, neither Duncan-Jones or Creighton offer any explanation as to why speed of circulation should be given primacy over collection method, especially in light of the *monnaies rognées*. At best, we have two alternative hypotheses neither of which, in our current state of knowledge, can be dismissed.

3.10 The work of Duncan-Jones

Two of Duncan-Jones' publications which are of particular relevance to other work contained in this thesis are reviewed. These analyses were also presented in *Money and Government in the Roman Empire* (Duncan-Jones 1994) which is not reviewed here.

3.10.1 Speed of coin circulation

In the first paper Duncan-Jones (1987) attempted to demonstrate variable speeds of coin circulation from coin wear using both gold, silver and bronze coins, and by performing a comparison to modern coinage. The first point to note is the small number of hoards used: three gold coin hoards, three silver hoards and a single bronze hoard. The main statistical technique used was linear regression quoting correlations. There are severe methodological problems.

Duncan-Jones compared coins of different dates within the same hoard. Although this removed the problems of variable post-depositional and post-recovery factors, it introduced the assumption that all the coins used were minted at an identical target weight. In practice, this appears to be generally true but needs detailed investigation. In order to remove the problem of occasional aberrant coins, Duncan-Jones calculated his regressions on the median weight of coins grouped by Emperor. This resulted in regressions based on only four points! Given that the coins were minted at a similar target weight, it is entirely unsurprising that there was a high correlation between his best-fit lines and the data points and it is difficult to assign any significant meaning to this.[9] In short, the regression analyses are invalid. The differences between the wear rates between hoards was interpreted as differences in the speed of coin circulation; for the gold coin hoards this resulted in the lowest rate, and therefore speed, being in Scotland and the highest rate in Portugal, although Duncan-Jones is rightly cautious (p. 240). The methodology is carried through to the silver and bronze issues.

Duncan-Jones did make, however, the important observation that the older a group of coins is, the higher the level of variation in the coin weights will be (p. 246–248). Coins, especially precious metal coins, were usually struck to a carefully controlled target weight, but once released from the mint had widely different histories. Though this is a predictable observation it is one worth making.

Duncan-Jones' conclusion that the rates of wear on bronze coins were higher than that on silver coins, which in turn were higher than that for gold coins, and that this reflected the number of transactions these coins were used for, seems inherently likely, and unlikely to be altered by a sounder analysis. Similarly, the observation that the rates of wear were lower than 19th or 20th century rates of wear is also unlikely to be changed. His conclusions about the differential wear rates between regions, however, cannot be supported due to fundamental flaws in the analyses.

This paper, and that of Rogers discussed above, are important in that they reveal some of the potential pitfalls in the use of coin weights, (see section 14.4, page 401), especially in any attempt to examine differences in the speed of circulation of coin (*cf.* Chapter 9).

3.10.2 Regional supply patterns

In the late third and early fourth centuries AD, when a system of regional mints was established, the regional distributions of coins by mints can easily be seen (*e.g.,* Greene 1986, Fig. 20). Prior to this, a large proportion of the coinage in use, especially in the west, was minted in a few centres only, mainly Rome. If one considers the logistic aspects of the transport of both the bullion for the production of the coinage, and the transport of the resulting coinage itself, this fact in itself is incredible (Howgego 1994, p. 5).

The question tackled by Duncan-Jones (1989) was the extent to which the patterns produced by the supply of coinage to various regions were destroyed by subsequent movements of coinage due to trade, taxes or other possible mechanisms. To do this he examined the distribution of coin types in three gold hoards and six silver hoards dating to the second and third centuries. The analysis of gold hoards uses a 'crude coefficient of divergence' (p. 123) and a Spearman rank correlation (p. 124) although it is not entirely clear how these have been calculated.

The comparison of the silver hoards was achieved through the use of tables, the coefficient of variation and factor analysis (pp. 125–133). These various approaches showed that there was a tendency for certain coin types to concentrate in certain provinces indicating that batches of new coins were sent from the mint to the provinces, and that subsequent trade and tax flows were not

[9] In Table II , p. 239, a correlation of $r = 0.9354$ is quoted for the Portugal hoard excluding data for A. Pius; in fact this figure can only be obtained including the data for A. Pius and excluding that for Nero.

sufficient to destroy these patterns entirely. The factor analysis published here is of interest in that it is one of the few published analyses in numismatics which uses a recognised multivariate technique.

Although these results are likely to remain unchanged, there are a number of methodological problems. Firstly, only nine hoards are used to come to these conclusions, and those nine hoards are widely spread both geographically and temporally. Also, one of the hoards used, the Réka Devnia hoard, has been shown to be extremely unusual in composition, as well as in size, as was admitted by Duncan-Jones (p. 126, n. 10). The second criticism, common to much published work in archaeology (Baxter 1994, pp. 224–226), is the poor manner in which the analyses were reported. For example, the factor analysis was based on a 'covariance matrix using rotated loadings' but the manner in which those loadings were rotated (there are many possibilities) was not given. It appears that the analysis was also performed on percentages, although this is not explicitly stated. The final, and most minor point, is that the coefficients of variation in Table VII (p. 130) were calculated on percentages. As the coefficient of variation is the standard deviation expressed as a percentage of the mean, the same problems of calculating standard deviations of percentages as discussed above (p. 66) apply.

More controversial than the methodology used, is Duncan-Jones' conclusion that the regional patterning of coinage demonstrates that the Roman economy was not an integrated whole, but a series of 'small local cells.' This debate has been outlined in section 2.4.

3.11 Ryan, computing and the coinage of fourth century Britain

Fourth century coin finds had a dual aim: firstly to examine the pattern of fourth-century coin finds from a large number of sites in southern Roman Britain, and secondly to demonstrate the efficacy of computer-based methods, both for the storage and manipulation of coin data, and for its analysis (Ryan 1988). The data structure developed and used for this work (Ryan 1988, Chapter 3) was modified and used in the construction of the CHRR database (see Chapter 5 below).

Ryan presented a number of analyses including spatial analyses and an investigation of the age of coins at the time of deposition. I wish here, however, to outline the Principal Components Analysis (pp. 72–87) as this is one of the few multivariate analyses on coin data that has been published although it was a development of an earlier analysis (Ryan 1982). Ryan initially analysed 151 sites but found that sites with $<$10 coins severely disrupted the results and so these were removed leaving 103 sites. The coins lists for these sites were analysed at two levels: firstly with the assemblage divided into the 'traditional' (Reece) periods of which there are seven in the fourth century, and secondly by what Ryan called 'minimum issue periods' of which there are seventeen.

The analyses were performed on a covariance matrix calculated on proportions. The use of proportions in PCA has been a matter of some controversy (Aitchison 1986) and will be discussed further below (sections 3.12.2 and 14.4). In the first analysis, using Reece's periods, the first three principal axes accounted for 86.7% of the variance in the data. The first axis revealed a contrast between coins of AD 330–48, and coins of AD 364–78 and AD 388 onwards, the second axis represented the variation in the *Fel Temp Reparatio* series (AD 348–64), especially in comparison to the next period (AD 364–78). The first three axes of the second analysis accounted for 66.5% of the variation in the data. This analysis, using the minimum issue periods, showed a broad agreement with the first analysis, but also showed that some variation was masked by use of the longer periods, primarily the contrast between issues of AD 330–335 and AD 335–40.

Using finer resolution data is often a trade-off between being able to observe broad trends in the data, and losing detail where that detail can sometimes be meaningful, but can also be 'noise' created by random variations in an increasingly sparse data set. Also, as Ryan noted, "even if further components can be extracted from the higher resolution data their interaction in terms of the issue and deposition of coin becomes less appropriate" (Ryan 1988, p. 77).

Ryan then proceeded to examine the object scores from the second analysis and presented two scattergrams (maps) of the first *v.* second components, and the first *v.* third components (his Figs. 4.8 & 4.9). The 103 sites were divided into six groups: cemeteries, hoards, temples, rural settlements, urban sites and villas/other buildings. No totally distinct groups emerged although some types of site tended to be grouped together, especially temple sites (*cf.* Reece 1980, p. 121). Following a discussion of the patterns, Ryan noted that although the results could not be used to discriminate between different types of site, they could be used to show that these sites have different, if overlapping, patterns of coin deposition. He suggested that temples may have a distinctive profile because unrecognised votive hoards are often included in the site list and it is therefore important to differentiate between votive hoards, where there is no intent to recover, and other hoards where there concealment was only intended to be temporary.

These analyses are important as much for demonstrating the applicability and usefulness of multivariate techniques, as for their interesting results. Also, in contrast to Duncan-Jones's (1989) factor analysis, the analyses are thoroughly discussed and presented, although a little more technical detail, perhaps in a footnote, would have been useful.

3.12 The work of J. D. Creighton

3.12.1 Introduction

While this study has been in progress a second major study was completed (Creighton 1992a) which also deals with the analysis and interpretation of coin hoards, although in this case they were 1st–3rd century hoards from Roman Britain. Some of the methods and conclusions were presented in public[10] and one paper has been published (Creighton 1992b).[11] There is a great deal of overlap in aims between Creighton's thesis and the current work, and some of his analyses were the direct stimulus for analyses presented here (see especially Chapter 9). In view of this, Creighton's methodology is closely re-examined here.

Creighton's thesis began with a general statement of aims and problems such as the lack of economic data, in the sense of contemporary statistics, in the ancient world (p. 10), and the incon-

[10] *Palaeoeconomic reconstruction: modeling the money-supply to Roman Britain* presented at TAG 1988 in Sheffield, and a further paper delivered to the *Conflict or Co-operation* conference held in Oxford, October 1989.

[11] Creighton (1995) appeared after this section had been written. As a speculative paper it is extremely interesting if impossible to prove or disprove archaeologically. In the present context, however, it does not contain material which requires review.

sistency of the recording of possible economic indicators in recent scholarship (p. 13). He looked forward to the construction of 'multivariate' archaeological models for the study of the macro-economy. Within this model he listed a number of possible monetary variables (p. 13):

1. quantity of money
2. division and distribution of money
3. speed of circulation
4. points of entry of new money into the coinage pool
5. 'monetization' of society
6. possible expansion and contraction of the monetary economy

He notes that these factors are impossible to examine directly (p. 15), and reviewed some attempts to look at these factors including Crawford's die estimates (see section 3.13.4 below), and Hopkins' (1980) work (p. 15; see Chapter 11 below). He criticised Hopkins' use of a 2% decay rate, stating this is too high and that based on Casey's work this rate is in fact only 0.003%. Creighton has, in fact, misunderstood the decay rate — Casey's estimate is only the possible loss rate on a site; it does not include other factors such as hoarding and export to regions outside of the main coinage pool, which are subsumed in the concept of the decay rate. Later in his thesis (p. 224), Creighton goes on to state that the most likely decay rate for *sestertii* is 8%.

Creighton then presented a historical and conceptual survey of hoard studies. He firstly reviewed the problems of hoard typologies (pp. 18–22) and then moved on to examine the place of hoards in the currency system seeing them as dynamic stores of wealth (pp. 23–29 *cf.* Chapter 6). He then attempted to see if savings and emergency hoards can be identified, firstly by reviewing attempts at the micro-excavation of hoards (pp. 29–32), and then by the analysis of hoard structure.

3.12.2 PCA of hoard data

Creighton suggested (p. 32) that the pattern of hoarding over time should consist of a constant background of currency hoards, with occasional peaks of hoarding representing extra hoards related to specific events. From the work of Robertson, Creighton noted that there is a peak of hoarding under Marcus Aurelius (Robertson 1988, Fig. 2, p. 28). He decided to examine the hoards of this period to see if these could be divided into currency and emergency hoards (pp. 33–35). Eighteen hoards dating to the reign of Marcus Aurelius were chosen, to which were added a further 37 hoards dating from Hadrian to Commodus. These extra hoards were included "to aid interpretation."

There are severe methodological problems with this analysis. He was not explicit as to which statistical technique he employed; the analysis was performed using CLUSTAN and it appears that he thought that he was performing cluster analysis. However, Fig. 21.07 (reproduced here as Fig. 3.3) is clearly a map from a Principal Components Analysis (PCA); no eigenvalues, component scores or other supporting information were provided and it was not stated whether the analysis was performed on a correlation or covariance matrix. Creighton did, however, present the data for this analysis (Creighton 1992a, Appendix 2.11, pp. 296–7) from which it is clear that it was performed on percentage data. The use of PCA on compositional data (*i.e.*, data which has a fixed sum, such as percentages or proportions) is controversial, and sophisticated techniques have been developed for this purpose (Aitchison 1986). Application of these techniques is not, however, universally accepted (Tangri & Wright 1993; *cf.* Baxter & Heyworth 1989; Baxter *et al.* 1990; Baxter 1991; 1992b, 1993; see also Baxter 1994, pp. 73–77). In the case of coin hoard data, there was no reason to introduce this problem — it is perfectly acceptable to analyse tables of raw counts, or counts transformed by some other procedure other than conversion to percentages. Also, as will be shown (section 8.2.5), an alternative technique primarily designed for the analysis of count data, *correspondence analysis*, would have been a better choice. Creighton also analysed hoards as small as six coins. Such small hoards cause large problems statistically, and numismatically. Reece (1988c, p. 53) usually restricts his analyses to assemblages of over 100 coins; here I have set a lower limit of 30 coins, based on experience of the results of multivariate analysis of coin hoards.

Creighton stated that if the hoards of Marcus Aurelius can be divided into currency and emergency hoards, there should be a 'blur' between the distribution of hoards of Marcus and Commodus on the resultant map, and that this blur should be more marked than the blur between hoards of other periods. He then went on to state that the analysis accounted for 45% of the variation in the data set, and that the blurring between Marcus and Commodus appeared to be no greater than between other periods.

In order to examine Creighton's analysis further the data were input to a dBASE table[12] and analysed using the computer package CANOCO.[13] Fig. 3.3 reproduces Creighton's results (Creighton 1992a, *cf.* Fig. 21.07).[14] It was found that Creighton had analysed a correlation matrix in his analysis, with the first axis accounting for 27% of the variation in the data and the second axis accounting for 18%. From Fig. 3.3 we can see that four of the Commodus hoards (lozenges) fall within the group of hoards from Marcus Aurelius (open squares), but similarly, there is a mixing of hoards of Antoninus Pius (filled squares) with those of Marcus Aurelius. There is no particular evidence to suggest two groups within the Marcus Aurelius data. The problem with this analysis is that it is dominated by factors other than those which Creighton wishes to examine. The object map shows a strong chronological trend in an arc or horseshoe curve[15] going from a hoard of Hadrian at the upper right extreme to a mixture of hoards of Hadrian and Antoninus Pius at the bottom centre, and then to hoards of Commodus at the upper left. By introducing hoards of various dates, Creighton has introduced this strong chronological trend which masked the very variation he sought to examine.

[12]There were a number of problems with the data: hoard C028n (Brecon) has a total of 28 coins but from the percentages this must be 27 coins; hoard C228 (Southants. [*sic.*]) is dated to AD 121 but has no coins later than Trajan; C258 (Westmeston) is dated to AD 140 but has no coins later than Hadrian; hoard C198 (Piercebridge) only totals 70% and it seems most likely that coins of Antoninus Pius which are stated to form 7.5% of the hoard actually form 37.5%; hoard C022 (Blerchley [*sic.*]) is dated to Commodus but has no coins later than Marcus Aurelius.

[13]This program is discussed in detail on pages 147–148.

[14]In Fig. 3.3 the y-axis is reversed compared to Creighton's figure. This reversal is unimportant — simply changing the sign of the y-co-ordinate would reproduce Creighton's figure. Finally, CANOCO scales the PCA results to a map with scores between -1 and $+1$, again this is unimportant.

[15]See section 8.2.2, page 149 for an explanation of this phenomenon.

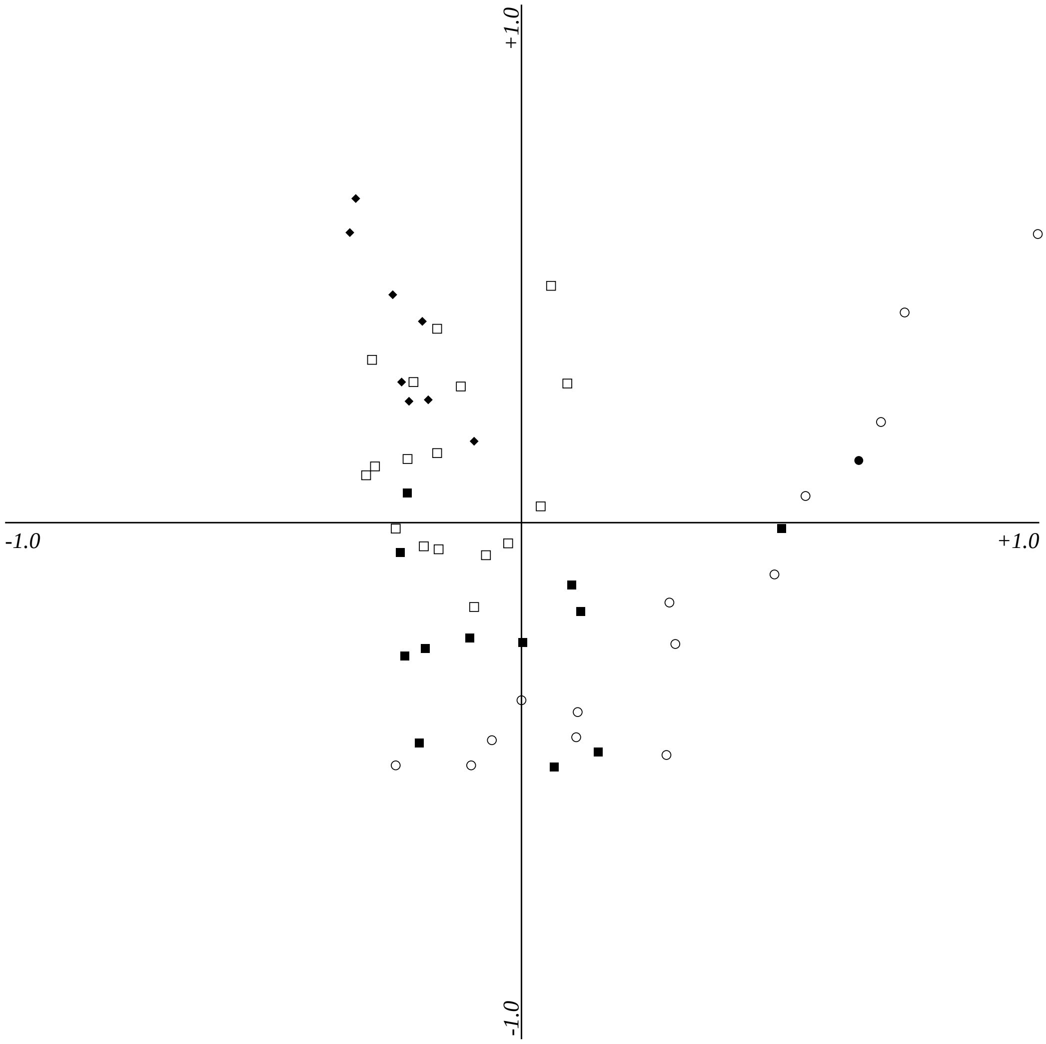


Figure 3.3: Object loading map from PCA of a correlation matrix of Creighton's hoard data from Creighton (1992a, Appendix 2.11). Data analysed is as given with exception of correction of hoard C198 (see footnote 12, page 82). Data points are hoards, closing under: ● Trajan; ○ Hadrian; ■ Antoninus Pius; □ Marcus Aurelius; ⧫ Commodus. First (horizontal) and second principal components.

Creighton also made no attempt to examine the variable loadings or the variable plot. Fig. 3.4 is the variable plot from the analysis of his data.[16] The first axis has periods from the Republic to Vespasian at the positive end, and Trajan to Commodus at the negative end. This is seemingly curious in comparison to the object map which shows many Hadrianic hoards at the right hand side of the map, although they do spread along most of the horizontal axis. A correspondence analysis of count data derived from Creighton's table (not presented) shows a similar pattern, although in a more extreme fashion. The first axis should be interpreted as representing the relative proportions of early coinage, primarily Republican, Mark Antony and Augustus–Claudius, in contrast to later coinage of Trajan–Commodus. Similarly, the second axis appears to present a contrast between coinage of Domitian–Hadrian with that of Antoninus Pius–Commodus. This large variation in the

[16]See page 163 for a more detailed explanation of PCA biplots; see also Baxter (1992a), Neff (1994) and Baxter (1994, pp. 66–71) for more detailed discussions.

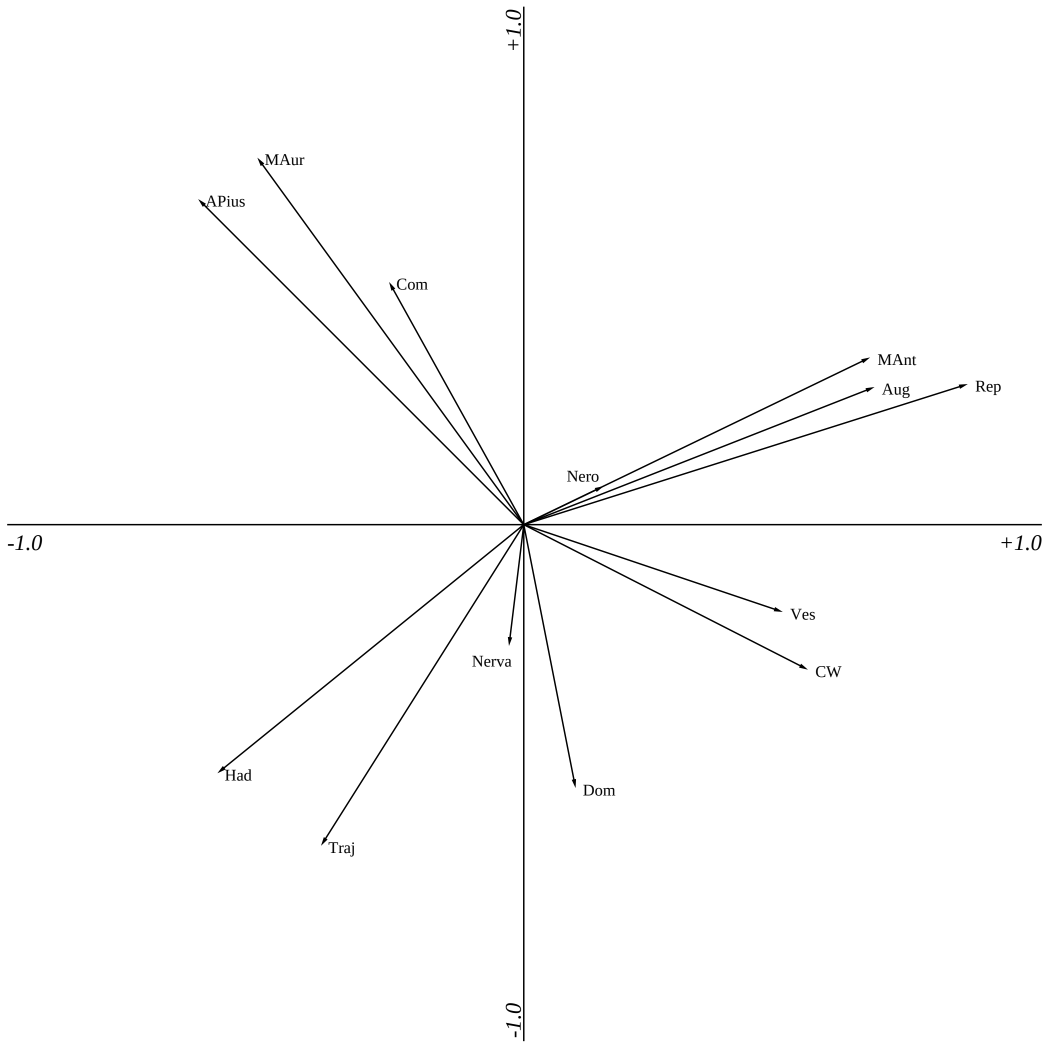


Figure 3.4: Variable plot from PCA of correlation matrix of Creighton's hoard data as for Fig. 3.3 against which this figure should be compared. Each arrow represents a variable (period of issue); loosely speaking, the length of the arrow represents the importance of the variable in the analysis, the angle between variables their approximate correlation. First (horizontal) and second principal components.

Republican coinage in Hadrianic hoards had already been noted by Reece (1988d, pp. 91–94) and is attributed to the deliberate removal of these coins from circulation by the authorities, probably starting under Trajan. By the reign of Antoninus Pius very few hoards contain Republican coinage; in this data set only three hoards out of forty post-Hadrianic hoards contain Republican coins. Creighton has thus not only introduced an unnecessary time element into his analysis, he has also introduced a further source of variation which had already been noted elsewhere.

This is the only recognised multivariate analysis Creighton presented in his thesis. As will be clear by the end of Part II of the present work, I believe that Creighton failed to appreciate the huge potential of multivariate methods in the analysis of hoard data from which his research could have gained considerable benefit.

Following this analysis, Creighton discussed the possibility that hoards can be used to represent the composition of the coinage pool and concluded that they can if many hoards are similar in composition, and we accept that they may only represent the composition of certain denominations within the pool (p. 35–37).

Moving on from this, Creighton discussed the hoard database, the data recorded and the problems encountered (pp. 38–46) before moving on to various analyses designed to identify changes in the speed of circulation of coinage.

3.12.3 Coin wear and the velocity of coin circulation

Having reviewed the work of Rogers and Duncan-Jones (pp. 49–50; see sections 3.9 and 3.10.1 above), Creighton presented his attempt to detect variations in the speed of coin circulation from coin weights (pp. 50–63). He rightly noted the following points (pp. 50–51):

- Any analysis must not mix issues from different Emperors as they may have had different target weights at minting, and different metallic compositions which might affect the wear rate.
- Any analysis must allow for chronological variation in wear rates.
- Any analysis must allow for spatial variation in wear rates.

Creighton selected 15 *denarius* hoards with good weight data; these hoards close between AD 61 and AD 221. The *denarii* contained within the hoards were divided into 12 periods (p. 51). Creighton firstly examined the weight of Vespasianic *denarii* in these hoards and noted that there was a downward trend in the weight of these coins over the 13 hoards included (two hoards close before Vespasian, AD 69–79), and that this trend did not appear to be linear (Fig. 23.02). He therefore plotted a second order polynomial line through the weights; R (*sic.*) $= 0.74$. He then proceeded to calculate the rate of wear using differentiation, and then repeated the process for all the coin issue periods, and finally combined the individual rate of wear curves into a general pattern of wear which he interpreted as being evidence for a decrease in the speed of coin circulation from AD 43–*c.* 120 which then rises again from *c.* AD 150–230.

This analysis has a number of problems. The first is a general numismatic problem, but one which has relevance for the statistical problems. Firstly, Creighton was right in stating that the use of coin weights is problematic due to problems of differential corrosion and cleaning, to which one might add systematic errors due to incorrectly calibrated scales. An example from the Republican period is the coins of L. Piso Frugi (*RRC* 340/1) in the Maccarese and Cosa hoards; both these hoards close in 74 BC and were found in central Italy. The average weight of these coins was 3.91g. in the Maccarese hoard and 3.86g. in the Cosa hoard. Comparison of the mean weights using the two-tailed two-sample t-test shows a statistically significant difference at the 0.05 level.[17] There is no archaeological reason for this difference and we must therefore conclude that it is due either to differential corrosion/cleaning, or errors in recording. Indeed, simply subtracting 0.05g. from

[17]Maccarese: 41 coins, $\bar{x} = 3.86$g., $s = 0.111$; Cosa: 64 coins, $\bar{x} = 3.91$g., $s = 0.118$; $t = -2.06$; $P = 0.041$; therefore reject H_0 at the 0.05 level.

every coin in the Cosa sample results in an identical mean weight, and there is also no statistically significant difference in the variance between the two groups.[18]

This observation is relevant to a critical understanding of Creighton's analysis. In his analysis of the Vespasianic *denarii*, for example, he was plotting his polynomial curve through a large number of individual points, *but*, those points are not independent — they come from, at most, 13 separate hoards.[19] Furthermore, when comparing the curves gained from the analysis of each period, *each curve is not independent* as they use the same sample of hoards. So, for example, the relatively low weight of coins deposited in AD 221 all come from the Akenham hoard. This created a steep slope between AD 195 (Great Meldon) and AD 221 based, in fact, on two independent samples. The problem was exaggerated by the small numbers of coins in this hoard, *e.g.*, the sharp fall in weight at the end of the Republican curve (Fig. 23.04) was based on *one* coin! If we compare figures 23.07 and 23.08 we can see that Creighton used the full time span of the first graph for the *denarii* of Titus–Nerva despite the fact that only three coins were in hoards closing before AD 117, but he did not use the first half of the Trajanic curve which is strongly influenced by the five coins in the Verulamium hoard, as these cause the curve to rise at first!

Although Creighton is rightly cautious about his results, he failed to appreciate the implications of his coin weights not being independent, and this must cast further doubt on his conclusions.

3.12.4 The creation of a benchmark

Creighton then moved on to create a 'benchmark' (pp. 68–70). This benchmark was in effect a series of average hoards derived from 125 hoards in his database with good information and over five *denarii*. Unfortunately, Creighton did not give the *exact* method by which these average hoards were calculated, stating that it was by 'extrapolation and interpolation' (p. 472). Given the importance of the benchmark in later analyses this omission is unfortunate. What is clear, however, is that the data used were better for some periods than others; as Creighton noted, the proportion of *denarii* up to and including Trajanic *denarii* (Fig. 24.01) appeared less variable than the proportion of *denarii* up to and including Vespasian (Fig. 24.02).

3.12.5 Use of contingency coefficients

Creighton firstly discussed what the variability around the mean (*i.e.*, his 'average' hoard) might represent and concluded (pp. 71–3):

- If there is a wide variation around the mean, *i.e.*, high inter-hoard variability, this must either imply a slow velocity of coin circulation, or new issues being produced.
- If the hoards are uniform, there must either be a fast velocity, or no new issues being produced.

Chapter 9 examines this hypothesis in some detail; here it is sufficient to note that this interpretation is far too simplistic.

[18] Cochran's C test for equality of variances: 0.53, P=0.62. Figures from STATGRAPHICS.

[19] In his Fig. 23.02 there appears to be only 11 hoards used, and of those three have only four coins between them, and a further hoard has only four coins.

Creighton then attempted to quantify variability by the use of Cramér's contingency coefficient 'Φ' (pp. 73–76). This statistic, usually known as Cramér's V^2 (Bishop *et al.* 1975, pp. 386–387),[20] is a measure of association based on the χ^2 statistic and is basically a scaling of χ^2 which removes the effects of sample size. Creighton used this statistic as a measure of similarity: if V^2 is near to zero he interpreted this as there being little variation between hoards, if V^2 is near to 1 there was a high degree of variability between hoards. Creighton divided the hoards into batches of ten years and computed V^2 for each group. The values of V^2 were then plotted on a graph (Fig. 24.08–24.09).[21] The details of this technique were given in Appendix 2.43 and the details of the contingency tables in Appendix 2.44. Creighton stated that the pattern revealed is (p. 76):

1. Invasion to mid-second century: no systematic picture.
2. Mid-second–early-third centuries: very similar suggesting high rate of circulation.
3. Early to mid-third century: *antoninianus* introduced, abandoned and then re-introduced. No systematic picture but indication that the circulation rate is slowing down.
4. Very little similarity as the *denarius* is driven out of circulation.

There are two criticisms of this analysis: one methodological and one numismatic. The methodological problem lies in the manner Creighton calculated V^2. In his Appendix 2.44 the contingency tables used were presented. As would be expected, the number of rows and columns in these tables varied according which decade the table represents. Apart from the first table, Creighton restricted the number of columns to four. However, in combining phases to create the columns, he was not consistent. For example, for hoards closing AD 110–119, the columns were Phase A (Republican), B–E (Mark Antony to the Civil War), F (Flavian I) and G–I (Flavian II to Hadrianic), whereas for hoards closing AD 120–128, the columns were A–E, F, G and H–I (Trajan to Hadrian). Presumably, the column combinations were an attempt to ensure that the expected value of each cell in the tables was greater than 5, a conservative rule of thumb often used to avoid the χ^2 test giving erroneous results in cases where there are either small sample sizes or sparse contingency tables. The problem is that the value of χ^2, and thus of V^2, will change according to which columns are combined. For example, the two tables cited above had values of V^2 of 0.1344 and 0.0860 respectively. If we combine the columns in the two tables so that we only have three, A–E, F and G–I, the value of V^2 rises to 0.1870 for the first table and 0.1214 for the second. One should also note that the associations appear greater if V is used, rather than V^2. In any case, (Bishop *et al.* 1975, p. 393) note that "the major difficulty in their [χ^2 based measures] use is lack of clear interpretation."

The second problem is numismatic in that we are not comparing like with like, *e.g.*, hoards closing just after the conquest can contain coins from 211 BC up to their closing date (? AD 50);

[20]Note, however, that Bishop *et al.* (1975) actually define V, not V^2 whereas both Shennan (1988) and Iman & Conover (1983) define V^2 (although in the later case it is called Φ). Both the STATGRAPHICS and SPSS packages, however, provide Crámer's V. For the purposes of this section, I will use V^2 for ease of comparison with Creighton's results.

[21]Creighton produces a similiar graph in his paper on this topic (Creighton 1992b), but in this case the y-axis has been plotted on a logarithmic scale to emphasise the difference between the values of V^2.

hoards closing during Trajan can have coins from 211 BC to AD 117, and thus coins minted at about the time of the conquest would have had 70 years for their distribution to further homogenise. This is most clear in the latter 3rd century when the debased *antoniniani* drove out the finer *denarii*; hoards of that period are much less 'similar' according to Crámer's V than previously.

Creighton's approach has some merit, but is weak in application. Although it may have reduced the number of usable hoards, and would have possibly taken longer to collect the data, a better approach would have been to divide the coins into the same ten year groups into which the hoards were divided. Having done this, Crámer's V could then be calculated for coins dating to the last few (? four) decades of the hoard. Although this would not remove the problem of the variable number of hoards in each table, it would ensure that the tables were more comparable. At present, Creighton's results must be treated with extreme caution, and his interpretations more so.

3.12.6 Comparing hoards to the benchmark

Creighton was dissatisfied with the results of the contingency table analysis as he felt that a ten year resolution was too coarse (p. 77). He therefore developed a technique suitable for individual hoards based on hoard structure (pp. 78–103). This method consisted of comparing hoards to the relevant 'average' hoard from his benchmark (see section 3.12.4). This comparison was achieved by calculating the area (*net area difference*, NAD) between the cumulative proportion curves for the hoard and the average hoard of the same date. He defined four types of hoard:

1. normal: very close to the average hoard
2. archaic: more older coin than the average hoard
3. modern: more newer coins than the average hoard
4. average but variable: a hoard rather unlike the average hoard but where the hoard's cumulative proportion curve crosses the average hoard curve and the positive and negative areas balance out.

Although Leese (1983, p. 52) suggested the use of the area between two cumulative proportion curves as a dissimilarity coefficient, she was able to control the sample sizes. In this case, Creighton was using hoards as small as five coins. These small hoards will always have large area values due to the coarseness of the cumulative proportion curve. It was not until page 107, after extensive discussion and interpretation of the results, that Creighton finally admitted:

> A second effect is simply that the cumulative composition curves of smaller hoards will show a greater variation around the norm than larger ones, simply due to the lack of precision caused by the small sample size. Both these trends are observed in Figs. 26.01–26.02.

There are three alternative courses of action:

1. only use large hoards (100+ coins?)
2. use a standard (dis)similarity coefficient which accounts for variable sample size

3. use medium sized hoards (30+ coins) and Dmax (Kolmogorov-Smirnov distance)

The last course of action was that adopted in Chapter 10 below.

Having illustrated his method (pp. 78–88), Creighton moved on to present a chronological analysis of the results (pp. 89–95). This was done either by calculating the area between the hoard and its contemporary average hoard, and plotting the result, or by identifying the average hoard closest in structure to the hoard and calculating the difference in their dates. Both methods showed hoards being more similar to the average hoards in the period *c.* 140–210 than previously or subsequently. Creighton interpreted this in terms of changes in the speed of circulation and went on to suggest that the fall in the speed of coin circulation in the Severan period was due to the large injection of coinage into the coinage pool at this time. This interpretation will be discussed fully in Chapter 9, page 284.

Creighton's attempts to identify changes in the speed of coin circulation are an example of what Casey (*pers. comm.*) calls a 'wigwam argument' — each strand is weak in itself but the whole combined is strong. The problem with this type of argument is, to continue the analogy, that if you start removing or breaking the individual poles, the whole structure becomes weak and unstable. In this case, the three analyses presented which claim to identify changes in the speed of circulation all have severe methodological problems, and two of them are both based on the same interpretation of inter-hoard variability which will be shown to be fallacious (see Chapter 9). Unfortunately, the supposed pattern of changes in the speed of coin circulation is most likely to be an artefact created by dubious methodology and a variable supply of coinage to Roman Britain.

Following this, Creighton went on to plot the NAD values for hoards on distribution maps (pp. 95–103; Figs. 25.16–25.20), dividing the hoards into 50 year groups. The pattern revealed clearly showed new coinage entering the Romano-British coinage pool in military areas such as along Hadrian's Wall. It is interesting to note that there is no evidence to suggest coins entering the coinage pool in London, the Provincial capital. Creighton made the interesting suggestion that the provincial administration may have been paid for by locally raised taxes, whereas the army was paid for by a mixture of local taxes and imported revenues. Creighton's interpretation of the significance of differences between the maps based on changes in the speed of circulation was again based on his interpretation of inter-hoard variability outlined above.

3.12.7 Hoard size

Following the analysis of hoard structure, Creighton investigated the possible significance of hoard size (pp. 104–115). He firstly plotted his NAD figures against hoard size and, unsurprisingly, finds that small hoards, especially those less than 20 coins, have high NAD figures, tending towards the modern (Fig. 26.01). This he interpreted as being the result of poor dating, and the coarseness of the cumulative proportion curves, for small hoards (p. 107). The effect that this factor may have had on previous analyses was not discussed. He denied that there is any trend for large hoards to be more archaic than smaller hoards, and thus that there was any evidence of large hoards being 'savings' hoards. Estimating from his graphs, however (Figs. 26.01–26.02), shows approximately 12 out of 13 hoards over 400 coins either being average or archaic in structure, and no hoard over 1000 coins exhibiting a modern profile.

Creighton then demonstrated that the mean size of hoards increased from the conquest to AD 220, but rightly noted that the mean was biased by a few very large hoards in the later period. He therefore also used the median as a more robust statistic and a similar, if much less marked, pattern was revealed (p. 107 & Figs. 26.03–26.04). There did appear to be an increase in the average size of hoards, and also an increase in the number of large outliers. Creighton then moved on to discuss the use of rank-order graphs as a means of assessing changes in the distribution of coinage holdings (pp. 107–116). The technique was similar in spirit to the use of Gini's coefficient and Lorenz curves in the analysis of social structure from burial evidence (*e.g.,* Morris 1987). Unfortunately, although there was a clear difference between the curves for AD 40–237 which are all very similar, and the curves for AD 230–299 for which there are marked differences (Figs. 26.07–26.08), the interpretation was ambiguous. This last analysis was extremely interesting and worth further investigation, especially in the light of Reece's observation that coin loss in Italy occurs at a regular rate over the period 40–400, whereas coin loss in Britannia was very low until *c.* AD 230 when it increased rapidly. It would appear that there was a large change in the use of coinage in Britannia in the third century which cannot be entirely dismissed as solely the result of the changes and debasement of the coinage.

3.12.8 Site finds and the coinage pool

In the above I have discussed Creighton's work in detail as it relates to the analysis of coin hoards. Section 3 of Creighton's thesis investigated site finds and the coinage pool, and section 4 presented a series of case studies. These are discussed in less detail than his hoard analyses, but again I concentrate on the methodological aspects of his work.

After presenting a conceptual and historical survey of the analysis of site find assemblages (pp. 117–122), Creighton then attempted to define a loss correction factor which would allow the value of the coin to correct its relative representation in the coinage pool. This was attempted using Reece's data from central Italy (pp. 123–125). This gave a rather high figure for the number of exchanges involving *denarii* and so Creighton compared the results with material from Pompeii and concluded that the high numbers of *denarii* lost, in comparison with bronze coins, was in relationship with the high numbers of *denarii* carried, not exchanges involving *denarii* (pp. 125–127). He concluded that we need to examine different denominations separately when examining the coinage pool as the loss rates between denominations are affected by different factors such as visibility and value.

Following this, Creighton discussed Ryan's site finds database (Ryan 1988) and his changes and additions to it (pp. 128–132). Creighton then discussed the relative distribution of coinage by period over eight types of Romano-British site (pp. 133–143), firstly by a graph of all periods and site types (Fig. 33.01) and then as a series of ratios (Figs. 33.02–33.10). Creighton only examined nine of the possible 28 two-way comparisons. Although some obvious, and some interesting patterning, was revealed, this is a good example of where multivariate analytical techniques such as correspondence analysis or log-linear modelling may have helped. Creighton summarised his results in Fig. 33.11. In general terms, there appears to be a gradual increase in the quantity of money in the countryside over time. Creighton's tentative conclusions from section 2 are now presented as established facts

(p. 141). Creighton then proceeded to analyse the ratio of silver and bronze coins in the various site types but the results appear ambiguous, although silver tends to concentrate on military sites.

From this Creighton moved on to provide a new model of coin circulation. (pp. 149–169). He noted, rightly, that coin circulation is dynamic, but our evidence for it, primarily hoards and site finds, are static, and thus our models and analyses also tend to be static. One factor which he felt would be interesting to model was the supply of coinage to a region. Noting that the life of an individual coin issue or series can be represented by a battleship curve (*cf.* Collis 1988), and that the composition of the coinage pool at any date can be calculated from the hoard evidence, what was needed was a method to move from a proportional scale graph to a absolute scale graph. This was achieved by an ingenious combination of the hoard and site find evidence. The method will not be outlined in detail here but it suffices to say that the key stage when the estimated supply curve is compared with the real data is flawed as the χ^2 statistic has been wrongly calculated — the χ^2 test cannot be applied to tables of percentages as Thomas (1978) has so clearly stated. If, however, the model survives this error, it appears to show a varied pattern in the total numbers of coins in circulation in Britannia.

3.12.9 Case studies

Creighton then moved onto a series of case studies. These include an investigation of the late Iron Age coinage pattern especially of the Iceni (*cf.* Creighton 1992b), the function of Claudian copies, and the rôle of brass in late Iron Age and early Roman Britannia. He made the interesting suggestion that:

> This discourse has been simply to establish that in the religious and hoarding sphere of late Iron Age and early Roman life, broaches and coins could fulfil similar functions. The circulation of coinage could be used to reinforce social status whilst broaches could be used to display social status. (Creighton 1992a, p. 208)

The suggestion that brass as a metal may have had a value greater than would normally be attributed to it in the present due to a prestige factor is interesting, and a salutary reminder that the relative values of metals is not universal, but varies over time and space.

Creighton then went on to present a long review and re-analysis of Walker's Bath report (pp. 211–230). As part of this analysis he attempted to examine the supply of *sestertii* using two methods. The first was the same method as used for *denarii* mentioned above, the second used a combination of the *sestertii* in hoards with a wastage (decay) rate. He examined the effect of various rates between 0–14% (Figs. 42.08–42.11) and concluded that 8% is the most likely figure as it produced a curve which was in close agreement with the results from the first method. This was a direct contradiction to his assertion that the decay rate was 0.003% mentioned above, and it is also much higher than any other estimate of the decay rate for a coin series in normal circulation, *i.e.*, not subject to deliberate removal from the coinage pool. We must, therefore, conclude that there is likely to be a major flaw in at least one of the two methods.

The next case study was an analysis of the debasement of the *denarius* (pp. 231–247). In this Creighton used David Walker's estimates of the silver content of *denarii* (Walker 1976; 1977, 1978). Unfortunately, these can now be shown to be highly unreliable and thus the basic data for this section is unusable. Creighton's suggestion, however, that the debasement of the *denarius* was solely to account for loss of silver due to coin wear is frankly fantastic. The last case study was an examination of the transition from the *denarius* to the *antoninianus* (pp. 248–254).

Finally, Creighton attempts to integrate his results into an overall framework using the quantity theory of money (pp. 254–278). There are many interesting and useful comments and suggestions in this section but all of his conclusions are based on two basic premises: firstly, that the quantity theory of money is applicable to Roman Britain and secondly, that one believes the results of his analyses, and in particular his fallacious correlation of low inter-hoard variability and high speeds of coin circulation. He concludes by noting that the development of 'monetization', and economic growth more generally, are not constant, but can be variable if not cyclical (*cf.* Going 1992). In his concluding remarks (pp. 279–281) he also made the very valid point that it is possible that a large proportion of production and consumption probably lay outside the monetary economy and remained within traditional networks of exchange based on social relations.

3.12.10 Summary

Creighton's thesis was an extremely ambitious attempt to use coin data to examine many aspects of the ancient economy. It contains many brilliant ideas which are marred by methodological flaws, which could have been avoided, and thus the resultant interpretations rarely have any secure basis. For example, an investigation of the causes of inter-hoard variability, although a rather unexciting topic, would have prevented Creighton drawing erroneous conclusions from that variability. It seems fairly clear that he did not seek advice from a statistician, who surely would have prevented some of the errors.

This thesis is, however, extremely important in that it raises a series of new questions which might be asked of coin data, although many of them seem as yet unanswerable (*e.g.,* see Chapter 10). The work presented here in Part II is less ambitious in its aims than that of Creighton, but lays a strong foundation for the analysis and interpretation of Roman Republican hoards. This extensive review has been necessary for a number of reasons: firstly, because of the overlap between my work and Creighton's; secondly, because it illustrates many of the problems encountered in the analysis of hoards; thirdly, because it demonstrates the validity of my more cautious approach; and lastly, because the results of Creighton's work, although still largely unpublished, are being used by others (*e.g.,* Going 1992) who have not appreciated the problems.

3.13 Estimating the size of coin issues

3.13.1 Introduction

One topic which has stimulated much debate over the past forty years, and has often been quite controversial, is the problem of estimating the size of ancient coin issues, either in absolute or relative terms. The recent resurgence of this debate was the stimulus for my original study (Lockyear 1989) and thus for the present work. I examine one particular aspect of this debate in Chapter 11 and it is appropriate therefore, to review this debate fully here.

Only in a very few cases, such as the Amphictionic coinage of Delphi (Kinns 1983), do records survive that enable us to examine the size of ancient coin issues directly. Numismatists have, therefore, developed techniques which it is hoped will enable such estimates to be made. The essence of the method is that the number of dies used to strike an issue of coinage can be used either to compare relative sizes of issues, or to estimate absolute sizes if some information is available regarding the number of coins struck per die. There are, therefore, two main tasks. The first is to estimate the number of dies used, and then to estimate how many coins were struck per die.

3.13.2 The use of die-links and estimation formulæ

Dozens of papers and formulæ dealing with this topic have been written and I will not attempt to review them all here. The methods have been subject to one general, and two detailed reviews including computer simulation experiments to assess their effectiveness (Metcalf 1981; Esty 1986; Lyon 1989). The most commonly employed methods are those of Lyon (1965) and Esty (1984). Esty (1986, n. 21, p. 198 & Appendices 1–2, pp. 199–209) lists proposed methods which should *not* be used.

All these methods use the same type of data, *i.e.*, the number of dies used to strike the coins in the sample under examination. Die-analysis is a simple, if time consuming operation. Coin dies in antiquity were cut by hand and thus between dies of the same type or design, there will be minor variations in the letter-form, the design and the relative positions of the elements. With a careful examination of a sample of coins, the number of dies used to strike those coins can be counted. This count, however, will be an under-estimate of the number of dies used to strike that coinage, unless the sample is very large and very complete, which is rarely the case. The task of the formula is, therefore, to give an estimate of the number of dies originally used, and preferably a confidence interval, *i.e.*, a range within which the estimate is most likely to fall, usually a 95% confidence interval. This number of dies is then multiplied by the average number of coins struck per die to give an absolute output figure. Some methods also use the number of dies represented by only one coin in the sample, the number by two, three and so on in their estimates.

All of these methods rely on the sample of coins being a random selection of those struck. Many also rely on the numbers of coins struck per die being constant, which is known to be untrue. The method suggested by Esty (1984) does not assume equal output, and is the least effected by non-random sampling (Esty 1986). I shall briefly outline the method, without any formal mathematical proof. Esty's method is based on the concept of the coverage of a sample originally introduced into the statistical literature by Good (1953).

The definition of the coverage of a sample is the total number of coins struck by dies identified in the sample, divided by the total number of coins struck. Thus, if in a sample of 100 coins 58 dies were identified, and these 58 dies struck 580,000 coins of a total of 1,200,000 coins, the coverage would equal 0.483. More formally,

$$C = \frac{T_0}{T} \tag{3.1}$$

where C is the coverage, T_0 is the number of coins struck by dies found in the sample, and T is the total number of coins struck. To calculate the total number of coins struck we can rearrange the formula,

$$T = \frac{T_0}{C} \tag{3.2}$$

In a real situation, we do not know T_0, the numbers of coins struck by the dies in the sample, but we can estimate this by multiplying the number of dies in the sample by a figure for the average number of coins struck per die. Thus,

$$T' = \frac{T_0'}{C} \tag{3.3}$$

where T' is an estimate of the total number of coins struck, and T_0' is an estimate of the number of coins struck by dies observed in the sample where $T_0' = \kappa \times d$ where d is the number of observed dies, and κ is the number of coins struck per die.

We now need an estimate of the coverage, C', which can be estimated by

$$C' = 1 - \frac{N_1}{n} \tag{3.4}$$

where N_1 is the number of dies which are observed exactly once in the sample, and n is the size of the sample. This estimate can be very good, and is not affected by unequal die output. We need, however, some confidence limits so that the accuracy of the results can be assessed. If n is large, and N_1/n is not very near 0 or 1, the limits are given by

$$1 - (N_1/n) \pm z\sqrt{\left(\frac{\frac{N_1+2N_2}{n} - \left(\frac{N_1}{n}\right)^2}{n}\right)} \tag{3.5}$$

where z is 1.96 for the 95% confidence limit, 1.65 for the 90% or 1.0 for the 68% limits, and N_2 is the number of dies represented by two coins in the sample.

Esty provides the following worked example. In a hoard of 204 coins there were 178 distinct dies of which 156 dies where represented by a single coin, 19 by two coins, two dies by three coins and 1 die by four. Using his notation $n = 204, N_1 = 156, N_2 = 19, N_3 = 2, N_4 = 1$. Using equation 3.4 we get

$$C' = 1 - \frac{N_1}{n} = 1 - \frac{156}{204} = 0.235.$$

Thus our best guess is that the 178 dies represents 23.5% of the coinage struck. Using formula 3.3, and a figure of 10,000 coins struck per die, we can estimate the size of the whole coinage as

$$T' = \frac{T_0'}{C'} = \frac{\kappa \times d}{C'} = \frac{10,000 \times 178}{0.235} = 7,570,000.$$

This single, point estimate is very likely to be wrong and so we calculate the 95% confidence limits for C'

$$C' \pm 1.96\sqrt{\left(\frac{\frac{156+2\times 19}{204} - \left(\frac{156}{204}\right)^2}{204}\right)} = 0.235 \pm 0.083.$$

Using values of C' of 0.152 ($0.235 - 0.083$) and 0.318 ($0.235 + 0.083$) we can state that with $\kappa = 10,000$, there is a 95% probability that the total number of coins struck was in the range 5,600,000–11,700,000.

Two further points must be noted. Firstly, if we are only interested in the relative sizes of issues, rather than the absolute sizes, we can work with an arbitrary value of κ providing we are happy to accept that it is constant between the issues we are comparing.

Secondly, we cannot convert the coverage estimate, C', to an estimate of the total number of dies (D') used to strike the issue, unless we are prepared to make an assumption as to the distribution of the number of coins struck per die. If we accept the simplest situation of equal output, we can simply divide the number of observed dies d by the coverage C'. In the case of the above example this would give us

$$D' = \frac{d}{C'} = \frac{178}{0.235} = 757.$$

Esty (1986) suggests that the distribution of the numbers of coins struck by dies will actually follow a negative-binomial distribution with a shape parameter (t) of 2. If this is the case, the number of dies can be calculated by

$$D' = \frac{d}{C'} + \frac{n(1 - C')}{tC'}. \tag{3.6}$$

A revised estimate using this formula with $t = 2$ gives an estimate of the number of dies of 1089. It is very important to note, however, that this does *not* affect the total numbers of coins struck as estimated above. The negative-binomial distribution allows for a large number of dies which broke quickly and produced very few coins, hence the increase in the number of dies, but no increase in the numbers struck.

Lyon (1989, p. 8), however, does not agree with the use of the negative-binomial correction to the die estimate unless there is clear evidence to suggest that the number of coins struck per die is distributed in this fashion. Esty & Carter (1991–1992) explicitly examine the distribution and found that negative-binomial distribution with a shape parameter of 1.5–2 fits the empirical data extremely well. Incidentally, they also note that the variability between reverse dies is generally greater than between obverses. This is almost certainly due to the fact that the obverse die is mounted in an anvil, and the reverse is the die struck with a hammer. Lastly, they note that it is important for die studies to record not only the sample size, and the number of observed dies, but also number of dies represented by two coins, three coins *etc.*

3.13.3 How many coins were struck per die?

In any of these studies, an estimate of the average number of coins struck per die (κ) has to be made if the *absolute* size of the coin issue is to be calculated. If the relative size of coin issues is all that is necessary, then this value is less important, but the assumption that it remains relatively constant between the issues being compared is fundamental. The sources of information for this value are few and far between. For ancient coinage the only direct evidence is the Amphictionic coinage (Kinns 1983).

The Amphictionic coinage is unique in the ancient world because some of the treasurer's accounts from Delphi record balances and expenditure in this coinage enabling the total amount struck to be calculated and compared with the extant coin data. There is also information which records some details of the minting operation itself. The Amphictionic coinage consisted of three denominations, of which the largest, the stater, is the most abundant. There are, however, only 31 surviving coins from this issue, of which 26 are staters. Within these 26 coins, however, there are only 7 obverse dies represented, of which 8 are struck from a single die. It would seem highly unlikely that there are many more dies to be found, and the application of the Lyon formula and others suggests a maximum of nine obverse dies. From the surviving records, these dies probably struck between 100-157.5 talents, and this gives a range of 23,333 coins per die (9 dies, 100 talents) to 47,250 coins (7 dies, 157.5 talents). Although this range is large, the possible means are much larger than had been previously suggested. Sellwood (1963) on the basis of experiments in striking coins, suggested between 10,000–16,000 for hot striking and 5,000–8,000 for cold. Low figures in the range Sellwood suggested have been used widely in Greek numismatics (Kinns 1983, nn. 68–71, p. 19).

Within medieval numismatics, there has been a similar disagreement, although more data for die-output is available. One controversy was a disagreement between Grierson and Metcalf over the size of the Anglo-Saxon coinage, especially that of Offa — the debate is summarised by Grierson (1967). In short, Metcalf had estimated the size of Offa's coinage to 10–30 million pennies; Grierson preferred a total of $\frac{1}{2}$–1 million pennies. Grierson, among others, was wary of the use of Brown's formula (Brown 1955–7, p. 580, n. 2), which has subsequently been shown by Esty (1986) to have problems. Even the use of Lyon's formula (Lyon 1965) resulted in die estimates somewhat above those that Grierson and Lyon were prepared to accept, and the validity of Metcalf's die analysis was questioned (Grierson 1967, p. 154). The problem, according to Grierson, lies in the multiple mint system in use in Britain at this time which results in any single hoard being dominated by the products of the local mint rather than being an accurate representation of the overall composition of the coinage pool. In other words, both Brown's and Lyon's formulæ depend on the use of a random sample, and at this period the local variations in the coinage pool make hoards unrepresentative of the whole coinage pool (Grierson 1967, pp.155–7). Finally, Grierson again pointed out the problem of using an average number of coins per die for different series noting that estimates had varied from 1,800–20,000 coins per die.

A more constructive paper was that of Stewart (1964). In this paper he questioned his own conclusions that the average number of coins struck per die in the Newcastle and Bristol mints during the recoinage of 1300–2 was 30,000 coins per obverse die, and that the York issue of 1353–5 appeared to have struck about 72,000 coins per die. These estimates were considered by many to be too high: evidence from Bruges suggested 2,500–5,000 coins per die for an issue of 1468–9 and another issue from Ghent of 1492–3 had an average of between 5,000-10,000 coins per die. A re-interpretation of the written record suggested that the Newcastle/Bristol figure could be brought down to 10,000 coins per die, and the York figure may be the result of an incomplete record of the dies purchased by the mint. However, other evidence for Chester suggested that a figure of 24,000 per obverse die was possible and thus the problem of Newcastle and Bristol remained open. Stewart went on to state:

> Reservations are to be made in using the frequency of occurrence of coins in hoards as an indicator of the relative size of issue. However, in a homogeneous coinage such as that of Edwardian sterlings, provided a hoard was gathered in a single coinage province with reasonable internal communications, and buried sufficiently long after the issue of the coins for geographical bias to have been eliminated, the products of the different mints should have been circulating evenly and should be so represented in a large hoard. (Stewart 1964, p. 300)

We should extend this caution to any monetary system with multiple mints. Stewart then went on to state:

> ... while the evidence as now presented appears even more complex and inconsistent, the fact seems to emerge that there is no such thing as an average output figure for medieval coin dies—not even for dies for coins of the same metal at the same of comparable mints within a period of less than a century. (Stewart 1964, p. 302)

This quote was cited by Buttrey (1993, p. 345), although somewhat out of context, and is more pessimistic than the data presented by Stewart would seem to demand.

3.13.4 Crawford's method

In the second volume of *Roman Republican Coinage* (hereafter RRC), Crawford presented an attempt to estimate the size of the majority of the silver *denarius* issues of the Roman Republic and to correlate this with expenditure on the army (Crawford 1974, pp. 640–707). This study has proved extremely controversial and the methods used, his conclusions, and the uses to which his die estimates have been put, continue to be a matter of often acrimonious debate. Some parts of this debate will be examined in detail in Chapter 11, and it is therefore worth describing Crawford's method in detail.

The first stage of the study was to produce an estimate of the number of dies used to mint every issue of coinage from 157–50 BC. To do this via die counts and estimation formulæ would be impossibly time consuming. For the Roman Republic, however, there are a small number of issues which have control-marks or symbols (Crawford 1974, pp. 584–589). These control-marks, sometimes letters or numbers, sometimes small pictures, are unique to the die for some issues. So, for example, the issue of P. Crepusi (RRC 361/1a–c; Hersch 1952) has a series of numbers cut onto the reverse die surface, and a series of letter/symbol combinations on the obverse. Thus, for a small number of issues, we can easily obtain a die count by counting the number of symbols. A list of these issues used by Crawford is given in Table 3.1.

There are, however, several complications even with this step. Firstly, Crawford needed to work either with the obverse, or the reverse dies. This is because the reverse die, which was held in the hand or tongs and hit with a hammer, struck fewer coins than the obverse which was set in an anvil, hence the overlap between different dies which enables groups of dies to be identified (*e.g.,* the issue of C. Piso Frugi, RRC 408/1a–b, Hersch 1976). The die symbols sometimes occurred on the

moneyer	ratio	issue	catalogue obv. : rev.	Table L obv.	Table L spec.	year
C. Antestius	1.53	219/1a–b	15 : 23	15	23	146
N. Fabius Pictor	1.38	268/1a	4 : 5	18	25	126
		268/1b	14 : 19			
Ti.Q	0.48	297/1a–b	(87) : 109	(87)	42	112–1
Mn. Fonteius	0.89	307/1a	(11) : 14	(11)	(8)	108–7
		307/1b–d	(38) : 48	(38)	(36)	
M. Herennius	0.52	308/1a	120 : (150)	120	(66)	107
		308/1b	(126) : 158	(126)	(63)	
C. Fabius C.f.	0.60	322/1a	58 : (72)	58	(21)	102
		322/1b	(64) : 80	(64)	(51)	
C. Fundanius	0.59	326/1	57 : (71)	57	34	101
Lentulus Marcelli f.	0.38	329/1a–b	85 : 85	(68)	29	100
		329/1c–d	13 : 13	(10)	1	
C. Censorinus	0.99	346/1a–i	102 : 113	102	101	88
	0.70	346/2a–c	(90) : 100	(90)	63	
P. Crepusius	0.53	361/1a–c	283 : 296	283	150	82
C. Annius T.f.T.n.†	0.34	366/1a-3c	(99) : (108)	85+(14)	41	82–1
		366/4	(31) : 34	(31)	4	
C. Marius C.f. Capito	0.39	378/1a	19 : 19	(112)	44	81
		378/1b	6 : 6			
		378/1c	100 : 100			
L. Papius	0.41	384/1	211 : 211	(190)	80	79
M. Volteius	0.62	385/3	(61) : 68	(61)	38	78
M. Plaetorius Cestianus	0.62	405/5	54 : (60)	55	34	
C. Piso L.f. Frugi	0.36	408/1a	53 : 59	196	72	67
		408/1b	144 : 175			
L. Roscius Fabatus	0.37	412/1	240 : 241	(218)	81	64
L. Buca *etc.*	0.27	480/1–22	379 : 414	379	103	44

Table 3.1: Detail of issues used by Crawford to calculate the number of obverse dies. Brackets around die counts indicate estimated values. Brackets around specimens indicate an 'odd' specimen count. † The figures for this issue are complicated as counts for the different varieties are either true counts or estimates; the obverses consist of 85+(14) and the reverses of (86)+22. From Lockyear (1989, Table 1.3) with corrections, data originally from Crawford (1974, Table L, pp. 652–3, pp. 381–386).

obverse, sometimes the reverse and sometimes both. In those cases where a die count was available for only one die, the other was estimated at a ratio of 4:5 obverse:reverse, for issues struck before 96 BC and 9:10 obverse:reverse for issues struck after that date. These ratios were derived from the issues of C. Antestius (RRC 219/1a–b) and N. Fabius Pictor (RRC 268/1a–b) for issues before 96, and P. Crepusius (RRC 361/1a–c) and L. Buca *etc.* (RRC 480/1–22) for issues after 96 BC.

A further complication was that some issues of coins with die marks had paired symbols, that is all the coins with one symbol on the obverse, have the same symbol on the reverse. Issues with paired symbols are listed in Table 3.2. In this case the obverse dies must have been under-used and so Crawford adjusts the obverse die count by $\frac{4}{5}$ before 96 and $\frac{9}{10}$ afterwards.

By these means Crawford obtained an obverse die count or estimate for twenty Republican issues (see Table 3.1). From the work of Thordeman, and others, he could reasonably expect that there should be some relationship between the obverse die counts and the total number of specimens in a hoard. To increase his sample size and coverage, Crawford selected 24 hoards (Table L,

moneyer	issue (RRC)	date (BC)
L. Iulius Caesar	320/1	103
Lentullus Marcelli f.	329/1a–d	100
P. Sabinus	331/1†	99
C. Marius Capito	378/1a–c	81
L. Papius	384/1	79
M. Volteius	385/4	78
L. Roscius Fabatus	412/1	64

Table 3.2: Issues with paired control-marks which are different for every die. Data from Crawford (1974, p. 586). † *Quinarius* issue.

period	dies : specimens
Down to 126	$\frac{2}{3}:1$
125–92	$1\frac{2}{3}:1$
91–85	$1\frac{1}{4}:1$
84–58	$2:1$
57–31	$3:1$

Table 3.3: Crawford's ratios used to calculate obverse die numbers.

pp. 642–672) and summed the number of coins of each type where he had die counts. The ratio of specimens in the hoards to the die counts was then plotted as a scattergram (Fig. 5, p. 673, reproduced here as Fig. 3.5). From this a series of multiplication ratios were derived (Table 3.3 and Fig. 3.5) and then the die counts were estimated for every issue by multiplying the total number of specimens for the issue by the ratio — the results per year are given in Appendix C. Crawford does not state, however, how he estimated the dies for the small number of issues where there was a 'freak' value in the hoards, *e.g.*, the 400 examples of 341/2 in the Fiesole hoard (p. 650, n. 8, see also nn. 4–12, pp. 644–658).

Having thus gained an estimated die count for every issue of *denarii*, he then multiplied this count by 30,000 to get an estimate of the absolute size of the issue. The origin of this now infamous figure was based on a single issue of coinage.

> The issue of C. Annius was *presumably* used to pay the two legions (*at least*) which he commanded for *at least* a year; their cost *may be* regarded as over 3,000,000 denarii, in this period. (Crawford 1974, p. 694, emphases mine).

Crawford notes that estimates for the Greek coinage are much lower, but generally Greek coinage was struck with higher relief and more care. My emphases in the above quote indicate some of the problems with this estimate. All other arguments aside, it also seems inherently unlikely to me that the state would generally pay anyone only in new coin. Three reasons can be offered: firstly, the process of melting down and reminting coins collected in taxes would result in a loss of revenue through coin wear. Secondly, if all taxes were reminted, there would be a very high decay rate which is not visible in the evidence (see Chapter 11), and lastly, there is no reason to assume that whatever the legions were paid on paper, was ever paid to them in coin. Few have seen any real justification for this figure.

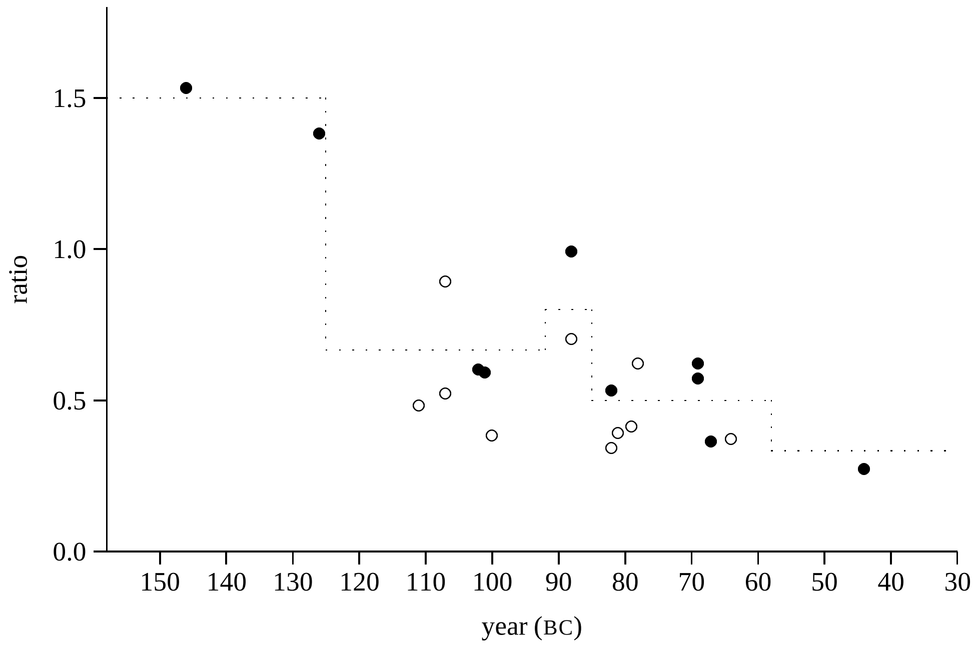


Figure 3.5: Ratio of hoard specimens to obverse dies. Filled circles are calculated from counted dies, empty circles from an adjusted or calculated die figure. Lines represent the ratios used by Crawford to calculate die numbers for all other issues. After Lockyear (1989, Fig. 1.2).

The last stage of Crawford's analysis was to estimate the cost of the army per year and to see if there was any correlation between the quantity of coinage struck, and of that cost. His estimates of the cost are also controversial (*e.g.,* Mattingly 1977). Given the doubt attached to 30,000 coins per die, this absolute correlation cannot be supported. What can be supported, however, is a general correlation between the number of legions and the size of issues. There is no doubt that there were huge issues of coinage minted during the Social War, and during the Civil Wars, to which the specifically military issue of 'legionary' *denarii* (RRC 540) attests.

Despite the obvious problems with the figure of 30,000 coins per die, it has entered the numismatic literature as a factoid and has been widely employed. This will be discussed further below when Buttrey's critique is considered. Crawford's die estimates have subsequently been used for other purposes such as Hopkins' (1980) modeling of the growth of the coinage pool, the comparison of hoards with an estimated population (Chinchilla Sánchez 1982) and the analysis of the pattern of supply of coinage to Transylvania (Poenaru Bordea & Cojocărescu 1984).

3.13.5 Initial criticisms of Crawford

There were a number of reviews of *RRC* published soon after its appearance, all acknowledged the monumental achievement, and all had criticisms. Both Hersch (1977) and Mattingly (1977) mainly centred their comments around detailed aspects of the arrangement of the coinage. Hersch did not offer a detailed critique of Crawford's estimates, but simply stated that:

> his results seem specious, with the number of dies shown for very rare pieces almost always being overstated, and the totals for common issues, when they can be checked, being underestimated. (Hersch 1977, p. 36)

Mattingly (1977) offers a more detailed critique of the estimates, mainly based upon the average of 30,000 coins per die which he felt was too high, and also criticised the idea that the only large item of expenditure was the army.

A more detailed critique of Crawford's method was offered by Frier (1976). He calls Crawford's choice of hoards 'curious' (p. 376) and stated that they do not help account for the under-representation of early issues. Here Frier mis-understands Crawford's method — the ratios derived from the scattergram are empirical and help to account for under- and over-representation in the 'master-hoard' due to the dates of the individual hoards included. He goes on to note that the obverse-reverse die ratios used by Crawford were obtained from a very limited number of cases. As regards the ratios derived from the scattergram, he notes that in not one single case does an observed ratio match the ratios used, and feels that the application of these ratios to the entire Republican series is 'not rational' (p. 377–8). He attempts to calculate the margins for error in Crawford's calculations, and states that they can be as wide as $\pm30\%$ or more. He states:

> Crawford's hope must be that his results will average out in the long run. But his statistics seem to transform a pious hope into a delusive certainty... Every step in the multiplication simply cumulates these margins of error and biases. (Frier 1976, p. 378)

Frier then goes on to note the problems with 30,000 coins per die already referred to, and the accuracy of dating of the issues.

Despite these initially damning reviews, Crawford's estimates continued to be used by other scholars, and his catalogue became the standard reference work. In a more friendly, and somewhat later review, Burnett (1987) noted the more important point that Crawford's analysis had moved the study of coinage beyond the traditional playing with dates, sequences and attributions, or even the discussion of the meaning of the types, into the study of the economy. Even if his analysis is rejected entirely, it moved the study of Republican coinage onto another footing. In the same review, Burnett notes that Crawford's later book, *Coinage and Money under the Roman Republic* Crawford (1985), also changed our perceptions of Roman coinage by forcing us to look at how the Romans used what had been traditionally regarded as non-Roman issues. Along with Buttrey (1989) however, he notes Crawford's unfortunate tendency to state as fact what are in reality no more than educated guesses.

3.13.6 Lockyear's use of regression

Crawford's series of ratios for estimating the die counts from specimens (Fig. 3.5, Table 3.3) look rather odd to a statistician's eyes. I therefore decided to derive a new series of multiplication factors by performing regression analysis on the data (Lockyear 1989, pp. 27–9) in which all the points which had been adjusted by Crawford were omitted. The results are shown in Fig. 3.6. There was a high correlation between the line and the points ($r = -0.88; r^2 = 78.3\%$). From the regression result, new die estimates were calculated for every issue. Crawford's 'freak' totals in the 24 hoards were not omitted. The results were plotted as a graph (Lockyear 1989, Fig. 2.12, *cf.* Fig. 2.11) and are included here in Appendix C.

To illustrate the effect of the standard error of the estimate on the die estimates, a series of estimates were produced where the multiplication factor was chosen by a normal random number generator with the mean set at the estimated factor from the regression, and the standard deviation

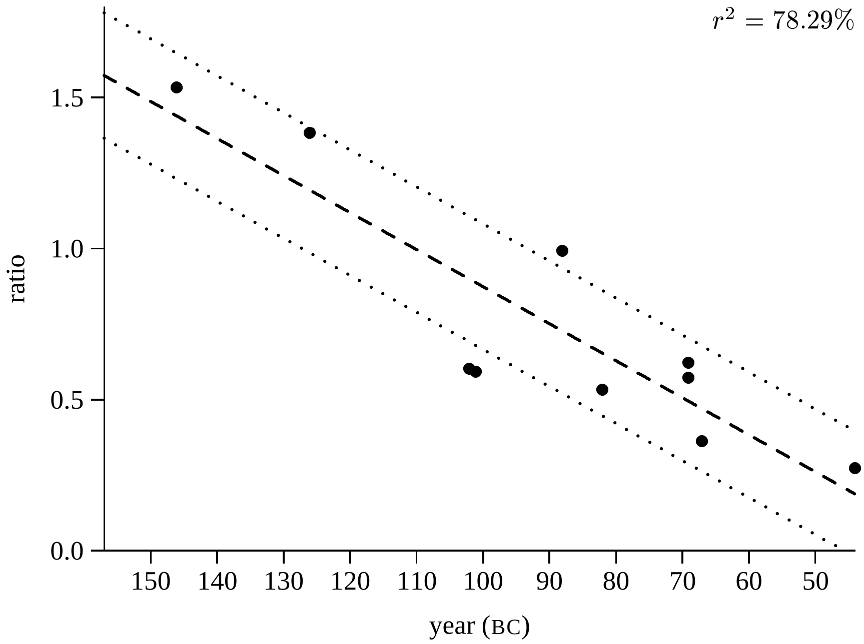


Figure 3.6: Regression plot of obverse to reverse die ratio against year. All 'adjusted' figures omitted. After Lockyear (1989, Fig. 2.9).

set at the standard error of the estimate. In general, the results were very similar to the regression based figures, but one or two die estimates were much larger or smaller (*e.g.*, in one run, 55 BC was estimated at 11,067 dies compared to 654 by Crawford and 670 by regression).

At the time, I was very sceptical that the regression based results were any better than Crawford's despite, perhaps, being on a firmer statistical footing. I also had no way of checking the results — comparison to the 24 hoards in RRC, the only data available at the time, would have been a circular argument. Chapter 11 presents a fresh attempt to examine the whole problem, and section 11.2.7 examines the results of the regression-based estimates.

3.13.7 Preston and the decay rate

Preston (1983) attempted to calculate the decay rate, called by him γ, by linear regression of the die counts of 29 issues against the occurrence of coins of those types in 3 pairs of hoards (Maccarese and Pontecorvo, Casaleone and San Giuliano, and Alvignano and Avetrana). His purpose was so that this 'correction factor' could be applied to issues in hoards to allow for time and to enable more accurate die estimates. If one follows Crawford's method exactly, this step is unnecessary, but the estimates of γ are nonetheless interesting. The results are reproduced in Table 3.4. As can be seen, the decay rate from these analyses appears to be between 2.5–4%, slightly higher than the widely used figure of 2%.

hoards	period	n	γ	$\hat{S}(\gamma)$	r
Maccarese, Pontecorvo	113–76	22	0.039	0.009	−0.72
Casaleone, San Guiliano	113–64	28	0.025	0.007	−0.57
Alvignano, Avetrana	113–64	28	0.038	0.008	−0.68
Combined	113–64	78	0.033	0.004	−0.65

Table 3.4: The results from Preston's regression analyses; n is the number of observations, γ is the estimate of the decay rate, $\hat{S}(\gamma)$ is the standard error of that estimate, and r is the estimated correlation coefficient. After Preston 1983, Table 2.

3.13.8 The Buttrey critique

Despite the many initial criticisms of Crawford's work, the figures he produced continued to be used by others, and their work used in turn by Crawford (*e.g.*, Crawford 1985). In recent years this has led to a more vociferous criticism of his work, but also of the use of die estimates in general, and perhaps more worryingly, the usefulness of the numerical analysis of coin assemblages (Buttrey 1989; Howgego 1992; Buttrey 1993; 1994).

For example, Howgego (1992, especially pp. 2–4) questions the usefulness of numerical techniques in the study of the use of coinage and proposes 'alternative approaches'. These are little more than a careful examination of the written sources, similar in method to that used in an earlier paper (Howgego 1990). Although not doubting the validity and usefulness of the texts, it must be acknowledged that they are also limited. They are in fact extremely scarce, and vary in time over many centuries, and in origin from many parts of the ancient world. If we are interested, for example, in the use of coinage in Roman Britain, there are no written sources. Can we really make generalisations about coin use in 'the ancient world'?

More specifically, Crawford's die estimates and Hopkins' use of them (Hopkins 1980) are subject to bitter criticism, especially in three papers by Buttrey. In the first he attacks Crawford's 'master hoard' stating that "He [Crawford] assumes that the profile of hoards from different periods and areas, is roughly that of the original coinage: chi-square tests comparing hoards show this to be unlikely" (Buttrey 1989, p. 74). Buttrey does not provide details of these tests so that his results can be verified. It should be noted, however, that Kolmogorov-Smirnov tests would have been more appropriate, and that given the size of the coin hoards the fact that significant results had been obtained is unsurprising (Lockyear 1989, pp. 25–27, & Appendix B).

In the second paper Buttrey (1993, p. 336–8) criticises the Crawford's die-estimates for not taking into account the decay rate. This is a red herring — Crawford's estimates were based on ratios derived from an empirical observation between his 24 hoards and the die counts and no adjustment is necessary. The fact that Crawford's die counts are an extrapolation from a very small number of actual counts is true, but Buttrey does not empirically assess the problems, he only states that they are insurmountable. Buttrey had previously criticised the ratios used by Crawford stating: "He [Crawford] does not establish that the coin finds and dies of *any* two issues fall into the same pattern; and the varying multiples that he derives from his comparison can be shown by a linear regression test not to fall into the pattern that is fundamental to his argument" (Buttrey 1989, p. 74). Again, no details of this test are presented. As was noted above, linear regression can be used to suggest an alternative set of ratios, but cannot be said to show that Crawford's are wrong. This will be examined in section 11.2.7 below.

Buttrey's criticisms of the figure of 30,000 coins per die are valid (Buttrey 1993, pp. 340–341) but his criticisms of the use of an (unknown) average figure reveal a stunning misunderstanding of the very concept of an average and how it may be used (pp. 342–345). Buttrey is correct in that in one specific year using an average can result in an estimate which is way out. However, statistics and probability allow us to predict the chances of an estimate being way out, and how far out this estimate might be, and how many times in a selection of years the estimates will be outside certain limits.

In examining the rate of attrition (decay rate) Buttrey notes that it will be variable and presents in evidence the numbers of hoards buried by year during the Republic (pp. 345–347). Again, however, Buttrey notes the problem but does not attempt to quantify the effect on the analyses which might be affected by it. For example, does the decay rate vary between 1–15% which surely would create many problems, or does it vary between 1–3%, or even 1.9–2.1%, variations which are likely to be insignificant to the wider picture?

In a follow-up article (Buttrey 1994) Buttrey examined in more detail the concept of multiplying the die-count by an average in more detail. He rightly notes that there are many factors which will affect the number of coins struck per year including how much damage to a die was regarded as acceptable, the metal being struck, the technology of die manufacture *etc.* In arguing that we cannot compare the size of coin issues based on die counts when those issues were of different metals, or struck in different places, or struck at different times, he is stating what many numismatists would consider as obvious. However, he extends this to include every ancient coin issue, even when those issues form part of a relatively homogeneous series such as the Roman Republican. Buttrey is uncompromising: "... regarding the calculation of ancient coin production: It cannot be done."

Although many of the points Buttrey makes are entirely valid, he is too anxious to demolish all, and his criticisms lack much empirical investigation or any attempt to disentangle the valid from the invalid. This, coupled with a undisguised personal antagonism towards Crawford, may have defeated his own purpose as his critique has been dismissed as an unfortunately public case of sour grapes. A more reasoned critique, with a more careful consideration of statistical procedures, could have led to a genuine advance in scholarship.

3.13.9 Summary

The estimation of the size of coin issues and die counts has a long and chequered history characterised by bouts of wild optimism and scathing scepticism. It is an area where mathematics and statistics should have much to offer numismatics but where misunderstandings and distrust have led to polarised opinions and stalemate. It is hoped that the empirical approach to just one example, the Roman Republican series, presented in Chapter 11, will be seen as a constructive step forward.

3.14 Crawford's die estimates and the supply of coinage to Romania

In a small number of Romanian papers Crawford's die estimates have been used in a novel and interesting way. The method was originally outlined by Ocheşeanu (1981) and then used with some

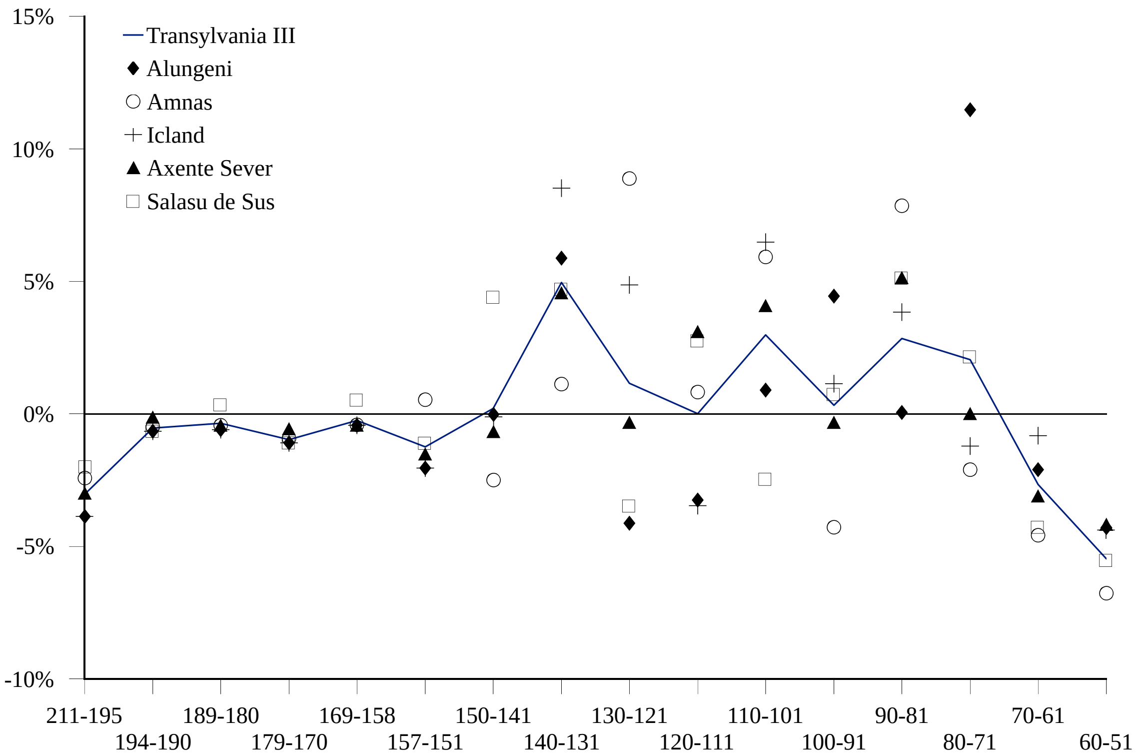


Figure 3.7: Five Transylvanian hoards and their average plotted as a deviation from the estimated number of dies which is plotted as the abscissa. From Poenaru Bordea & Cojocărescu 1984.

success by Poenaru Bordea & Cojocărescu (1984). I shall briefly outline the method and results using the latter paper.

The paper in question is a publication of a small hoard of *denarii* from Icland. In the discussion of this hoard the authors wished to compare it with others of a similar date, and four further hoards from Transylvania were chosen. Each hoard was converted into percentages, and then an average 'master' hoard was calculated. For the same period as covered by the hoards, the authors counted the number of dies per year using Crawford's estimates, which were again converted to percentages. This allowed the plotting of two graphs. In the first, the hoards were plotted along with the 'average' hoard and the yearly die estimates. In the second, the yearly die estimates were used as the abscissa and the hoards including the average hoard were plotted as a deviation from them — this graph is reproduced here in Fig. 3.7.

This graph is very similar to Thordeman's graph and those produced by Volk (see sections 3.2–3.3 above). In a 'normal' situation, the oldest coins should be below the abscissa and the newest above it. Here, the newest coins are grossly under-represented. The authors interpret this as showing that after an initial influx of coinage in the mid-70s–mid-60s BC, there is a rapid fall off in the supply of *denarii* to the area.

Finally, the authors calculated the standard deviation of the percentages and plotted the hoards against this using the average hoard as the abscissa in a manner similar to Reece.

There are many theoretical objections to this paper including problems of calculating 'average' percentages, the use of Crawford's estimates in this way, and using standard deviations of percentages. However, despite these objections, the results compare favourably with those to be presented in Chapter 10, and their interpretation will be shown to have much merit.

3.15 Numerical and statistical techniques — summary and conclusions

It should be obvious from the above reviews that the analysis of coin assemblages and hoards is a difficult task and one which requires the analyst to be aware of both numismatic and statistical problems. A recurrent problem is that of the quantity and quality of the data. It can be seen that is is impossible to generalise from a single, or even a small number of hoards, and that meaningful analyses have to be conducted on large data sets. In many cases these large data sets do not exist. In some situations where there apparently was a large quantity of data, *e.g.,* Creighton's analysis of coin weights, these data were, in fact, not independent, which limited their usefulness. The number of studies which use large data sets is increasing, *e.g.,* Ryan (1988), Creighton (1992a) and Guest (1994), and this is surely partly the result of the increasing use of computers in archaeological research.

The one area where there appears to have been a large degree of input from statisticians and mathematicians is the problem of estimating die numbers from samples. Multivariate techniques, such as will be employed in the next Part, have seen little use, although in metallurgical studies which have not been reviewed here their use is more common, *e.g.,* Ponting (1994). If we are to move beyond the simple visual comparison of a small number of hoards, the use of multivariate methods, be they of the home-grown variety employed by Reece (1995), or more formal statistical techniques, are essential.

If one essential insight were to be drawn from the above reviews, it must be that it is that any coin, assemblage or hoard must be seen in context, or against some form of background. Patterns in coin evidence are a series of layers resulting from different factors: production, supply, use and loss. To observe the different layers we have to use methods which allow us to assess which part of the pattern is the result of which factor — a process which is by no means easy.

This chapter has provided the background against which the analyses presented in Part II can be seen and compared. The analyses presented are not comprehensive and many more questions could be posed and examined using the data collected. The analyses do, however, examine some specific problems raised in this chapter, as well as giving a detailed picture of the distribution of *denarii* under the Roman Republic. They also represent, in the biased view of the author, an advance in the methodology of the study of hoards and coin assemblages.[22]

[22] A number of important papers were omitted from this review for various reasons. I would particularly like to draw the readers attention to the Bath coin report by Walker (1988), *cf.* Buttrey (1993, 348–349); spatial analysis papers by Hodder & Reece (1977, 1980) and Clark (1978); and to various papers contained in Carcassonne & Hackens (1981). Although not primarily numerical, papers contained in *Coins and the Archaeologist* (Casey & Reece 1974; 1988) remain essential reading.

Part II

Analysing hoards

Chapter 4

Aims and methods of analysis

4.1 Introduction

The previous chapter reviews some of the methods by which coin assemblages have been analysed in the past. The chapters contained in Part II examine various aspects of the corpus of Roman Republican coin hoards which form the core data set for this thesis. After an initial review of the aims of this Part, the available data and their problems are discussed in detail (chapter 5). Chapter 6 examines models of coin circulation hoard formation. Chapter 7 examines the coverage of the database and general aspects of the distribution of hoards. Chapters 8 and 10 compare hoards in order to identify global spatial and temporal patterns in the data and various statistical techniques are compared. Chapter 9 examines the problems surrounding the interpretation of inter-hoard variability between periods especially in connection with past attempts to identify changes in the speed of circulation of coinage. In chapter 11, the debate surrounding Crawford's estimates of the number of coins minted *per annum* is reviewed (section 11.1, *cf.* 3.13.4), and then the problem is re-examined (section 11.2) by building on earlier work using simulation studies (Lockyear 1989; 1991). The results of this Part are then summarised in Chapter 12.

4.2 Aims and Methods

The aims of this Part can be divided into three overlapping categories: archaeological, numismatic and statistical.

The archaeological aims are:

1. to understand the various *formation processes* involved in order that we can separate out patterns which are the result of these processes.

2. to identify spatial and temporal patterns in the data.

3. to interpret the results.

The formation processes at work on this data set are complex. They include the effects of sampling error, the problems of regional publication traditions, post-recovery factors, the problems of analysis and variations in the minting pattern. Some aspects of formation processes have already been discussed in Part I.

Having examined the global patterns some interpretations of them will be offered. However, a detailed interpretation of these patterns requires a good knowledge of both the period and area under discussion. Therefore, Part III examines the material from Romania in a more detailed context.

The four primarily numismatic aims are to examine:

1. the speed of circulation of coin.
2. the decay rate (attrition rate, sink rate, see page 130).
3. the validity of Crawford's coin die estimates.
4. Buttrey's recent criticisms of the whole process of estimating sizes of issues (Buttrey 1989; 1993, 1994).

The speed of circulation of money forms part of the classical economists' equation for the calculation of prices (Crockett 1979, p. 48). Recently, Duncan-Jones (1987) and Creighton (1992a) have attempted to examine this factor (see sections 3.10.1 and 3.12 above). An alternative methodology for assessing this problem is presented (chapter 9).

The decay rate of coin, *i.e.*, how quickly coin is removed from the coinage pool (Lockyear 1991) has been estimated by a number of authors (Thordeman 1948; Patterson 1972; Preston 1983; Volk 1987). Crawford's die estimates have been the subject of a number of critical reviews and articles. The most recent and vitriolic reviews (Buttrey 1993; 1994) strongly question the use of the decay rate. Given that the CHRR database (see chapter 5) provides a much larger volume of material for examination, it was decided to see if coin populations derived from Crawford's figures were similar to real hoards. Various parameters, including the decay rate, could be varied to examine their effect. This is similar to the previous work (Lockyear 1989; 1991) but with the huge advantage that data *not* used by Crawford is now available to test his figures.

The statistical aims are:

1. to assess the usefulness of various techniques in the analysis of coin hoards.
2. to compare the techniques.
3. if necessary, to develop variants of techniques.

As I am a 'para-statistician'[1], I have examined the various techniques empirically. Does the technique, when compared to the data and/or other techniques, provide results which are interpretable even if not archaeologically interesting? Can problems be seen, and can they be circumvented? Unsuccessful methods will be reported with a brief explanation of why I considered them to be so. The development of variants of techniques has been undertaken only when it was felt necessary, and at all times in consultation with statisticians.

[1] The term comes from Orton (1992) and was applied to me by Hilary Cool (*pers. comm.*)

The statistical aims of this project are carried forward into Chapter 14 in Part III which examines the problem of copies in Romania.

Rather than attempt to outline all the statistical methods that have been used in this thesis, it was considered more appropriate for the discussion of each method to be kept with the sections which use them. Often the results of one analysis are the *raison d'être* of the next analysis, and how that was performed. The analyses have been presented in as logical order as possible although some cross-references were necessary.

The author's more philosophical views on the rôle of statistics in archaeology and numismatics have been outlined in section 1.4.

Chapter 5

The Data

5.1 Introduction

This section is intended to outline the nature, sources and problems with the data used in the analytical part of this thesis. This chapter is included as an essential part of the continuing theme of *formation processes.* Without an understanding of the problems of the data it would be impossible to assess the validity of the following analyses and the conclusions drawn from them. This chapter is essential to the understanding of:

- the project archive
- the project database which will be made available to interested parties
- the reasons for the manner in which the analyses were performed and their possible shortcomings

Also outlined are the strategies adopted for the collection, input and manipulation of the data, and the structure of the *Coin Hoards from the Roman Republic* (CHRR) database (see below). There are some differences from the previous version of the database (Lockyear 1989, appendix C).

5.2 Roman Republican Coin Hoards and the CHRR database

5.2.1 Categories of data

The main category of data is hoards of the Roman Republic and the early Principate. The working definition used is similar to that used by Michael H. Crawford (*Roman Republican Coin Hoards*, henceforth RRCH, Crawford 1969c). In this case a hoard is any two or more coins deposited together. Many hoards of this period contain coins from several different issuing authorities. Therefore, a hoard is included if it contains at least one Roman coin. Also following Crawford, hoards are included down to the issues of C. L. Caesares (*c.* 2 BC to AD 4, Sutherland 1984, henceforth RIC $1^{(2)}$, pp. 55–56, nos. 205–212). The earliest hoards are those containing *denarii* (*i.e.*, post 211 BC). Pre-*denarius* hoards are not considered. In the main data tables of the CHRR database issues of the Republic and the early Principate are recorded to as exact a catalogue reference as possible. Non-Roman and poorly identified coins are recorded as general categories, *e.g.,* Iberian *denarii*, miscellaneous Republican *asses*. For the rest of this work I shall refer to the coinage under investigation as Republican despite the fact it also contains some of the early Imperial material.

Throughout this work the unique identifier for a hoard, a three letter code, will be given in SMALL CAPITALS whenever a hoard is mentioned. This is in order that there can be no doubt as to which hoard is being referred to as the full hoard name is not necessarily unique. For example, there are several hoards from Padova and two from Carbonara. A concordance between the code and the data listed in Appendix A is given in Appendix B.

As well as the list of coins for each hoard, subsidiary data have also been collected where this was possible. These other types of data include:

1. where the hoard was found
2. under what circumstances the hoard was found
3. associated artefacts, including container
4. completeness of the hoard
5. original size of the hoard where this is different from the detailed list
6. what catalogue was used (if any)
7. context, *e.g.,* in a Roman town, villa, *etc.*
8. any other relevant data.

For the majority of the hoards only a few of these facts are known, or knowable. Only the data which needed computerisation for this thesis have been input (see section 5.2.6).

The gathering of the secondary data is surprisingly time-consuming. Michael Crawford's records (see section 5.2.2) do not consistently record this extra information although some is published in RRCH. Thus, in a large number of cases, I have obtained the listing of coins relatively easily but had to refer back to original publications to obtain the subsidiary data. The difficulty of this task is increased as these hoards have been published in a wide variety of languages. Many are in Italian and Romanian, some in French, Spanish and German. However, much is published in Czech, Hungarian, Polish, Russian, Catalan, Serbo-Croat, Bulgarian, Greek, Portuguese *etc.* The transcription of the coin lists can be straightforward. References to the standard catalogues are generally obvious, legends given as read, and type descriptions follow a formula. However, with older references this can be difficult depending on the level of detail given. For the subsidiary data, the age of many reports makes the data difficult to extract even to native speakers of the language concerned.

The second major category of data is information about the individual coin types. The COIN-TYPE table (see below) is directly derived from *Roman Republican Coinage* (henceforth RRC) and RIC 1[(2)]. The sorts of data included in these catalogues include the type, legends, place of minting, denomination, dates and moneyers. At present the only data used are the dates, the typological scheme and the denominations.

5.2.2 Sources of data

The sources of hoard data for this project are varied. The majority are from Michael Crawford's records now housed in the British Museum. In the discussion below regarding *problems* with the data, these should not be seen as *criticisms.* This data set was collected for Crawford's own purposes. These comments should be seen solely as background information to the CHRR database.

The sources of hoard data falls into several categories:

1. unpublished data
   (a) with detailed list (usually compiled by Crawford)
   (b) with no detailed information
2. published data
   (a) articles about individual hoards, or a small group of hoards
   (b) *corpora* of hoards but with only summary information (*e.g.,* RRCH)
      i. by period
      ii. by region
      iii. by type or issue of coin
   (c) *corpora* of hoards but with detailed information *e.g.,* Chiţescu (1981). These can be divided as in 2b.
   (d) other works which contain details of hoards, *e.g.,* RRC and *Coinage and Money under the Roman Republic* (Crawford 1985).
3. derived data — these are lists derived from reports. Crawford has for many hoards produced a detailed list of coins with Sydenham (1952) reference numbers.

The British Museum archive

It is necessary here to explain the archive in the British Museum as this information is vital for understanding the archive for this project. The main task was to cross reference the data stored in four locations. These are RRCH, a filing cabinet with hoard records collected by Crawford and now housed in the Department of Coins and Medals, Crawford's personal card index which accompanies the filing cabinet, and the various publications in the Department's library.

RRCH is a published list of hoards with references, closing dates, locations *etc.* of 549 coin hoards and 18 other coin finds. This work forms the basic list of hoards, and RRCH numbers are given as standard reference numbers in a number of other works. For many of the hoards in RRCH the detailed coin list or publication is stored in Crawford's filing cabinet. These data take several forms:

1. offprints or photocopies of the original articles. The lists of coins are either given with references to one of the many catalogues, or simply with a description of each coin.

2. index cards with a detailed list of coins catalogued using Sydenham (1952). These can either be original lists from the coins themselves or derived from publications. These are generally pre-RRCH/RRC.

3. handwritten lists. Some of these are as 2 but many simply record as little information as is necessary for the identification of the coin type. Rarely, references are ambiguous. In many cases it is possible to decide between two possible references on the basis of the position of the reference in the list which is usually in, or nearly in, the same order as Sydenham. Therefore the list usually looks like this:

   2 NATTA

   1 NAT

   1 SAVF

   etc.

   These lists take some considerable time to deal with as the coins have to be looked up in RRC, all possible ambiguities sorted out, and then input to a separate datafile and 'uploaded' (see page 120).

4. typed lists. These are usually hoards which have been prepared for publication. For example, most of the hoards that appeared in RRC, Table L, are typed up.

5. letters, lists or computer listings that have been sent to Crawford from other numismatists.

Not all the coin hoards in RRCH are contained in this filing cabinet and not all the hoards in the filing cabinet are in RRCH. Those hoards which are not in RRCH but are in the filing cabinet also have a card in Crawford's card index. This index has a card per hoard for finds which have come to his attention since the publication of RRCH. These cards may simply have a reference, or may have a detailed list of coins if this is small enough to fit onto one card. It follows, therefore, that not all the cards in this index have entries in the filing cabinet.

For those hoards which are either in RRCH or the card index or in another source but not in the filing cabinet the original report had to be located. For many of these they were obtained from either the excellent library of the Royal Numismatic Society or the library of the Department of Coins and Medals. There were some, however, not available in either which were obtained from other sources.

Other sources

As well as this information there are a number of other *corpora*. These include Chiţescu (1981), Săşianu (1980) and Blázquez (1987–1988). Sometimes these are cross referenced with RRCH, or in Crawford's records. In Chiţescu (1981) for example references are sometimes given to RRCH. There are many more hoards in Chiţescu than RRCH but there are two hoards in RRCH which do not seem to appear in her corpus. However, many hoards in her corpus use different names to those in Crawford. Therefore, new hoards not in Crawford's records have appeared, but it is frequently the case that eventually the reference was found. This cross checking was time consuming.

For the coin types there are many catalogues of coins of the Republic. They are of two sorts: catalogues of the coins of the Republic and catalogues of specific collections of coins. The former are generally of more use unless the collection is very large and comprehensive. Many hoard reports use one (and sometimes more) of the former type of catalogue. Occasionally the latter type is used, usually Grueber's *Coins of the Roman Republic in the British Museum* (Grueber 1910). The data used in the CHRR database are derived directly from RRC and RIC 1[(2)]; more specifically, the date of the coins and the place of minting. Alternative dating schemes *etc.* could be stored in separate data tables and linked to the COINTYPE table via the unique identifier.

5.2.3 Problems with the data

There are problems with the data which have to be considered and which greatly affect what analyses are possible. Some of these are inherent in the coins themselves, some are a result of the manner of publication or recording and some are simply the result of various post-recovery factors.

The first major area of concern is that very few of the hoards have been recovered in controlled conditions. The hoard from Cosa (COS) is an exception. For example, the hoard from Montiano (RRCH 266, MNT) was found during agricultural work; the hoard from Barranco de Romero (BDR) was found during building works. Many hoards have no details at all about their origins. Crawford records if the hoard is out of a larger one, or is *x* coins out of a known number. For example Oleggio (RRCH 241, OLE) has 228 *denarii* out of 527 'but including all issues represented in the total'. If the coins for which we have a record are a random selection from the hoard then there are no problems. However, if the list is of a carefully selected collection of coins from the hoard then this could easily create problems during the analyses. In many ways there is less distortion of the composition of the hoard if the hoard was found by workmen when compared to selected sorting by a numismatist! When hoards are seen to be 'odd' in an analysis, the first question must be 'what is the data quality like?'

The next major difficulty is the fact that the published hoards can be listed by several different catalogues, or may only be listed by description. Those listed by descriptions only can vary in quality. The hoard from Valdesalor (VLD; Callejo Serrano 1965), for example, has very full-looking descriptions, but when it comes to cataloguing them according to Crawford it is very difficult to assign some of the coins to a precise reference. This is not helped by the fact that they are not in any order so that identical coin types are spread over the report. Also, the quality of the photographs is so poor as to make it all but impossible to see what is on the coin from them. It is possible to describe Republican coins with very few details (as Crawford does on his handwritten lists) and get to an exact reference. This can be difficult to decipher at first when one is less than totally familiar with the material.

The many different catalogues used in the coin lists created problems which had to be overcome. Sometimes coins in RRC simply do not exist in other catalogues. If the report states that there is a variation on a catalogue reference it may be possible to identify that coin. Some coin types are subdivided into a large number of separate types in older catalogues but are not in Crawford. For example the *denarii* of L. Piso L.F. L.N. Frvgi only have one reference in RRC (340/1) but can be between 650 and 671d in Sydenham (1952), and Calpurnia 6–11 in Babelon (1885, 1886).

Although there is a minor loss of information converting the reference, this is not particularly a problem unlike the reverse situation when issues in an older catalogue are divided into several Crawford issues, usually minor variants which are given an alphabetic sub-division of a reference, *e.g.*, 197/1a and 197/1b. In this case the coin is given the first possible Crawford reference and this fact is noted via the concept of a 'query code' (see page 124). These codes are a method whereby the reliability and/or accuracy, and/or status of a coin can be encoded in the database.

Another difficult problem is where hoards are catalogued according to a catalogue for which no concordance yet exists. In this case the coins in the list are identified manually, rather than try to construct a concordance for the whole of that catalogue. These references were then added to the COINREFS table — see below, page 123.

Some coin types are difficult to distinguish on the basis on either descriptions or early catalogue references. This is especially true of types from the earlier periods. The various anonymous *dioscuri denarii* are generally impossible to separate out unless the hoard had been examined by Crawford, or by another reliable numismatist, since the publication of RRC. Crawford has only identified these *denarii* to exact types for the earlier hoards when he was studying their chronology. It should be noted that as well the those coin issues where all the types are anonymous, there are a number of anonymous *denarii* 'in the style of...' For example, RRC 110/1a is an anonymous *dioscuri denarius* with a wreath; 110/1b is 'similar, but no wreath.' Even with those anonymous *denarii* with symbols there can be some confusion. For example there are two *denarius* issues with a crescent (57/2 and 137/1). Some reports list symbols not given by Crawford and these are sometimes difficult to assign to one of his symbols, *e.g., denarius* 'with flower.' Wherever there is a major ambiguity the coin type has been recorded as being the first possible with a query code of 2 (this is equivalent to 'as...'; Reece 1975). As a result most of the anonymous *dioscuri denarii* are recorded as being 'as 44/5', the earliest *denarius* issue dated to 211 BC. This leads to either a) an unrealistically high peak of coins in 211 BC when the hoard histograms are plotted (if all coins are used) or b) hoards which appear to have far too few of the earliest coin types when only coins that can be identified precisely, or almost precisely (query codes 1 or 5, see below), are plotted. This means that any analysis performed on these earlier coins and hoards would have to use quite general information, or be very careful as to which hoards are used.

As well as these anonymous issues there are some later issues that are frequently lumped together by older reports, but have been separated out by Crawford. For example the various CN. DO, CN. DOM, CN. DOMI issues (RRC 147, 261 and 285) are often conflated in the earlier reports. Issues of Caesar, Mark Antony *etc.* are often also difficult to assign to correct references.

The identification of hoards when they have several names, or when a location has several hoards, can also cause problems. Padova, for example, has many hoards. Romanian hoards frequently have two names especially when they come from Transylvania which was for a long time part of the Austro-Hungarian Empire. The hoard from Nagykagya (RRCH 411, Chiţescu 1981, hoard 37, NAG) is recorded in RRCH as Nagykagya, Hungary and has 169 *denarii*, 22 barbarous imitations of *denarii* and was found with silver ornaments. In Chiţescu the hoard is called Cadea, the Romanian name for the town and has 171 *denarii* of which there are records for 131! Some hoards are simply given different names by different people. For example, Barranco de Romero in Spain

(BDR) is a hill top. Other reports for that hoard use the name of the nearest village which is Nerpio. Some *corpora* use a different definition of what a hoard is. For example Chiţescu (1981) lists a number of finds in the 'isolated finds' section of her book that Crawford has included as a hoard in RRCH. As well as cross-referencing the hoards by name there is also the task of cross-referencing them by the various corpus numbers, *e.g.,* RRCH, IGCH (Thompson *et al.* 1973), Săşianu (1980) and Chiţescu (1981). The CHRR database contains a concordance table between hoards and these catalogues.

Another severe problem is locating the hoard's findspot. The locations of hoards in Spain and Romania is not a major problem as Blázquez (1987–1988) and many Romanian scholars publish distribution maps, *e.g.,* Glodariu (1976).[1] However, for other countries this is much more difficult. Unfortunately, there are no distribution maps of sufficient quality known to the author of hoards in Italy. As many of the hoard names are of very small villages this can be a problem and the original work has again to be referenced. For example, of the 24 hoards in RRC (Lockyear 1989, figure 2.1) locations of eleven were found in atlases, one in *Coinage and Money* (Crawford 1985), six in a world Gazetteer, four by going back to the original references in the British Library, one from Mackenzie (1986) and one in an Italian directory of postal codes. For the present work the map reference of hoards was only sought when it was felt necessary to examine distribution maps as part of an analysis or discussion (*e.g.,* section 8.3.6).

Probably the most difficult and error-prone exercise of all is when there are several different sources of information which do not agree with each other, or have somehow to be combined. The hoards published in RRC (Table L) are a good example. Table L does not have a complete listing of coins: only those after RRC 197/1 and before the Principate are included. For most of the hoards the data are incomplete and the information already in the RRC database from Lockyear (1989) has to be correlated with the records in the British Museum or publications. In most cases this was merely tedious, but in some it was difficult or impossible. For example, the Alvignano hoard (RRCH 417, ALV) is recorded as having 2,317 *denarii*, 1 *victoriatus* and 3 *quinarii* in RRCH. However, the original RRC database (Lockyear 1989, Appendix C), and Table L from which this was derived, lists 2334 *denarii*. The typescript in the British Museum has the total 2,321 (all the coins) written at the bottom but when the list is added up it comes to 2,338 (all coins). This is otherwise unpublished so either the total is wrong and was carried over to RRCH or the coin list contains a mistake which was carried over to RRC; it is impossible to tell. Finally, the references in Table L do not relate exactly to RRC references. For example 197/1 in Table L is an incomplete reference as there are in fact types 197/1a and 1b. These discrepancies were picked up by the uploading program and the datafile had to be manually altered, aided by the specially written dBASE program ADD_A. For some of these hoards the data was re-input from the original report, *e.g.,* Pontecorvo (PON). Sorting out discrepancies between different data sources was time consuming but necessary.

As can be seen the use of secondary data is fraught with problems. However, if one wishes to take a broad overview of any field in archaeology then their use cannot be avoided; however it is also necessary to be constantly aware of the limitations and problems with the data available.

[1] It is difficult to construct detailed maps of smaller areas in Romania as small scale maps are still military secrets.

5.2.4 Storage and data manipulation strategies

Until recently, the only well designed relational database of coin assemblages known to the author was that of Ryan (1988). The structure of the CHRR database is an adaptation of that database. The CHRR database discussed below has a highly flexible structure which has allowed the easy manipulation and extraction of data. Although constructing the database has taken some time, the extraction of data for analysis was made possible, and easy, by the design and vindicates effort taken. The only other database of Republican hoards I am aware of is in Germany (D. Backendorf, *pers. comm.*) and is also implemented in dBASE. In this case all the data is in one huge table. This leads to a huge replication of data ('data redundancy' in database jargon) and difficulties in manipulating the data. For example, calculating the percentage of a type from a hoard was done manually![2]

Despite the obvious advantages of relational database structures, few archaeologists seem prepared to expend effort in the correct structuring of their data. This is short-sighted and the difficulty many then experience in using the data effectively, compared to the relative ease that data can be extracted from a database such as that described below, amply illustrates the value of careful database design.

The database

Where possible, each hoard was input directly into the database. This was achieved in two stages:

1. for each hoard, data were input to a separate small data file using whatever catalogue references (if any) were given

2. these datafiles were then 'uploaded' to the main database via a specially written dBASE program, UP2

This two-stage strategy was adopted for a number of reasons:

- it enabled the hoards to be input with whatever catalogue had been used in the list and then to be converted and uploaded later

- by having small datafiles this did not slow down the small 8088 single disc portable computer used for data capture

- by having a conversion/uploading process the data could be checked for publication and input errors

- data in difficult formats could be input leaving the conversion process for later

- it minimised the amount of time required in the British Museum

[2] Subsequent to the completion of this Part, Terence Volk has kindly bought my attention to his database of Republican coin hoards which is extremely similar in many respects to the CHRR database described here (Volk 1994–5). This database was orginally implemented using dBASE III+, but has now been ported to Paradox for Windows.

Even using this system there were many hoards where the data were not amenable to immediate input to a data file, usually due to a lack of any reference numbers. These were photocopied and the list constructed from RRC by hand.

The database management system (DBMS) used was dBASE III+. Although dBASE III+ is not a relational database management system (RDMS), the structure of the CHRR database conforms to the 'normal forms' required of such a database (Carter 1992, chapter 2). There are a few fields included which should not be part of a true relational database structure but were created to help speed up the running time of programs, for ease of data extraction, or for the development of the database. At an early stage the database was also uploaded to Ingres for PC on a 33mhz, 386 with 387 maths coprocessor. However, it was found that dBASE programs written by the author were considerably faster than the equivalent standard query language (SQL) commands, *e.g.,* the SQL command to produce a table of total numbers of coins per year per hoard took several hours when the main table was only 4500 rows (tuples). The equivalent dBASE program, YEARTOTS, took about five minutes with the same set of data. As a result, a suite of dBASE programs has been written by the author for various tasks. For example, outputting data in the correct format for analysis by the various statistical packages used. At a late stage the RDMS Access became available but it was not deemed to be an advantage to move from the existing functional set up at that time.

The CHRR database consists of three main tables, and a number of subsidiary ones. The one serious break with the relational database model was the use of the dBASE memo field in the SITENAME table for the recording of various miscellaneous facts. The main tables are:

COINTYPE this table contains data concerning the coin types under consideration. At present the basis for this table is RRC and RIC 1[(2)]. Additional coin types include general categories. Fields include:

- **ctype** numeric unique identifier (also identical to dBase record number saving on search time in programs). This is an internal number and would not generally be used directly.
- **issue** Crawford issue number. For example, P. Crepusi is issue 361, whereas individual coin types have a full reference of 361/1a *etc.* This is useful for grouping coins at a level between date and specific coin type without having to write very long pieces of code to do so.
- **date_from** the earliest date for that coin type.
- **date_to** the latest date for that coin type. Frequently this field and the previous one are identical. Dates are derived from RRC and RIC 1[(2)]. Alternative dates can be stored in separate tables for comparative analyses of dating schemes.
- **denom** denomination, *i.e., denarius, victoriatus*. Four letter codes used which link to the DENOM table.
- **by** the issuing authority *e.g.,* Roman Republican, Roman Imperial, Greek *etc.* Helpful with general categories.

This table consists of 2961 tuples of data (as of May 1995), the majority from RRC and RIC 1[(2)].

HOARDS this contains the detailed lists of hoards. Fields include:

`site` a three character alphanumeric code for each hoard. Links to many tables especially SITENAME.

`ctype` numeric code for the coin type. Links to the COINTYPE table described above.

`total` total number of coins for that coin type, hoard, and query category.

`query` a single number numeric code as discussed in detail below.

The unique identifier for this table is a combination of all four columns. As of May 1995 this table contained 26,282 tuples of data, all input by the author.

SITENAME this table contains general details about the hoard and its findspot *etc.* Some of the fields should not be part of the database in a strict interpretation of the relational database model. Most of these irregular fields either contain data derived from the other tables in the database, and can be updated by running the appropriate dBASE program, or they are for ease of data extraction and manipulation. The fields are:

`name` the name of the hoard.

`country` some countries have been sub-divided *e.g.,* Italy and Sicily. Countries formed after 1989 have been left as pre-1989, *e.g.,* USSR, Yugoslavia, Czechoslovakia.

`page` page in the project archive logbooks. Every hoard in the database has an entry in the log books recording any relevant information especially as regards the status of the hoard in the database and any problems that might exist with the hoard.

`enddate` the closing date of the hoard derived from the hoards table using the program ENDDATE. The date is the latest `date_from` field from the COINTYPE table. Used to select hoard groups for analysis on the basis of date.

`goodtotal` the total number of coins of specified denominations and query code categories derived from the HOARDS table using the ENDDATE program. Used to select hoards for analysis on the basis of size.

`weights` logical field — are coin weights given in the publication? As table HOARDS has one tuple per *coin type*, not per coin, coin weights for selected issues used in section 14.4.7 on page 442 are stored in a separate table. This field enables suitable publications to be found quickly. A negative entry does not mean that weights are not available as this information was added to the database half way through this project.

extract logical field — used to enable easy selection when the hoards required do not fit any easy extraction criteria. Set to `.T.` (true) by the program EXTRACT

dbfname the original dBASE datafile name for this hoard (see above).

code the unique identifier for the hoard. This is a three character alphanumeric code and links to the `site` field of the HOARDS table.

source this gives the source of the coin list input to the database (therefore not necessarily the publication). For example `mhchw` is one of Crawford's handwritten lists without reference numbers.

notes a dBASE memo field containing odd notes usually for parts of the database yet to be implemented. This field is not part of the relational database design but is a development aid.

pub details of whether has the publication been located, translated, photocopied and so forth

uploaded a logical field updated automatically when the hoard is uploaded from its initial temporary file (as recorded in field `dbfname` to the main tables via a dBASE program).

As of May 1995 the table contains 624 tuples of data.

These three tables contain all the main data and can logically stand on their own. However, there are a number of other tables. The most important of which is:

COINREFS this table is a concordance between the internal reference numbers used in the HOARDS and COINTYPE table and the various catalogues of Republican coins. Coin catalogues currently included are RRC, Sydenham (1952), Babelon (1885), Babelon (1886), Grueber (1910), and the Augustan issues from Mattingly & Sydenham (1923) and RIC 1$^{(2)}$ (Sutherland 1984). Selected parts of Riccio (1843), Cohen (1857) and Fabretti (1876) have been input as necessary. Fields include:

ctype the unique number in the COINTYPE table used in the HOARDS table.

cat the catalogue, *e.g.,* `syd` represents Sydenham (1952).

name this is the name of the moneyer, or Emperor, or moneyer's family. For most catalogues this is not necessary and the field is set to `n/a`. It is necessary, for example, for Babelon (moneyers family) and RIC 1$^{(2)}$ (Emperor).

denom with some catalogues, notably RIC 1, first edition (Mattingly & Sydenham 1923), the same reference number has been given to several denominations and thus the necessity for this field. Where the field is unnecessary it is set to `n/a`.

ref the reference number (*e.g.,* 340/1).

query see below.

This table is essential for the uploading and conversion process as the temporary datafiles use the original catalogue references. The table, as of May 1995, contains 13,231 tuples of data. This table can be used as a concordance between RRC and the other catalogues but cannot necessarily be used as a direct concordance between two other catalogues without careful consideration of the query codes as discussed in detail below.

Other tables include:

KRIS_CAT this is a table of my general coin categories such as 'misc. unidentified Republican *asses*'. For details of this data see below. Fields include:

`ctype` links to COINTYPE table

`descrip` description of the general category

`ref` unique number

`query` query code. This is always 8 — see below.

As of May 1995 there are 48 tuples in this table.

DENOM the meaning of the denomination codes used in the COINTYPE table. Fields include:

`denom` the four character code

`name` the denomination

QUERY_CD the meaning of the query codes outlined below

TYPES simple type names taken from the headings of early *denarius* issues in RRC in order to speed up manual identification of lists

CORPORA relates site code to various *corpora*, *e.g.*, RRCH, Chiţescu 1981.

HRDREFS links site codes to BIBTeX datafiles for generation of bibliographic references.

WEIGHTS weights of coins of selected issues from selected hoards used in the analysis of coin weights (section 14.4.7).

Many of the programs use temporary datafiles. The most useful one is YEARTOTS which records the coin hoards by total number of coins per year of issue (using the `date_from` field from the COINTYPE table).

'Query codes'

The major problem of accurately identifying coins either from the lists or from the coins themselves as discussed above was tackled by the use of a 'query code.' This idea was taken from Ryan (1988) and modified for this project. It is a variant of the recording terminology used by Reece (1975) which has become standard for the publication of coin lists from archaeological excavations. Each entry in the HOARDS table has a query code attached to it giving an idea of that coin(s)' status. The four main codes are:

1 exact reference; *i.e.,* the coin *is* 361/1a

2 as reference; *i.e.,* the nearest reference obtainable is 361/1a but it need not necessarily be that coin

3 copy of 361/1a; *i.e.,* a copy of exactly that coin

4 copy as 361/1a; *i.e.,* the nearest genuine coin that the copy may have used as a design

There are, however, a large number of references for coins of this period which cannot be converted to exactly one RRC reference, but can be assigned to one issue. For example, if the reference given in the hoard report is to Babelon, Valeria 18, this can be either be RRC 474/2a or 474/2b. The difference between these coins of L. Valerivs Aciscvlvs is minor: they both have an owl with a Corinthian helmet, a shield and spear(s) as the reverse type: 474/2a has one spear, 474/2b has two. They are minted in the same place (Rome) and at the same date (45 BC).[3] It would therefore be a great waste of information to record such a coin as code 2, but inaccurate to use a code 1. Therefore I have introduced a further code:

5 almost exact reference; *i.e.,* the coin is of the same moneyer, place of issue and date. Only in very rare cases is this not the same issue.

In the above example a coin with an original reference of Valeria 18 would have an internal reference 1913, code 5 (*i.e.,* almost exactly as 474/2a). It therefore follows that all references with a code 2 must have enough doubt around them for them not to be assigned to this code. This can occur when a) the coin is badly worn or damaged or b) the description given is not detailed enough to assign it to an issue. The latter is common with the early issues as discussed above. For example an anonymous dioscuri *denarius* with cornucopiae (either 58/2, 207 BC or 157/1, 179–170 BC) would be given a code 2 when the only information provided is the description.

This coding takes place at two different stages: during data input to the small temporary files and during the uploading process. In the first-stage case the code is given as a result of information in the hoard list. During the uploading process the program can update the code if necessary. The program can only decrease the data quality (*i.e.,* a coin coded 1 can be changed to a 5, but a coin coded 2 cannot be). This is achieved via the `query` column in the COINREFS table. Therefore, if the hoard contains a coin with a reference 'Babelon, Valeria 18', it will be entered to its temporary table with a query code 1. This is appended to the main tables during a run of the uploading program (UP2) with the correct code of 5 (`ctype` 1913). This is achieved by every entry in the COINREFS table having a query code attached to it indicating how accurate the cross reference with RRC was. It therefore follows that all RRC references in the COINREFS table have a query code of 1.

Data for the COINREFS table was scanned into text files from the concordances in RRC. This had to be carefully edited as the variable base lines used in the publication caused some problems. The scanned files were input to a dBASE file and then the final table constructed using a program. In many cases the RRC number in the concordance was incomplete or did not exist. These entries

[3]It should be noted that Babelon divides the issue into two (Valeria 18 and 19). Valeria 19 is the equivalent of RRC 474/2c. However, in Crawford's concordance he only records these two types of Babelon as being 474/2.

code	meaning
1	exactly identified coin
2	inexactly identified coin
3	copy of a specific coin
4	copy of a general type of coin of which the reference is an example
5	Almost exactly identified coin, *e.g.*, either RRC 408/1a or 408/1b
6	Coin in a Romanian hoard which is suspected to be a copy
7	considered extraneous, usually by Crawford
8	a general coin type, *e.g.*, miscellaneous Iberian *denarius*
9	total in hoard unknown, *i.e.*, only presence/absence of type

Table 5.1: Meaning of the various query codes used in the CHRR database

had to be checked by hand and the appropriate action taken. Where entries did not exist they were obvious misprints or errors. Where the reference was incomplete this was due to it having one of several possible minor differences (*e.g.*, 474/1a or 1b), and these were assigned a query code 5. In some cases (*e.g.*, Babelon, Valeria 19) it is possible to obtain a more accurate reference by referring back to the original catalogue.[4]

Some other codes are also used. Coins with a query code of 6 are those which are considered by Romanian scholars to be copies, *e.g.*, the coins from Poroschia (PRS, Chiţescu 1968b; Chiţescu 1980). This enables data sets including or excluding these coins to be easily extracted for comparative statistical analyses. Other codes include:

7 considered by Crawford to be extraneous

8 general reference; see table KRIS_CAT

9 entry in the `total` column of the HOARDS table only indicates presence/absence. This is usually set to 1.

A summary of these codes is provided in Table 5.1.

General Categories

The general categories in this database are stored as references to a pseudo-catalogue 'KL' which has its data stored in table KRIS_CAT. This is a table is of a form compatible with the COINREFS table and has been appended to it. However, for the sake of ease of development it is also stored as a separate file. As being a member of a general category such as this is slightly different from being 'as' or 'almost…' (see above), all genuine coins recorded as having a KL reference also have the query code 8. Copies of general categories are recorded with a query code of 4.

[4] Referring back to the original catalogue in all cases would be extremely time consuming and given the slight increase in accuracy in was decided that it was not economical to do so unless the error was noticed during some other task (such as writing this report!)

5.2.5 The coverage of the database

No attempt was made during the process of uploading hoards to ensure that the coverage of the database was representative either by country or by period. There are serious problems of coverage by country due to regional traditions in publication. For example, Romania stands out as having an enormous number of hoards compared to other areas. However, the relative lack of Bulgarian hoards is due to a lack of publication, especially in the detail required for uploading to the HOARDS table. This problem is exacerbated by the author having worked extensively in Romania. In Italy, the recent tradition has been not to publish hoards of this period in detail although this is partly offset by the large number of lists prepared by Michael Crawford. Chapter 7 discusses this matter in detail. The detailed analyses do not, however, require that the coverage across regions be representative in terms of the number of hoards provided the *quantity* of hoards at each period was large enough that the composition of the hoards could be seen to be representative.

5.2.6 Future development

As yet, many pieces of subsidiary data are not input to the database. For example, was the hoard found in a pot or with other finds? What year was it found and how? Much of this is contained in the project log-books but needs computerisation.

A database such as this can never be ‘complete.’ New hoards, new publications and old records continually come to light. This database is part of a longer-term project and will be periodically updated. Much information has yet to be converted into the detailed format of the HOARDS table, although more than enough data has been input for the purposes of the present project. Appendix A contains the list of hoards currently held on the CHRR database, relevant information and their status. The medium-term aim of the database project is twofold. Firstly, to publish a second edition of *Roman Republican Coin Hoards*, in co-operation with Michael Crawford. Secondly, to provide a distribution version of the database which will be available on disk and from the Southampton FTP server. Appendix A should be seen as giving details of the hoards used in the following analyses, and as a statement of the current state of the CHRR database, not as a complete ‘end product.’

5.3 Other Data

For Part Three of this thesis a number of other classes of data were collected. As part of the attempt to resolve the problems of copies in the Romanian material, an archaeometallurgical project was instigated by the author. The resultant data is analysed and discussed in section 14.4.3. The results of this project are stored in a database along with Walker’s estimates of the silver content of 1,991 *denarii* (Walker 1980). These data will also be available via anonymous FTP.

In order to discuss the coinage in Romania in context a number of other pieces of information were gathered. They include a survey of the published data for late La Tène settlements in the counties of Alba, Sibiu and Hunedoara, a brief examination of hoards of silver artefacts from Romania, and sites which have either circular sanctuaries, or *murus dacicus* walls associated with them.

Both the above classes of data will be discussed in more detail in those sections which use the data.

Chapter 6

Models of coin supply and circulation

6.1 Introduction

Before starting to analyse the hoard data we need to have some models as to how the supply and circulation of coinage might be reflected by coin hoards. It was this problem which was examined by computer simulation (Lockyear 1989; 1991). Here I wish to outline some models of coinage supply and circulation, and to predict how they might be reflected. For the moment, we can assume that hoards are a random selection of coins from the local coinage pool (Thordeman 1948). Variations within the hoards across time and space should therefore represent variations within the global pool.

6.2 The life of a coin

The life cycle of a coin can be represented as shown in Fig. 6.1. The figure attempts to show the various stages of production, supply and use and was used as the basis for the computer simulation. A similar model was presented by Haselgrove (1987). The first parameter which will affect the contents of hoards is the numbers of each type of coin struck. This will be determined by a variety of factors foremost of which are the availability of bullion, and the political desire, or need, to mint coin. The relative sizes of issues in the coinage pool at a certain date can be seen by examining hoards of that date. This does not give the relative sizes of the issues *as struck*. Each year a proportion of the coinage pool was lost (see below). The absolute numbers of coins struck is difficult to calculate. It has been proposed, although not universally accepted, that the global coinage pool grew (Hopkins 1980; *cf.* Buttrey 1993). These factors combine to make comparisons of the absolute sizes of coin issues difficult. One method which has been used to estimate the absolute size of coinage is to estimate the number of dies used to strike an issue and to multiply that by a constant. A variety of formulæ and methods have been used (Esty 1986). This procedure has recently been strongly criticised (Buttrey 1993; Buttrey 1994), see section 3.13.8, *cf.* Chapter 11.

Once a coin issue had been struck, it is possible that it was not all released by the state at once. However, it seems probable that coins were struck to meet state expenditure demands, and that rarely was there much delay in its release.

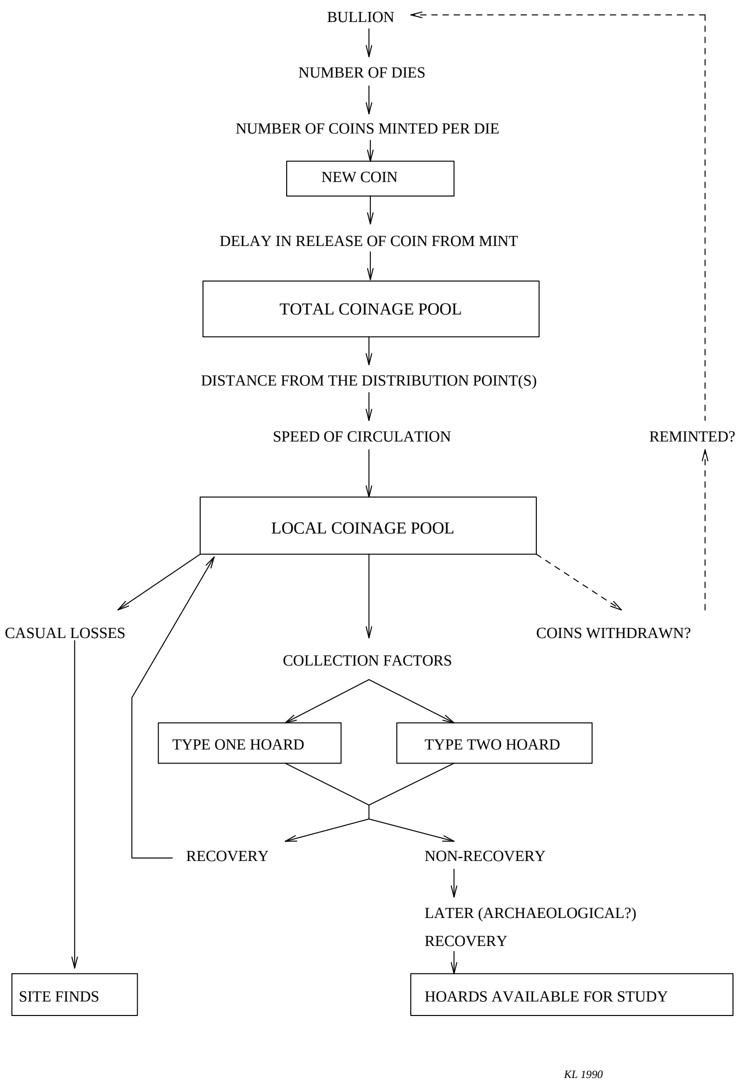


Figure 6.1: Model of coin circulation (from Lockyear 1991, Fig. 28.9).

The global coinage pool is defined as all the coins in the area under study at one time. Within this there will be local variations — that is, a series of local coinage pools. Some of the possible factors which will create or destroy local variation are:

1. Distance from distribution points. If the local pool is a long way from the initial distribution points it will take longer for it to receive the newest coins than areas near to those points.

2. Speed of circulation. The faster coinage circulates the sooner its distribution will be even.

3. Time. The longer the period since issue, the more likely the distribution of that issue will be even.

These three factors were combined in the simulation model as the introduction delay (Lockyear 1991). They combine to form parameter τ_1 in Goulpeau's model (section 3.8; Goulpeau 1981).

Having entered circulation, coins usually fall slowly out of circulation. This can happen as the result of:

- accidental losses (*i.e.*, dropped coins)
- accidental non-recovery of hoards
- deliberate disposal, *e.g.*, burials or ritual hoards
- melting down of coins for bullion
- export of coins to areas outside of the core area of coin use, *e.g.*, across the Rhine frontier into Germany.

Sometimes coin issues fall out of circulation quickly. This can either be via the recall of coinage by the state, or by deliberate disposal due to demonetization of an otherwise worthless, debased, coinage. The rate of loss is known as the decay rate (Lockyear 1991), τ_2 (Goulpeau 1981), the sink rate (Volk 1987), the wastage rate (Creighton 1992a) or the attrition rate (Buttrey 1993).

The model also provides two extreme theoretical mechanisms for the collection of hoards. The Type One (or emergency hoard) is when the hoard is collected in a relatively short period of time. An example would be a day's takings from a market stall. The Type Two (or savings hoard) is when the hoard is formed over a longer period of time, *e.g.*, coins being saved for a dowry.

Computer simulation was used to analyse how these factors would affect hoard structure. It was found that, at some periods, variation in either the introduction delay, or the decay rate, or the collection method could account for the observed variation in hoards (Lockyear 1989; Lockyear 1991). The reason for this being applicable to some periods only became clear during subsequent work and will be discussed in detail in Chapter 9 (see also Lockyear 1993a).

Haselgrove's model, which is very similar to this, was criticised by Creighton (1992a, section 2.12) as being ethnocentric. He claims that hoards are seen as an appendage to circulating money, whereas he would see them as 'dynamic stores of wealth.' He states that most coin would have spent the majority of its life in a hoard of some form. Creighton's figure is reproduced here (Fig. 6.2). The hexagon represents a variety of exchanges with coin being kept in small quantities, such as in a purse, to large amounts, such as in an *armarium* or strongbox. Whilst accepting his criticism that hoards are given a too peripheral rôle I do not accept that this is ethnocentric. If we are to define hoards as widely as Creighton does, then there is little difference between his model for the Roman period and an equivalent model for today. The main difference is that the *location* of larger hoards has changed to shop safes and bank strong rooms. If we use a definition of money derived from neoclassical economics, we can add chequing accounts and computer memory to his list of static locations of money. His model (Fig. 6.2) is self explanatory. Note that the *armarium*, or store of wealth, need not be that of an individual. It could be an army pay chest, a tax collector's revenues, or the state's financial reserves.

Important parts of the system are not represented well in either model. An important missing element from both models, especially when comparing different geographical regions, is that of supply. What mechanisms were used for releasing the coin from the mint into circulation? How

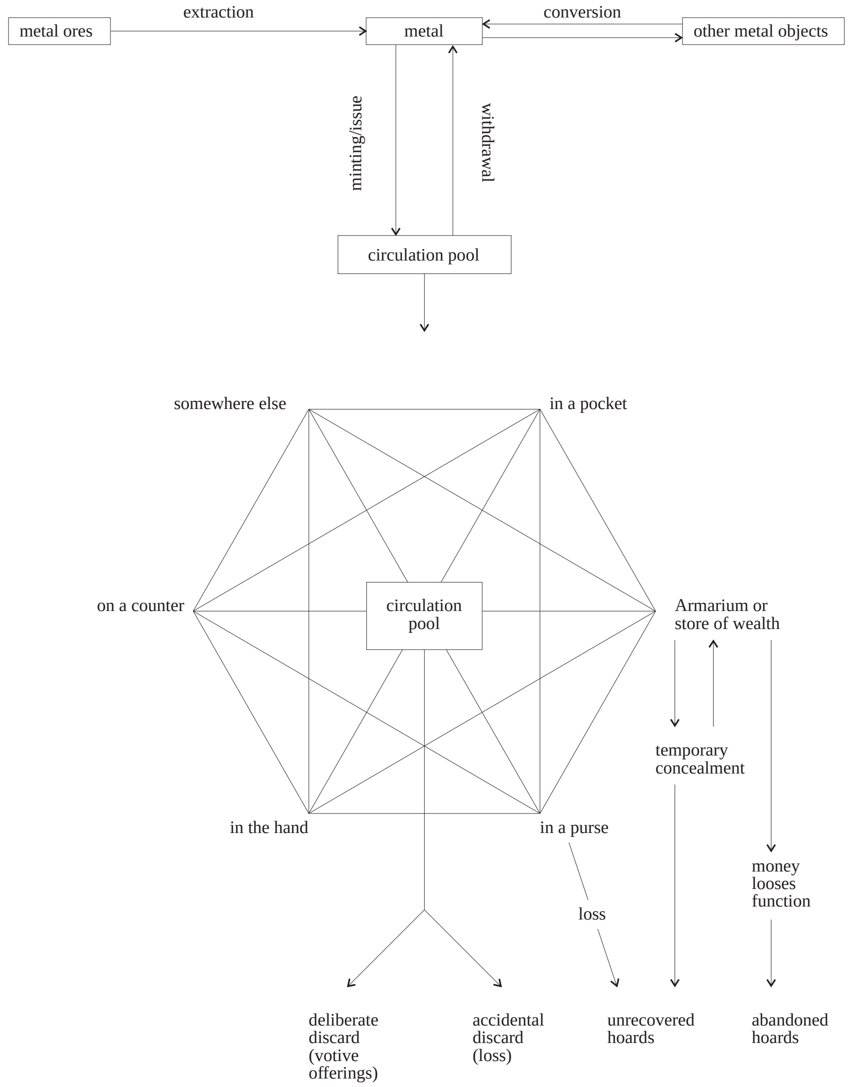


Figure 6.2: Model of coin circulation (after Creighton 1992a, Fig. 21.02).

would coinage move from one area to another? Can we suggest how the different possible mechanisms would affect hoard structure? In the rest of this chapter I will propose, and discuss, different possibilities.

6.3 Supply and distribution within a discrete area

Firstly, we can suggest a model for a discrete area. This could be a small region, or even a town. We can suggest that new coin entering the pool would be issued at a point or points within that area. As an example, let us take a fort near a town. The soldiers' pay is likely to contain a proportion of new coin. On pay day, the distribution of that coin is limited to soldiers' purses and private stores, including the fort's central strong room. The coins have a highly uneven distribution. Over time, the soldier spends his money and the coins enter the 'hoards' in shops, bars and brothels. These coins are then in turn passed onto others. After a while, the distribution of the new coins in that town is reasonably even. Towns with no troops, or other reasons for official payments, will only receive these coins as a result of trade and other contacts. We can summarise this as follows:

Stage 1: coins being struck; distribution limited to mint.

Stage 2: coins used by state for payment; distribution limited to payees.

Stage 3: payees use coins; distribution irregular within area where payees live and/or travel to.

Stage 4a: coins have been used for a while; distribution within initial area now even.

Stage 4b: coins used for a long period; distribution over large areas now even.

Stage 5 and 6: coins no longer used and are destroyed or lost; distribution now limited to loss sites, museums, collectors and archaeological units.

The distribution of coins will initially be centred around the points of supply. If the points of supply are widely dispersed it may be difficult to see trends in the hoard data. If there are few points of supply, or those points of supply are limited to a small area, it should be possible see a trend in the distribution at first. A good example is coin hoards between AD 197–238 in Britain. Hoards near military centres such as Segontium or Hadrian's Wall have a large proportion of the newest coins; hoards in the south have a low proportion (Creighton 1992a, Fig. 25.19).

The edges of the coin distribution present some problems. Some 'edges' are definite borders beyond which coins are simply not present, or are used in a way that the number and type of exchanges, if there any, are quite different from the model proposed above. A good example would be the distribution of coinage beyond Hadrian's Wall. Supply to such areas is likely to be highly erratic.

Another possibility is where a number of centres are producing coins as part of the same coinage system. Such multiple mint systems occur especially under the Empire in the fourth century. This can lead to the situation where coins of a mint become less common, in comparison to coins of a second mint, as one moves from the first to the second (see Fig. 6.3).

6.4 Types of supply

How does coin minted, for example in Rome, get to Spain or Romania? We can suggest three simplified possibilities.

Down the line movement.

This is the sort of movement described above. As coins are exchanged from their point of issue, a decreasing number will move further and further away from that point. The number decreases because some coins at each stage will move back towards the point of issue. Eventually, a physical, political or social border will be encountered restricting further movement. The random walk simulations which have been used to look at the creation of distribution patterns (Elliott, Ellman & Hodder 1978) can provide a schematic model to demonstrate this (Fig. 6.4).

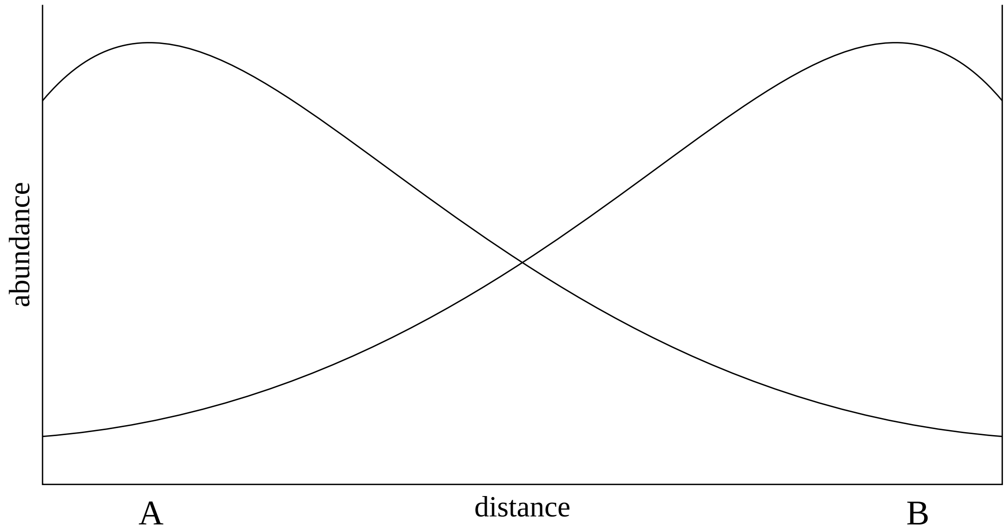


Figure 6.3: Idealised coin distribution between two mints (A and B) which are part of the same monetary system.

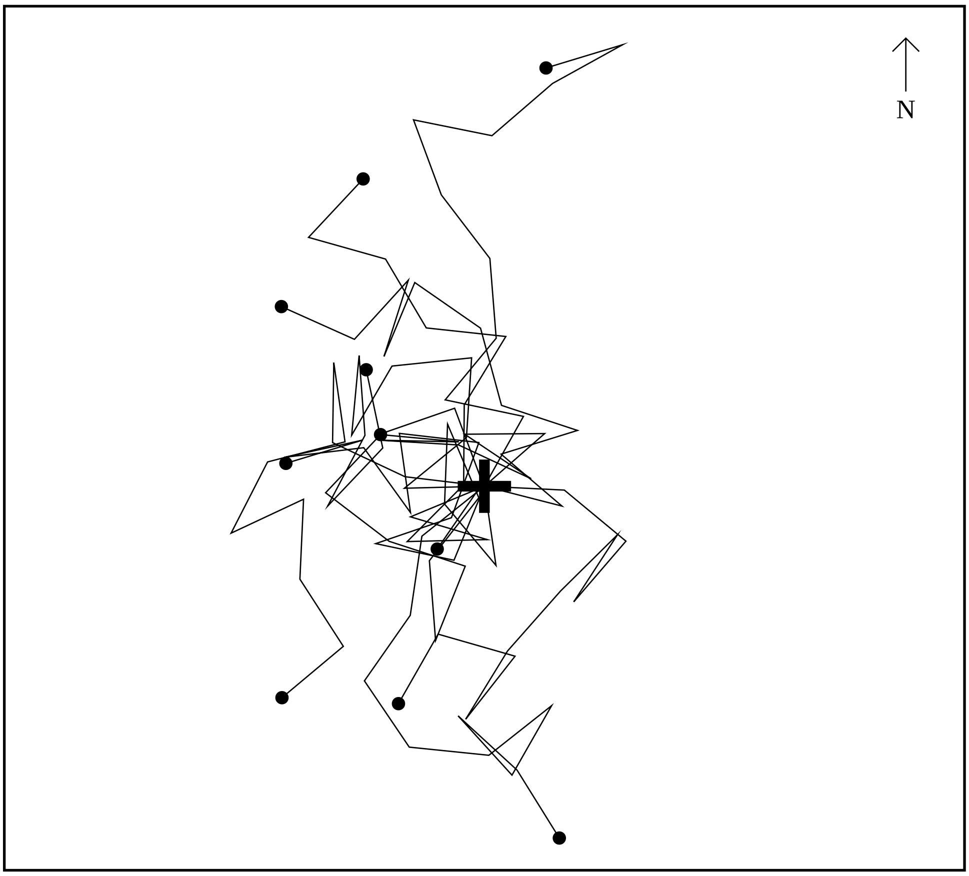


Figure 6.4: Down the line movement model. At each point coins can move in any direction including back towards the point of origin. This figure contains ten random 'walks.' Each starts from the same origin. The length of each step is constant, the direction random.

Public supply.

Some areas will receive coinage from the state as payments or subsidies. A common payment would be to troops stationed in an area. This coinage will then be released into the local coinage pool. Some of it might return to the area of production via taxation. The coinage used in payments would presumably consist of a mixture of older coins (from taxation), and the latest coins from the mint. If a hoard was recovered from this payment we could predict that it would have a higher than average quantity of new coin.

Private supply.

Coin may be moved large distances by private persons. These movements may be for a variety of reasons which include:

- trade
- loans
- other types of exchange between private persons
- with the owner; *e.g.*, emigration, or the return of a soldier to his home.

Unless the supplier has recently been paid by the state, we can suggest that a hoard from this supply would reflect the coinage pool in the area from which it was withdrawn.

6.5 Inter-regional patterns

If the contacts between the producer region and the target area are regular and large scale, we would expect, *all* other things being equal, for the composition of their respective coinage pools to be similar. The exception would be in the distribution of the latest coins where some regional dissimilarities would be seen. In the right circumstances, we would be able to see which areas were receiving official supplies of coin. What these 'right' circumstances are will be discussed in section 9.5, page 283.

If contacts were irregular, or new, we could predict the following:

1. If the contact was in some way official, the coinage received would have a higher proportion of new coin than the coinage pool 'at home.'
2. If the contact was private, *e.g.*, private trader, the coinage received would reflect the pool 'at home.'
3. If supply fluctuated, the pool would not reflect the pool at home as it would not receive coins in the same proportions as produced.

These possibilities are a simplified set. In reality there will be mixture of the various factors and our best hope is that there is a dominant factor which will show through the likely 'messy' pattern.

6.6 Other factors

A number of other important factors also have to be considered.

1. Do the coins perform the same function from area to area?

2. Do they circulate at the same speed from area to area? If coins circulated more slowly in one region than another, the time taken for the distribution of a coin type to even out will vary.

3. Does the target area have coinage of its own? Are the systems compatible? Does it matter?

Given the background discussion of money (Chapter 2), item 1 can be seen to be of utmost importance and interest.

6.7 Summary

The models outlined above are a gross simplification of the real situation. However, using these models as a starting point we can start to analyse the available data, and then to attempt to interpret it. The analyses themselves might lead to further refinement, alteration or rejection of the these models, which in turn could lead to further analyses and interpretations.

Chapter 7

The Incidence of Hoards

7.1 Introduction

This chapter will briefly overview the gross spatial and temporal distribution of hoards. The aim is to provide a general background pattern to the detailed analyses in the following chapters.

Crawford (1969a) demonstrated that the time distribution of hoards in Italy during the Roman Republic was not even. Peaks in the incidence of hoards correlated well with historically attested episodes; *e.g.*, the Social War.[1] This correlation is not, however, quite as clear cut as Crawford would like. During such episodes the quantities of coin produced were greater than at other periods and this leads to coins of those dates forming a large proportion of the coinage pool. If the coins in the hoards are randomly selected from the coinage pool, they will reflect this. The probability of selecting a coin of a certain year is directly proportional to its abundance in the coinage pool. If a hoard is collected in a year, or years, during which few coins were minted, the smaller the probability that the hoard will contain coins of that year or years. The smaller the hoard, the smaller the probability. Therefore, purely by chance, some hoards will be wrongly dated to those years whose coinage dominates the coinage pool. These years correspond to the periods of unrest noted by Crawford.

Lockyear (1993a, pp. 374–5) quantified, and discusses the problem at length. If, for the sake of demonstration, we accept Crawford's die estimates and a decay rate of 2%, we can calculate the composition of the global coinage pool between *c.* 147–50 BC. Lockyear shows that for a hoard of 100 coins, there is a probability 0.9995 that a hoard of 89 BC will contain a coin of that year. For a hoard of 75 BC, however, there is a probability of only 0.469 that it will contain a coin of that year. With smaller hoards the problem becomes more extreme. A hoard of ten coins collected in 75 BC has a probability of only 0.061 of having a coin of that year.

We must keep the above insights in mind when looking at the distributions described in this chapter.

Unfortunately, as discussed above, the CHRR database may not be ideally suited to the examination of these distributions (section 5.2.5, page 127). The first task is, therefore, to test for possible problems in the database coverage.

[1] It has also been demonstrated elsewhere that the detailed *geographical* incidence of hoards is *not* directly tied to such events. See especially Kent (1974).

7.2 Testing the coverage

Tables 7.1–7.2 present the total number of hoards by period and region contained in the CHRR database as of the end of 1994. The periods in the tables are those used in RRCH (Crawford 1969c) We can test the time distribution of hoards in the database by comparing them to other catalogues.

7.2.1 Italy

For Italy, including Sicily, Sardinia, Corsica and Elba, the only reasonably comprehensive catalogue is RRCH. For this area we can be confident that RRCH presents a representative picture due to Crawford's long standing personal involvement in collecting data from there.

Table 7.3 shows the number of hoards with at least one *denarius* in RRCH and the CHRR database. Comparing these two distributions using the Kolmogorov-Smirnov test (Shennan 1988, pp. 55–61) we can see that there is no statistically significant difference between the two.[2]

Looking in detail at the figures we can see that the distribution across periods is slightly more even in the database than in RRCH. This is due to an attempt being made to provide enough hoards for detailed analysis across all periods. The last period (26–2 BC) is slightly under-represented. This is due to hoards with Imperial issues being more difficult to input and upload to the database than those with only Republican issues. The complexities of early catalogues of the Augustan coinage result in early hoard reports requiring much more manual intervention during computerisation.

7.2.2 Spain and Portugal

For Spain and Portugal we can compare the evidence with Blázquez (1987–1988) which expands the data given in RRCH. The data are presented in Table 7.3. Comparing the two distributions as above shows no statistically significant difference.[3] Looking in detail, however, shows that the period 78–50 BC is relatively over-represented in the database, and 49–45 BC under-represented.

7.2.3 Romania

For Romania, the situation is more difficult. RRCH under-represents the Romanian material (Poenaru Bordea 1971) and Chiţescu (1981) is difficult to use for this purpose as the coin identifications are according to Sydenham (1952), and the hoards are ordered alphabetically. However, as the majority of the usable hoards in this catalogue have been input and uploaded and we can be confident that the database is representative. The only exception may be a slight under-representation in the last period, as with the Italian material.

[2]The null hypothesis (H_0) is that there is no difference. $\mathrm{Dmax}_{\mathrm{obs}} = 0.055; \mathrm{Dmax}_{0.05} = 0.15$. We therefore accept the null hypothesis.

[3]The null hypothesis (H_0) is that there is no difference. $\mathrm{Dmax}_{\mathrm{obs}} = 0.08; \mathrm{Dmax}_{0.05} = 0.23$. We therefore accept the null hypothesis.

	208–151	150–125	124–92	91–79	78–50	49–45	44–27	26–2	not uploaded	uploaded	total
uncertain				1		1		1	2	3	5
Albania									3		3
Austria			1				1		1	2	3
Britain							1			1	1
Bulgaria					1	1	3	2	13	7	20
Corfu							1			1	1
Corsica									1		1
Crete									1		1
Elba					1					1	1
Former USSR						1			6	1	7
France					5	3	6	3	20	17	37
Germany					1	1	3	3	5	8	13
Greece				1	3	2	2		8	8	16
Hungary					1	1			1	2	3
Italy	3†	11†	22	24†	25	18†	25‡	6	71	134	205
Jersey							1			1	1
Morocco									1		1
Netherlands						1		1	3	2	5
Is. Pantelleria				1						1	1
Poland									1		1
Portugal			3	1	4	2	4	1	8	15	23
Romania	1		2	17	40	20	28	17	18	125	143
San Marino									1		1
Sardinia				1				1	1	2	3
Sicily	1	4	4	2	3		3	1	3	18	21
Spain	2‡	1	20†	2	11	3	2	3	23	44	67
Switzerland							1		1	1	2
Tunisia		2							2	2	4
Turkey							2		2	2	4
Yugoslavia		1	2	1	2	1	3	2	11	12	23
total	7	19	54	51	97	55	86	41	207	410	617

Table 7.1: Number of hoards by region in the CHRR database as of December 1994. Hoard closing date determined by the latest Roman coin in the hoard. Date ranges those used in RRCH with slight modification. † Includes one hoard with no *denarii* . ‡ Includes two hoards with no *denarii*.

	208–151	150–125	124–92	91–79	78–50	49–45	44–27	26–2	total
uncertain				215		426		16	657
Austria			22				52		74
Britain							3		3
Bulgaria					35	459	168	208	870
Corfu							28		28
Elba					43				43
Former USSR						1			1
France					197	386	1258	1127	2968
Germany					12	13	84	42	151
Greece				42	157	51	688		938
Hungary					1	51			52
Italy	28	1716	3678	3069	15498	2762	12634	1799	41184
Jersey							13		13
Netherlands						2		60	62
Is. Pantelleria				40					40
Portugal			1448	5	449	80	3835	81	5898
Romania	1		4	164	2301	1482	3006	1388	8346
Sardinia				1395				18	1413
Sicily	15	133	301	1119	168		197	311	2244
Spain		2	1423	502	2209	509	219	74	4938
Switzerland							61		61
Tunisia		115							115
Turkey							132		132
Yugoslavia		497	191	4	207	109	111	13	1132
total	44	2463	7067	6555	21277	6331	22489	5137	71363

Table 7.2: Number of *denarii* in hoards by region. Only *denarii* with a query code of 1, 5 or 6 have been included.

Region	208–151	150–125	124–92	91–79	78–50	49–45	44–27	26–2	total
Italy *etc.* (RRCH)	7	13	28	36	31	14	34	17	180
Italy *etc.* (database)	3	14	26	26	29	17	26	8	149
Iberian Peninsula (Blázquez)	1	0	34	9	16	12	10	10	92
Iberian Peninsula (database)	0	1	22	3	15	5	6	4	56
Romania (database)	1	0	2	17	40	20	28	17	125

Table 7.3: Total numbers of *denarius* hoards by region. Comparison of catalogues (Crawford 1969c; Blázquez 1987–1988) with the CHRR database.

7.2.4 Other regions

As this thesis will concentrate on material from the above regions, no attempt has been made to ensure detailed coverage of other areas. However, no other regions have such large numbers of hoards with the possible exception of France at a late date.

Some of the differences between countries are due to publication traditions. Bulgaria is severely under-represented (Crawford 1977a; Poenaru Bordea 1971). Many hoards are published in summary form but detailed reports are not the norm there, as shown by the fact that 65% of the hoards in the SITENAME table have not been uploaded. In contrast, Romania has a long tradition of detailed hoard reports. Many French hoards are known from very old publications which are being listed in the series *Trésors Monetaire.* Germany has few hoards of an early date, although later hoards

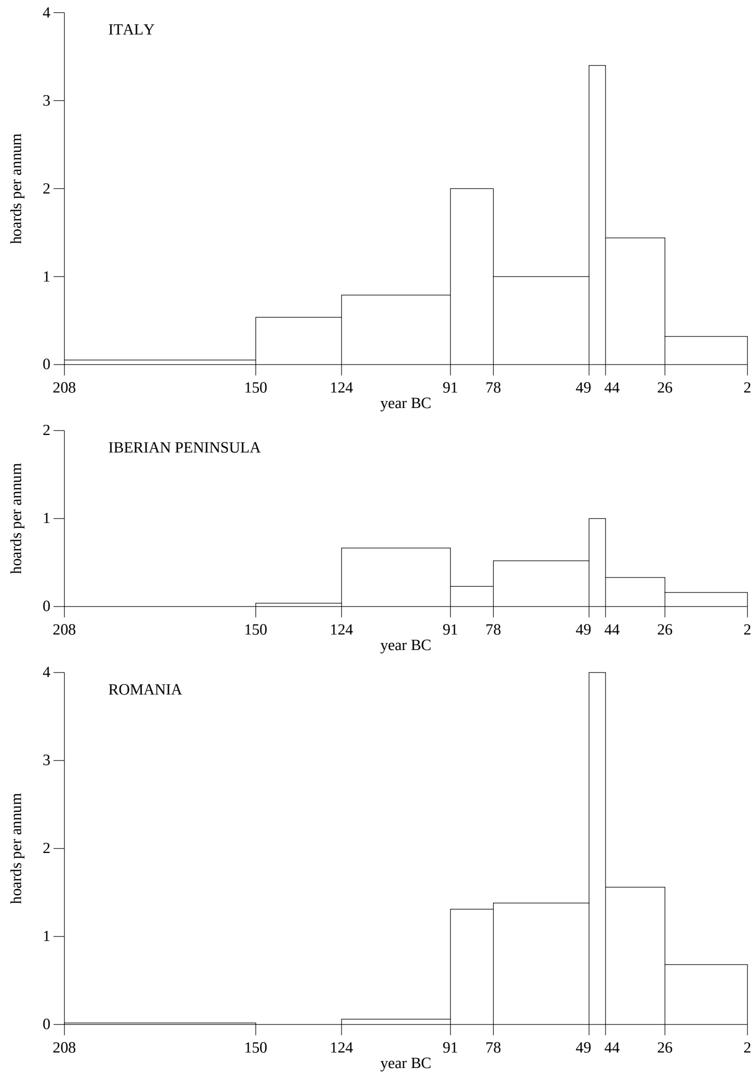


Figure 7.1: *Denarius* hoards *per annum* in the CHRR database. Italy includes Sicily, Sardinia, Corsica, San Marino and Elba.

are often published in detail. Although British hoards are usually well published, none contain only Republican *denarii*. The one hoard listed (Weston, WES, RRCH 476) contains three *denarii* hoarded with British coins and could easily be of a later date.

To summarise, the CHRR database does generally reflect the distribution of hoards over time although there is a tendency for periods with a low rate of hoarding to be slightly over-represented, and for the Augustan period to be under-represented.

7.3 The pattern

Fig. 7.1 presents three histograms of the number of hoards per year using data from the CHRR database. Comparison of the three histograms shows substantial differences. The absolute height of each bar is less important than the relative changes between bars.

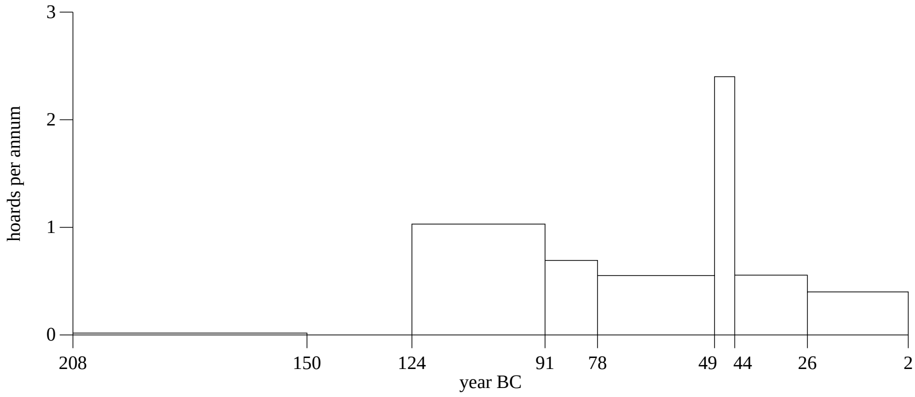


Figure 7.2: *Denarius* hoards *per annum* in Spain and Portugal from Blázquez (1987–1988).

The Italian pattern shows major peaks in periods of civil or military unrest: the Social War (91–88 BC), Spartacus' revolt (73–71 BC) and the Civil Wars of the 40s BC. This is the pattern as shown by Crawford (1969a). A visual comparison between the Italian graph presented here and by Crawford (1969a, p. 79)[4] shows a substantial difference in the earliest period. This is because Crawford's graph includes non-*denarius* hoards of which a large number are early hoards of *victoriati*. Why the lower fineness *victoriati* should have been hoarded preferentially to the new *denarii* during the Second Punic War is unclear.

Although the lack of hoards in the last period (26–2 BC) is slightly exaggerated, it is real. Guest (1994) shows that Italy all but ceases to hoard silver coins after the end of the first century BC. This is in contrast to peripheral areas of the Empire, for example Roman Britain.

The Iberian peninsula material shows comparatively more hoards in the period 124–92 BC and comparatively few hoards from 91–79 BC compared to Italy. The peak for Italy in the period 91–70 BC has been explained by Crawford by the Social War and Spartacus' revolt (Crawford 1969a). Two contradictory points could have relevance. Firstly, as both these events took place in Italy, it would be unsurprising that the peak is not large in Spain and Portugal. Conversely, these years, especially the 80s BC, also produced very large quantities of coin and one would have expected a moderate number of smaller hoards to have been dated to that period erroneously, as shown above. The significance and interpretation of the Iberian pattern from 124–70 BC remains unexplained.

The Iberian peninsula seems to have a relatively less marked peak in the period 49–45. The civil wars, which are cited as the cause of the peak in 49–45 BC for Italy, were also partly fought in Spain — the Battle of Munda took place in 45 BC (Scullard 1982, p. 142). Republican *denarii* were minted in Spain in 46–45 BC (RRC 468–471, 477–479). Fig. 7.1 appears to be misleading here — as noted above the number of hoards from 78–45 BC in the CHRR database is unrepresentatively high. Plotting the numbers of hoards from Blázquez (1987–1988) produces Fig. 7.2, which has a much higher peak for 49–45 BC. For Italy, the numbers of hoards per year for 49–45 is 3.5 times that of the previous period, for Romania almost 3 times, and for Iberia, using Blázquez's figures, just over 4 times.

[4] The graph is reproduced in Crawford (1985, Fig. 74); Casey (1986, Fig. 5, p. 64); and Lockyear (1989, Fig. 1.1, p. 8)

The overall pattern is even more irregular than shown in Figs. 7.1–7.2. Iberian hoards with 30+ *denarii* in the period 124–92 are concentrated in the period 115–100 BC. In the period 78–50 BC a detailed breakdown of hoards of 30+ *denarius* shows that 9 of 10 are in the period 78–69 BC, compared to 19 of 27 Italian hoards. These differences between Italy and the Iberian peninsula cause difficulties in the detailed analyses as we are not always able to compare enough hoards of the same date from different regions — see sections 8.3.3–8.3.4 especially.

The Romanian graph shows comparatively large number of hoards in the period 91–79 BC. This is misleading. The 19 hoards dating to pre-78 BC contain only 169 'good' *denarii* (*i.e.*, well identified *denarii* with a query code of 1, 5 or 6). Of these, 41 *denarii* come from the Bobaia hoard (BOB) which closes in 79 BC (Chirilă & Iaroslavschi 1987–1988). It is extremely likely that these very small hoards were actually concealed later, probably mainly after 80 BC.

In the period 78–50 BC substantial variation is masked by the large time period. 19 of 27 Italian hoards over 30 *denarii* occur 78–69 BC compared to only 9 of 27 Romanian hoards. Conversely, 8 of 27 Italian hoards occur 63–51 BC compared to 18 of 27 Romanian hoards. This concentration of hoards from 63–51 seems the more extraordinary when one considers the small size of the issues of this period. The dating of Romanian hoards is often problematic due to the copying of coins (see Part III). However, coins of the 40s BC are common in later hoards and this suggests that these hoards were not concealed much later than their closing date.

Romania also has a large rise in hoarding for the period 49–45 BC. This is a real peak with 20 hoards containing 1,482 good *denarii*. Although there were fewer hoards buried in Italy in this period, the size of the hoards is larger. Generally, the size of Italian hoards is larger than that of Romanian hoards. It could be misleading to plot histograms of the total number of coins recovered in each period as so many hoards are incompletely known. More detailed discussion of the Romanian pattern is reserved for Part III.

7.4 Conclusions

At a general level, the CHRR database appears to reflect real patterns in the data with perhaps the exception of 78–44 BC for the Iberian peninsula. The large time periods used in these comparisons do mask some variation in the hoarding pattern. The differences in hoarding patterns made inter-regional comparisons between periods at a detailed level difficult.

The Iberian pattern seems slightly different from the Italian despite both areas being under Roman rule at the period considered. The lack of a peak in the period 91–79 may be explicable in terms of political events. The relatively large numbers of hoards from 124–92 has been interpreted by Crawford as evidence of Italian and Roman settlers (Crawford 1985, p. 97–102) but this interpretation has not met with universal acceptance (Simon Keay, *pers. comm.*).

The Romanian pattern is more similar to the Italian, once the supply of coinage to Romania starts fully. This patterning however, masks important differences in the structure of Romanian and Italian coin hoards which is examined in the next chapter. Also, the problem of copies means that the dating of the hoards is not secure and the possibility exists that some may have been concealed much later.

Chapter 8

Comparing Hoards — Correspondence Analysis

8.1 Aims and methods

8.1.1 Introduction

When deciding on which techniques to use in any statistical analysis a number of considerations must be to the fore. Firstly, what is it we are trying to achieve — what is the question? Secondly, do the data meet the requirements of the statistical method to be employed? Lastly, is the technique likely to give *optimal* results?

In the case of the data set at hand we have a very general question. Is there spatial and/or temporal patterning in the structure[1] of coin hoards? If so, what is it and can it be characterised? Can we identify aspects of that patterning which are the results of less interesting factors, such as post-recovery biases, or the effects of sampling error, so that we can identify residual variation which could be more interesting. The neglect of the principles of formation processes in the interpretation of coin hoards, as in other classes of archaeological material, has led to serious errors in interpretation (Lockyear 1991; Lockyear 1993a).

Of the many dimensions of the data it would be possible to examine, it was decided to focus on one, variation in quantity of *denarii* in hoards grouped by `date_from`. For example, the hoard from Cosa (COS) has 6 *denarii* with a `date_from` of 92 BC, 56 of 91 BC, 204 of 90 BC, *etc.* This is what Creighton calls the 'age profile' of a hoard (Creighton 1992a, p. 79).

It would be possible to look for variation in the distribution of particular coin types. This has many problems such as the sparseness of the resultant tables and the large number of variables. Duncan-Jones (1989) has demonstrated that there can be interesting variation at this level of detail. The structure of the CHRR database would enable such detailed analyses to be performed in future.

The number of coins in a hoard grouped by `date_from` gives variables which are an *ordinal* data type (Shennan 1988, chapter 2). This is important as it enables us to use tests for that

[1]The term 'structure' of a coin hoard is used to mean the pattern of certain classes of coins in a hoard. The classes could be exact coin types, dates of coins or mints from which the coins originated. My use of the term derives from the statistical literature where it is often stated that we are looking for *latent structure* in a data set, *e.g.,* Wright (1989). Creighton (1992a) also uses the term.

data type which are more powerful than those designed for categorical data. For example, a common technique which has been used for the comparison of hoards is the χ^2 test (*e.g.,* Villaronga 1982). However, a more powerful test, the Kolmogorov-Smirnov test, is applicable to ordinal data (Shennan 1988, pp. 55–61, *cf.* Lockyear 1989, section 2.2).

A secondary aim of this Part is to compare and contrast various techniques which could be employed for the analysis of hoards by their 'age profile.'

8.1.2 Techniques

Simple picture summaries of the data are needed. Histograms are a powerful visual tool for examining data but are limited when several objects (hoards) need to be compared (*cf.* Lockyear 1989, figs. A2–A25). Reece (1974b) used scattergrams for plotting this type of data and this method was followed by Lockyear (1989, figs. A26–A30). It was found that plotting by `end_date` these diagrams were confused and they were grouped, therefore, into five year batches which produced a clearer result (Lockyear 1989, figs. 2.2–2.8). Ryan (1988) used cumulative percentage curves. This method, used here, is especially suitable for the representation of coin hoards, allowing the comparison of a number of hoards identified by colour or line style. It was found useful to plot a 'maximum difference' line in some cases.

The comparison of hoards using significance tests has been discussed (Lockyear 1989). The three main objections are:

1. Given our models of coin circulation, do we ever expect two hoards to be drawn from the same population? Although they may be drawn from the same global coinage pool are the local pools going to be the same? If we do *not* expect the local pools to be identical, significance tests where the null hypothesis (H_0) is one of no difference, are not an appropriate method.

2. Given the wide range of sizes of coin hoards, it is difficult to see possible patterns above the effect of sample size (Shennan 1988, pp. 77–8).

3. Given the number of hoards, we need to assess the problem of *multiplicity* (Mosteller & Tukey 1977, p. 28f.). This becomes a problem of multiple comparisons (O'Neill & Wetherill 1971).

In the following analyses, significance tests will only be used when appropriate.

It would be possible to use contingency coefficients (*e.g.,* Creighton 1992a; Creighton 1992b) but this method is fraught with problems as has been discussed (section 3.12.5); they are used in a limited fashion on page 255.

It was clear that some form of exploratory multivariate technique was required. Correspondence analysis (CA) is a technique specifically for the analysis of contingency tables and is thus highly suited to the analysis of this type of data (Bølviken *et al.* 1982; Greenacre 1984; Wright 1989; Greenacre 1993; Baxter 1994). It was used by Lockyear (1989, section 2.4) and Alcock (1991). Its advantages are that it provides information about the relationships between objects, and between variables, and when used with care between objects and variables (but see page 309 for a cautionary example). The results can be easily displayed as a scattergram for both objects and variables. This technique is not without its problems. Firstly, it is very sensitive to 'odd' samples and variables and these can dominate the results. Secondly, the technique is very good at *seriating* objects and variables — that is, putting them in some form of order according to their distribution along a gradient (Madsen 1989). This is often time, but can be space or social status. With coin hoards of relatively well dated material, this is not an advantage but a disadvantage. Lockyear (1989, section 2.4) found that it was difficult to find variation in the data set which was not connected to time.

Other multivariate techniques which have been applied to coin hoards include principal components analysis (Ryan 1988; Creighton 1992a) and factor analysis (Duncan-Jones 1989). However, most of these analyses were performed before CA became popular in the late 1980s (Baxter 1994, pp. 133–139).

8.1.3 Software

Graphs

HARVARD GRAPHICS was used for the production of the cumulative percentage line graphs used in this chapter. It has a limit of sixteen lines per graph. It was also used for the production of some of the other graphs in this thesis.

Correspondence Analysis

A number of computer packages for CA were available. IASTATS has a simple input format and usage and its output contains the standard diagnostic statistics outlined by Greenacre (1984).[2] However, the package does not allow the labelling of units or variables thus making the interpretation of large data sets very difficult. Plotting facilities are basic. MV-ARCH's BIGCA module also has a simple input format but less detailed diagnostic statistics and shares a similar problem with labels. Plotting facilities to screen or Roland XY plotter are available. The *Bonn Archaeological Statistics Package* did not offer CA at the start of this project.

Producing usable plots from either of the first two packages ought to be achievable by importing edited results into a spreadsheet or graphics package such as HARVARD GRAPHICS. In CA it is important to maintain the aspect ratio of the scattergram so that 1 unit of x equals 1 unit of y (Greenacre 1993, pp. 71–2). Such scattergrams are known as *maps*. However, spreadsheet and graphics packages generally do not provide the option to force this scaling and are thus not usable (Lockyear 1994).

CANOCO (ter Braak 1987; ter Braak 1990) allows unit and variable labels. Units are referred to as 'samples' and variables as 'species' due to the package's origin in ecology. These terms will be used in this thesis. Many options are available including detrended and canonical correspondence analysis, down-weighting, exclusion and/or making samples/species passive. Six options for the scaling of the species and sample scores are available. Problems include difficulties in the data input format and non-standard diagnostic statistics. Plotting of results is via the simple CANOPLOT

[2] Underhill & Peisach (1985, pp. 48–63) provide an easily understood explanation of the use of diagnostic statistics using examples.

program (*e.g.*, Lockyear 1989, Fig. B.1) or by the sophisticated CANODRAW program (Smilauer 1990). The latter program produces quite good plots, and attempts to prevent overlapping labels and points, but suffers from a major weakness in that some points may be omitted from the plots without warning (*cf.* CANOPLOT). The POSTSCRIPT output from CANODRAW also has some peculiarities. It was decided to use CANOCO and CANODRAW and to manually edit the POSTSCRIPT output, including, where necessary, adding the missing points and labels.

One consequence of this choice was the lack of standard diagnostic statistics, which have thus been used far less frequently than the author would have wished. In some analyses, *e.g.*, section 8.3.22, the need for better diagnostic statistics was such that the analysis was run through both IASTATS and CANOCO. The IASTATS output was made more useful by editing the output. The time involved in this process, however, precluded the production of these figures for all the analyses undertaken.

CANOCO options

CANOCO offers many options. Unless otherwise stated the analyses performed were 'ordinary' CA. In CA it is possible to run the analysis with only certain species or samples contributing to the analysis. Having obtained the results, it is possible to calculate co-ordinates for other samples or species which can be plotted on the same map. These are known as passive or supplementary points. CANOCO offers this option and 'species' (years) 211–158 were often either removed from the analysis or made passive due to their sparseness. It is also possible to down-weight species and objects, *i.e.*, reduce their importance, rather than make them passive. This option was not used as it is difficult to justify the degree of down-weighting applied.

Of the six scaling options, symmetric scaling was used unless otherwise stated. This is the most popular scaling in CA despite the problem that the distances between species and sample points are not defined (Greenacre 1993, p. 70). Asymmetric scaling options were used when either sample or species plots were of interest. Hill's scalings were not used. See Greenacre (1993) for an excellent discussion of scaling and CA generally.

Other statistical analyses

Sections 10.2 and 10.4 use modules from MV-ARCH. This is because MV-ARCH's modular structure allows the user to develop non-standard methods without having to write complete programs from scratch.

8.2 Correspondence analysis and the analysis of hoards

8.2.1 Introduction

This section will examine CA with a view to developing a methodology for the analysis of coin hoards by their age profile. After a review of some aspects of CA, an example data set will be analysed and discussed in detail as an example of how the method works. Section 8.2.5 then goes on to compare the technique to Principal Components Analysis.

8.2.2 The 'horseshoe curve' or 'Guttman effect'

The results of CA and other techniques with a similar aim are often presented as a scattergram or map. The distribution of the points on these maps often form a curve similar to an arch or horseshoe. As this pattern will be encountered and discussed below, a brief outline of one reason why this occurs is offered here.

In Fig. 8.1 the upper graph shows the relative frequency of three objects: A, B and C. The x axis represents a dimension such as time, (*i.e.*, the five samples were taken at different times), space (different places) or social status. Other 'gradients' are possible. In terms of hoards the five samples could be hoards with different closing dates or hoards from different areas. Social status as a gradient can be found, for example, in cemetery assemblages or between settlements.

The composition of the five samples is given. If we were to perform CA on such a data set a graph similar to the bottom part of Fig. 8.1 would result. The horizontal axis could be interpreted as representing the the distribution of A and C, whereas the vertical axis represents with, or without B. The order of the sample points is shown by the dotted horseshoe shaped line. This order, or seriation, is sometimes the aim of CA in archaeology. However, in ecology it is less desirable as the gradient is known — often a sample transect — and techniques to remove the curve have been developed, see section 10.5.

If we were to examine a large set of hoards from the database with a variety of closing dates we would certainly encounter a time gradient which would result in a horseshoe curve. Figs. 8.2–8.3 are maps derived from CA of 241 hoards. They all have 30+ well identified *denarii*, *i.e.*, with a query code of 1, 5 or 6. As can be seen a curve, similar to what was expected, has resulted and this is generally the result of a time gradient.

8.2.3 Dividing the data — selecting hoards for analysis

The next important question to answer is *what* to analyse. About 417 hoards were available for analysis at the time of writing. They consisted of some 86,000 coins. These hoards are of varying size and data quality, as is the information about their contents. The first choice is to set a minimum size of hoard for analysis. Creighton (1992a, p. 64), in his hoard structure analysis, set a minimum limit of five. Hoards of only five coins are too small for both numismatic and statistical reasons. In a hoard of five coins there is a high probability that the closing date of the hoard is a poor reflection of the date of collection of the hoard. The statistical problem which arises is that each coin in a small hoard represents a significant proportion of the hoard, and these small hoards will often, therefore, dominate any statistical analysis. The limit used here was 30 coins; this was chosen not on any theoretical basis, but on experience, and trial and error — hoards of this size did not dominate the analyses. This left some 260 hoards. In this chapter only well identified *denarii*, *i.e.*, those with query codes 1, 5 or 6, were analysed (see section 5.2.4 and table 5.1).

It would be possible to analyse all the hoards simultaneously. Figs. 8.2–8.3 are maps from CA of 241 hoards.[3] All species (coins grouped by '`date_from`', referred to below simply as 'years')

[3]When this analysis was performed 244 hoards were available. Three hoards were excluded as they dominated the first axis when this analysis was first run. These three hoards have exceptional numbers of legionary *denarii* of Mark Antony.

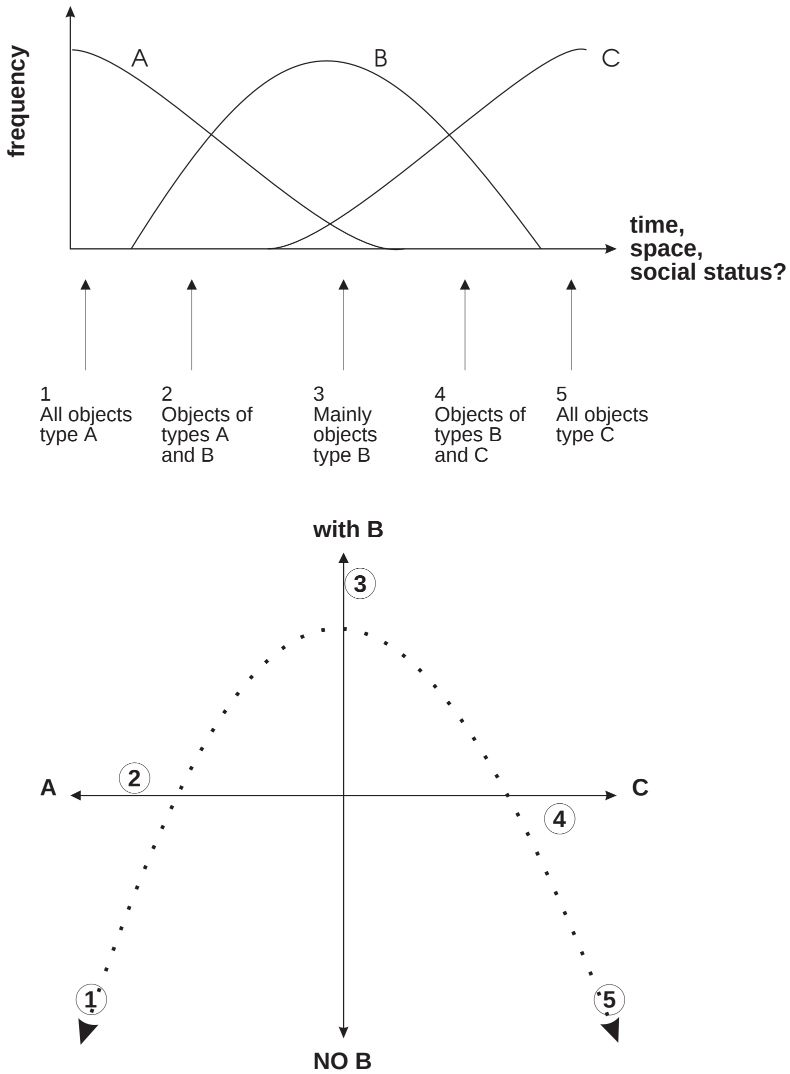


Figure 8.1: Diagram illustrating the usual cause of horseshoe curves in CA and PCA.

contribute to the analysis. The first axis has an eigenvalue of 0.460 and 'accounts for' 18.5% of the variance in the data; the second axis has an eigenvalue of 0.305, 12.3% of the variance, giving a total of 30.8%. Given the very large size of the data set this is acceptable.

It is immediately apparent that there are difficulties in interpreting the results. It is a reasonable seriation of the hoards, but this is a confirmation of what we already know. Some details and oddities can be seen. The hoard from Işalniţa (ISA, open square) stands out in the middle of the map. The two hoards from Padova (P03 & P07, open circles) lie at the right hand extreme of the curve despite not closing in 2 BC, the latest closing date in the sample. The time gradient, which we know exists, is dominant, but it is clear that other processes are also at work. The coinage of 90s–80s BC forms a large proportion of the coinage pool. This results in the relatively large dispersion of points in the bottom right quadrant.

Subsequent to this analysis futher hoards were uploaded to increase the numbers of early Imperial hoards available for analysis.

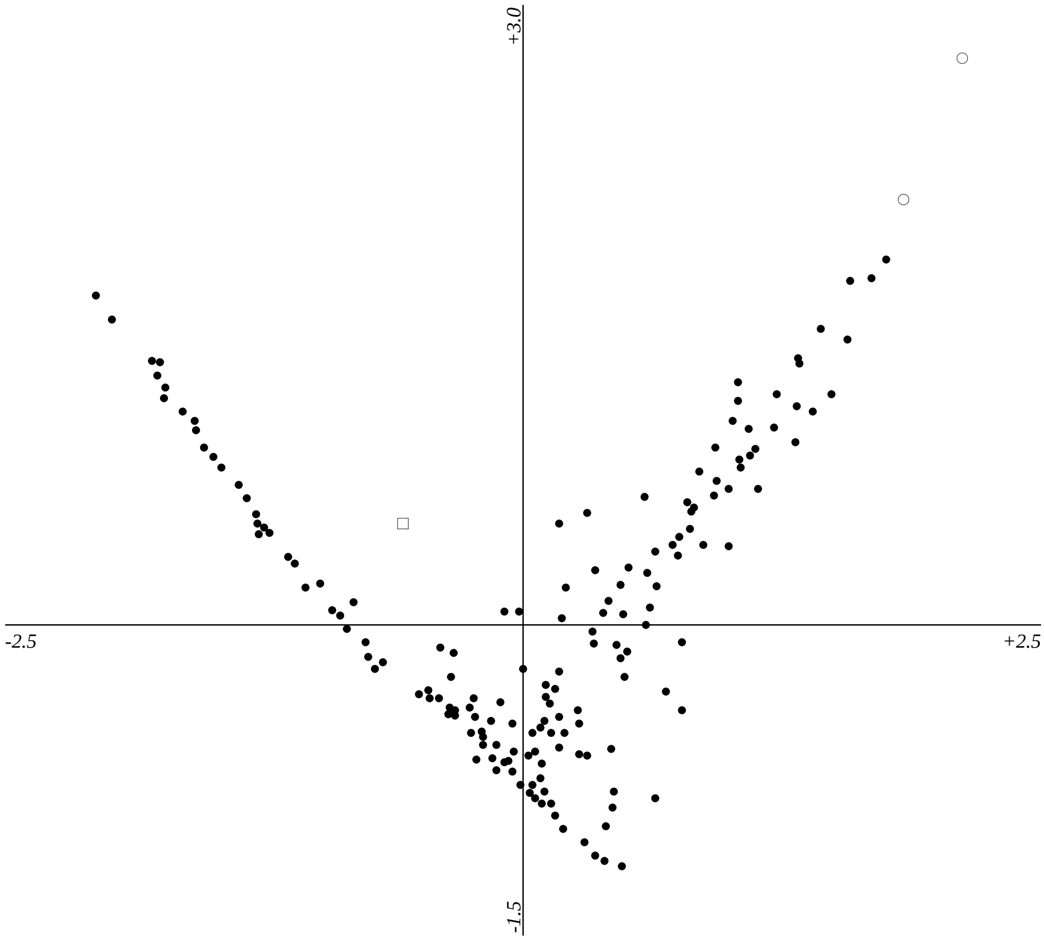


Figure 8.2: Sample score map from CA of 241 coin hoards. Points represent hoards. The open square (□) represents the hoard from Işalniţa (ISA); the open circles (∘) two hoards from Padova (P03 & P07). First (horizontal) and second axes of inertia.

Contra Creighton (1992a, p. 33) mixing hoards of different periods does not 'aid interpretation' in this sort of analysis. Several factors, most notably time and space, are mixed together (*cf.* section 3.12.2). The data set has to be divided, either into time periods and/or by region.

8.2.4 CA — a worked example and further problems

Eighteen coin hoards closing in 49–45 BC, one of the periods used by Crawford in RRCH (Crawford 1969c), were analysed using CA. Details of these hoards are contained in Table 8.1.[4] The eigenvalues for the following three analyses are shown in Table 8.2. In all the following analyses ordinary CA was performed with symmetric scaling of maps. Years (species) 211-158 were made passive (see page 148) due to their rarity in this data set. In this, and the following analyses, the term 'rare' should be taken to mean rare or uncommon in the *current* data set. Likewise, the term 'abundant' means common in the current data set. In the case of the latter term it should not be confused with a statistical measure of abundance.

[4]This data set, originally analysed for a public lecture, is only part of the data now available for the period 49–45 BC.

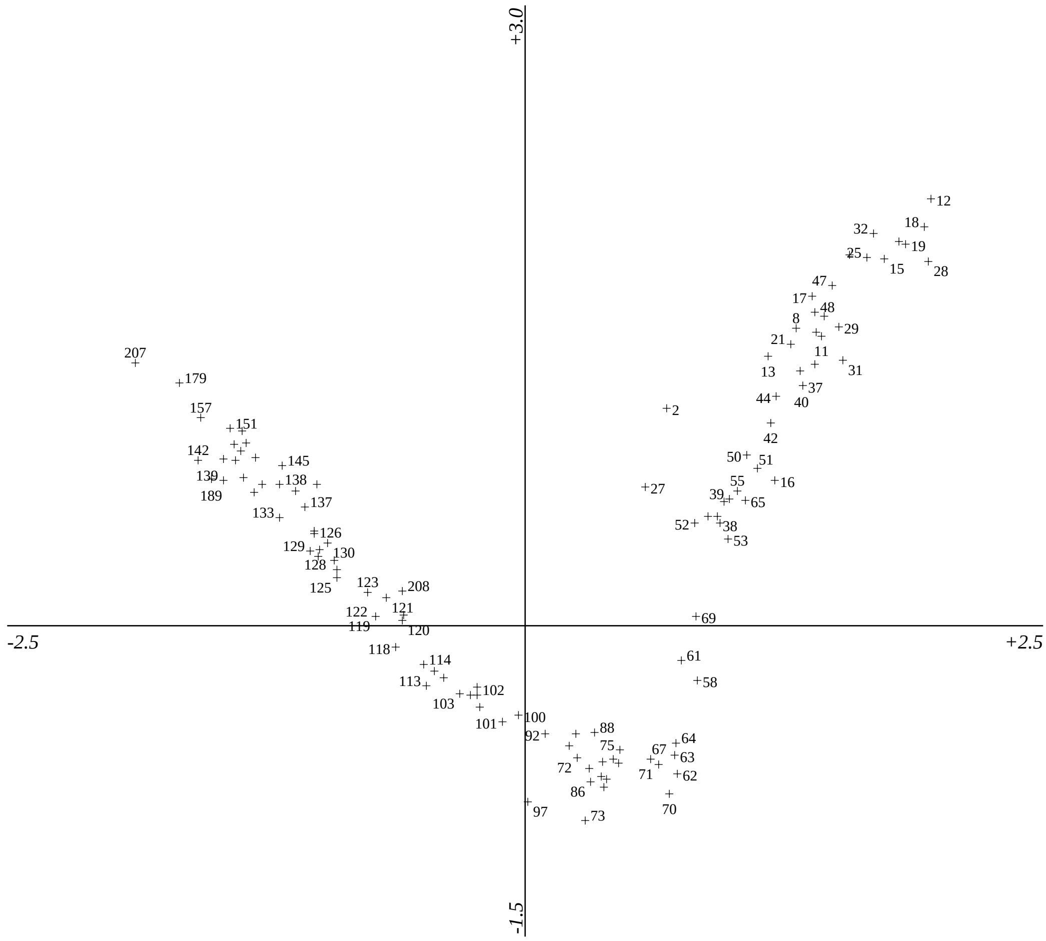


Figure 8.3: Species score map from CA of 241 coin hoards. Points represent years of coin issue (`date_from`). First (horizontal) and second axes of inertia.

Analysis one — all the data

The eighteen hoards contained 3538 *denarii*. Fig. 8.4 shows the species and sample score maps from this analysis. There are three points to note. Firstly, the hoard from Érd (ERD) appears to be very different from the other 17 hoards in this analysis standing clear at the top of the second axis in Fig. 8.4b. Years 157, 76 and 74 are in a similar position in the species map (Fig. 8.4a) *suggesting* that these years are particularly associated with Érd. Secondly, there appears to be a classic horseshoe curve centered around the origin of the maps. This is partly a result of the varying closing dates of the hoards. Two hoards closing in 45 BC appear on the right of the plot, and the three hoards closing in 48 BC on the left (marked by a triangle and square respectively). The species map shows a gradient around the curve from right to left — the order is not perfect but still marked. However, it appears that a second gradient is also present. Hoards Gulgancy (GUL) and Văşad (VAS) at the left extreme of the curve close in 46 BC along with the majority of the other hoards including Senhinho da Senhora (SEN) near the right hand end of the curve. This raises the question: how much of the pattern is the result of the known time gradient and how much the result of another, unknown gradient?

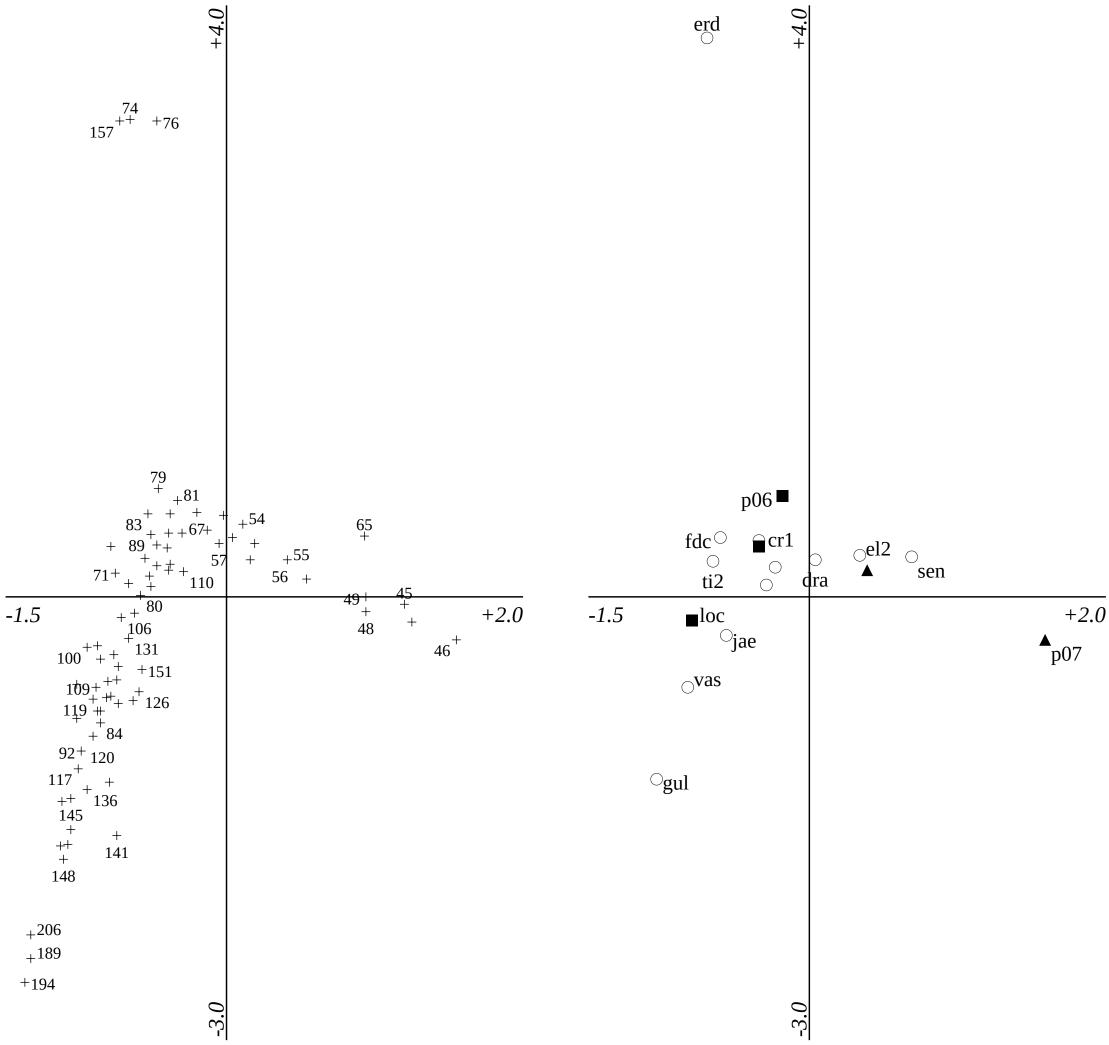
code	hoard	country	'end date'	'good total'
CR1	Carbonara	Italy	48	383
CRO	Crotone	Italy	46	86
DRA	Dračevica	Yugoslavia	46	109
EL2	El Centenillo	Spain	46	57
ERD	Érd	Hungary	46	51
FDC	Fuente de Cantos	Spain	46	387
GUL	Gulgancy	Bulgaria	46	459
JAE	Jaén	Spain	46	65
LOC	Locusteni	Romania	48	88
MOR	Morrovalle	Italy	46	125
P06	Padova	Italy	48	54
P07	Padova	Italy	45	655
SEN	Sendinho da Senhora	Portugal	46	76
SPN	Spoiano	Italy	46	264
SUR	Surbo	Italy	46	138
TI2	Tîrnava	Romania	46	148
VAS	Văşad	Romania	46	53
VLL	Villette	France	45	340

Table 8.1: Hoards in data set `48bctest.dat` used in CA and PCA discussed in sections 8.2.4 and 8.2.5.

	Axis				
	1	2	3	4	Total
CA Analysis one	0.569	0.224	0.184	0.069	1.482
CA Analysis two	0.322	0.261	0.134	0.088	1.177
CA Analysis three	0.323	0.137	0.091	0.087	0.935
PC Analysis one	0.242	0.174	0.121	0.096	—
PC Analysis two	0.284	0.151	0.117	0.086	—

	Axis				
	1	2	3	4	Total
CA Analysis one	38.4	53.5	65.9	70.5	70.5
CA Analysis two	27.4	49.5	60.9	68.4	68.4
CA Analysis three	34.6	49.3	59.0	68.3	68.3
PC Analysis one	24.2	41.5	53.7	63.3	63.3
PC Analysis two	28.4	43.5	55.2	63.8	63.8

Table 8.2: Eigenvalues (top) and cumulative variance explained (bottom) from the analyses on the data set listed in Table 8.1, see sections 8.2.4 and 8.2.5.



(a) Species map: data points are years of issue.

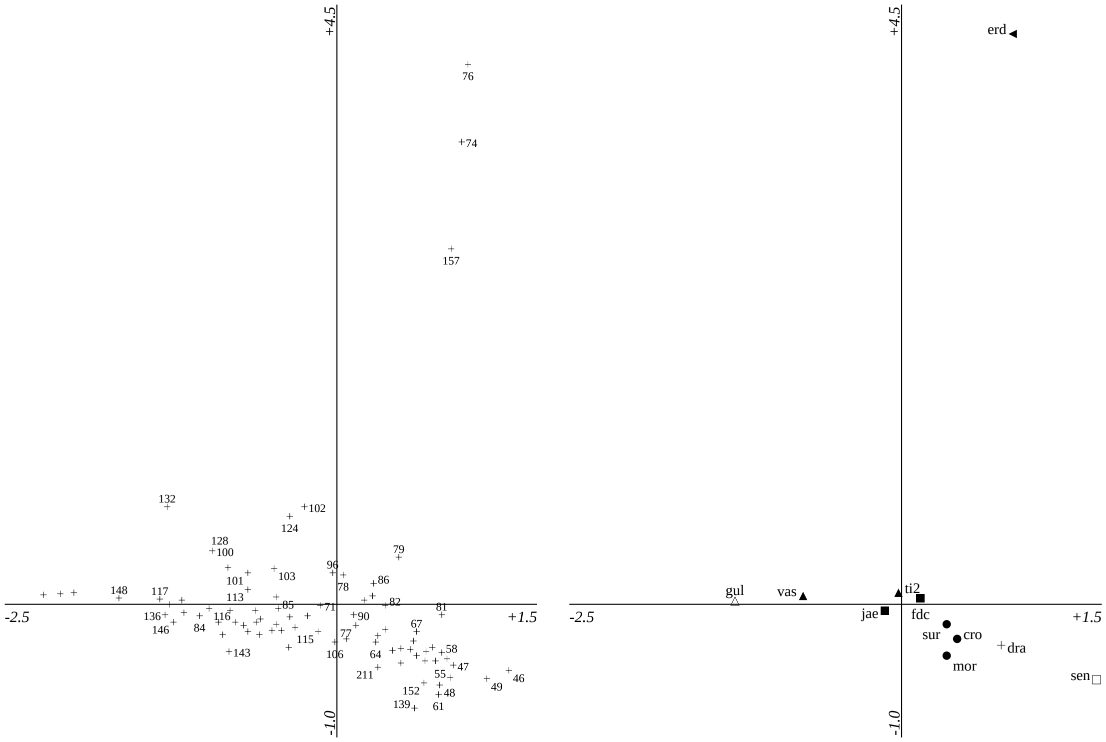
(b) Sample map: data points are hoards. ■ hoards closing 48 BC; ○ 46 BC; ▲ 45 BC.

Figure 8.4: Maps from CA of data set `48bctest.dat` shown in Table 8.1.

Analysis two — hoards closing in 46 BC

The second analysis contained thirteen hoards closing in 46 BC, some 2018 *denarii*. Fig. 8.5 presents the maps from this analysis. Again, the exceptional hoard from Érd dominates the plot standing clear on the second axis (Fig. 8.5b). The curve is no longer clear and the majority of the hoards cluster along the first axis. Some patterning is evident — the four hoards from Italy (filled circles) cluster tightly as a group. It is difficult to interpret these maps beyond the dominance of one hoard in the data set.

A common problem in CA is the large influence exerted by odd or unique items. Érd is a good example of this. Looking at the data, Érd has 26 coins with a `date_from` of 76 or 74 BC out of a total of 51 (50.9%). Compare this to other hoards such as Sendinho da Senhora with 1 out of 76 (1.3%) or Spoiano (SPN) with 3 out of 264 (1.1%). Having noted that Érd is an oddity, and how it varies from the rest of the hoards, a common procedure is to omit this sample and re-run



(a) Species map: data points are years of issue.

(b) Sample map: data points are hoards. ● Italy; ■ Spain; □ Portugal; ▲ Romania; △ Bulgaria; ◀ Hungary, + Yugoslavia.

Figure 8.5: Maps from CA of hoards closing in 46 BC, see Table 8.1.

the analysis. This is not ‘fudging’ as long as the exception is noted, described, and if possible, explained.

Analysis three — omitting Érd

In this final analysis, the remaining 12 hoards, containing 1967 *denarii*, were analysed. Fig. 8.6 again shows a curve, but this time it is not a result of variation in the `end_date` of the hoards. However, there is still a time trend from the top right quadrant to top left with the majority of the years from 92–57 in the bottom right quadrant. Only three years in this range have a positive value on the second axis (84, 81 & 75). There are some outliers and oddities. The last active species, 157, occurs at the bottom of the 2nd axis, 135 seems to float in the middle of the curve. Both these are quite rare years with only seven coins between them. We can interpret the first axis as representing the relative numbers of new coins compared to old coins. The second axis can be interpreted as representing the relative numbers of coins of 92–57 compared to coins of other years.

Comparing this map to Fig. 8.7. it can be seen that the hoards lie in a similar curve. To show how the sample and species points relate we can examine a few cases. Taking the three hoards at the extremes of the curve (SEN, FDC and GUL) we can identify the three years plotted nearest to

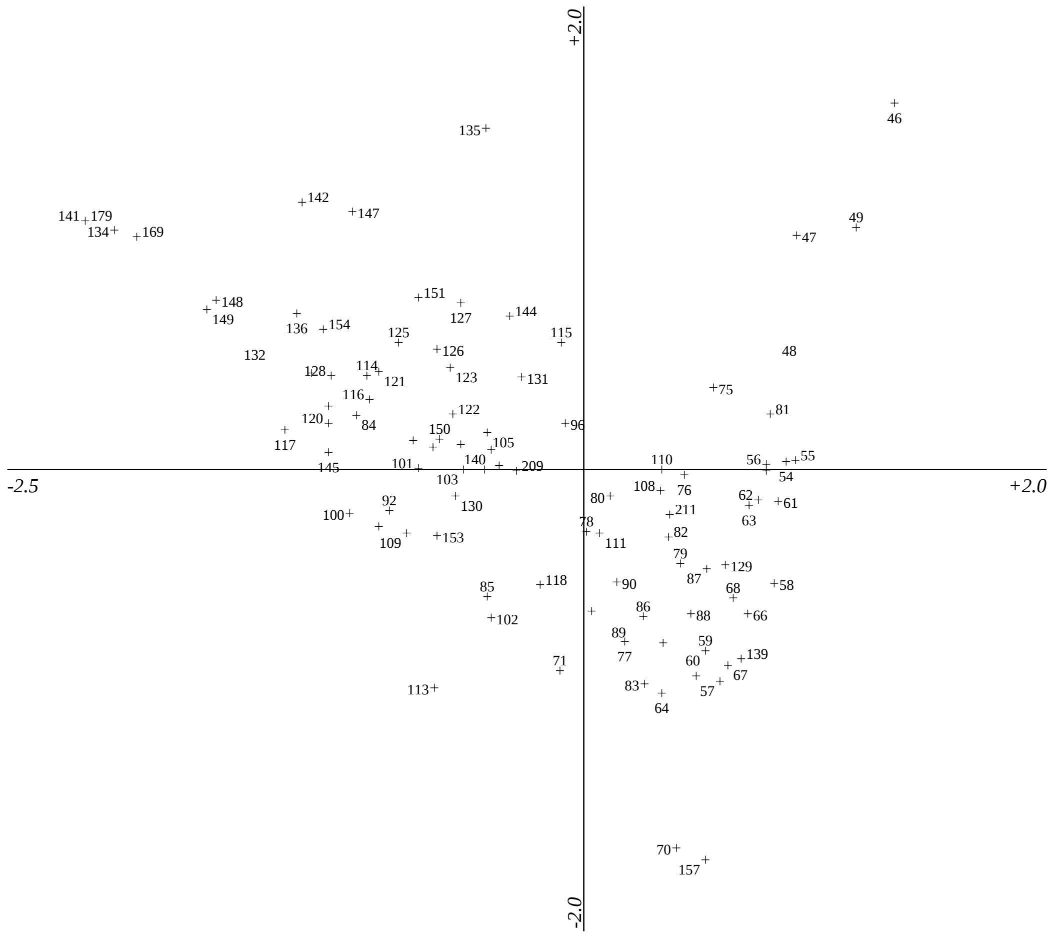


Figure 8.6: Species score map from CA of hoards closing in 46 BC omitting Érd, see Table 8.1. Data points are years of issue. First (horizontal) and second axes of inertia.

each on a joint plot and then calculate the percentage of the hoard totals belonging to those years.[5] This gives:

Years	GUL	FDC	SEN
146, 137 & 128	6.5%	1.0%	0.0%
89, 86 & 77	1.9%	8.0%	1.3%
49, 47 & 46	0.4%	2.5%	43.4%

The gradients along the horseshoe curve can be clearly seen. We can conclude that there is a trend from hoards with relatively less new coin but more old, to hoards with relatively more middle period coinage when compared to the oldest and newest coins, to hoards with mainly new coin.

We can examine the find spots of hoards represented in Fig. 8.7 by using different symbols. The four Italian hoards are closely clustered on the first axis although separated out on the second

[5]Theoretically, this process is incorrect as the plots have been produced using symmetric scaling, and thus the distances between a sample point and a species point on a joint plot are not defined. The correct procedure would be to select species (years) at the same extremes of the axes as the sample (hoard) points. The rarity of the extreme species, however, does not lead to such a nice illustration of pattern. The incorrect interpretation of these inter-point distances on symmetric maps can lead to erroneous conclusions (see page 309). I would like thank Mike Baxter for pointing out this important error.

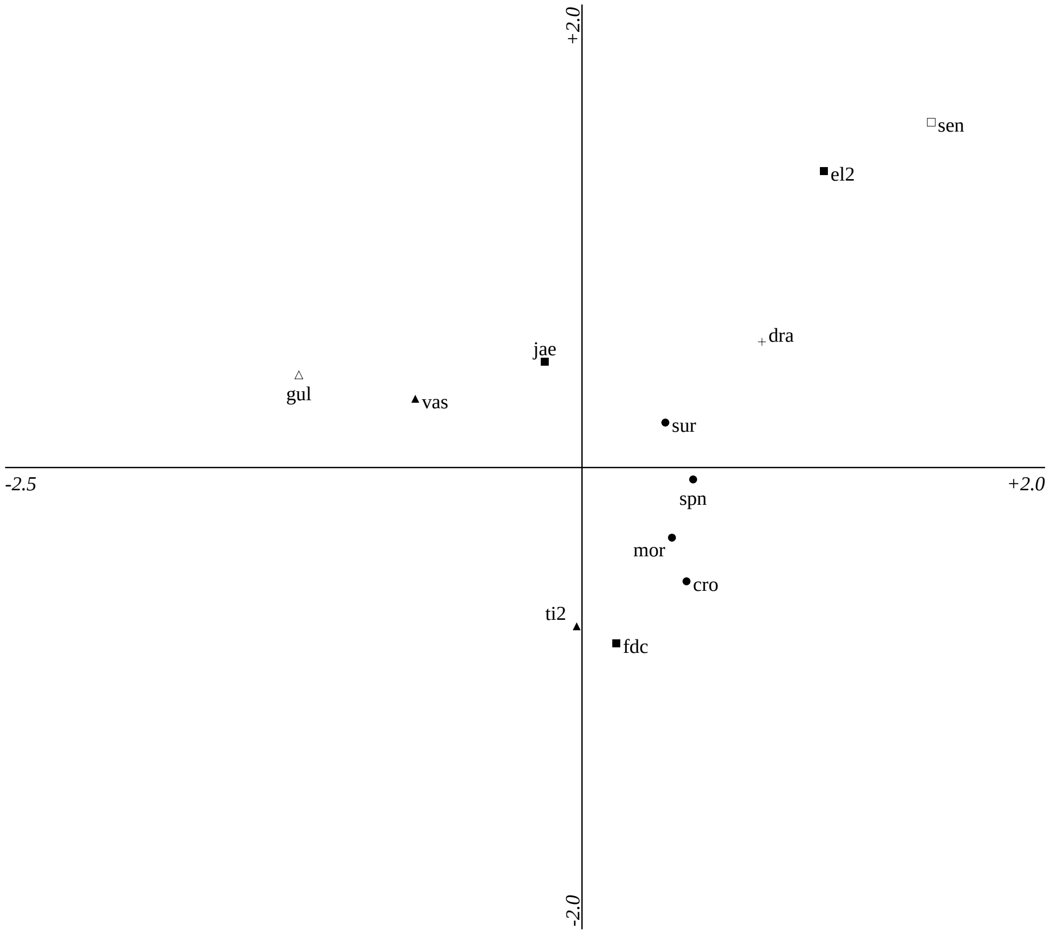


Figure 8.7: Sample map from CA of hoards closing in 46 BC omitting Érd, see Table 8.1. Data points are hoards. ● Italy; ■ Spain; □ Portugal; ▲ Romania; △ Bulgaria; + Yugoslavia. First (horizontal) and second axes of inertia.

axis. Lockyear (1993a) showed that the huge quantities of coinage minted during the Social War (91–89 BC) and shortly after results in a large proportion of the variation in hoard structure for these years being a result of sampling error rather than archaeological processes (see Chapter 9). To some extent the second axis reflects this. The Iberian hoards occur along the length of the curve showing a much greater variation than the Italian hoards. The Romanian and Bulgarian hoards have little of the most recent coin although Tîrnava (TI2) seems not too dissimilar from Fuente de Cantos (FDC) and the Italian hoards.

We can compare the results of this analysis with a cumulative percentage curve graph (Fig. 8.8). As can be seen, the Italian hoards form a compact group in the middle of the plot as would be expected from the CA. The Iberian hoards appear both sides of the Italian pattern with the Yugoslavian hoard, Dračevica (DRA), also falling below the Italian line. The Romanian and Bulgarian hoards show clearly above the Italian profile with Gulgancy (GUL, top most line) looking unlike other hoards. Tîrnava (bottom dotted line) has large quantities of coins from the 90s–80s. The remaining Romanian hoard, Văşad (VAS) is above Tîrnava having a larger proportion of earlier coins.

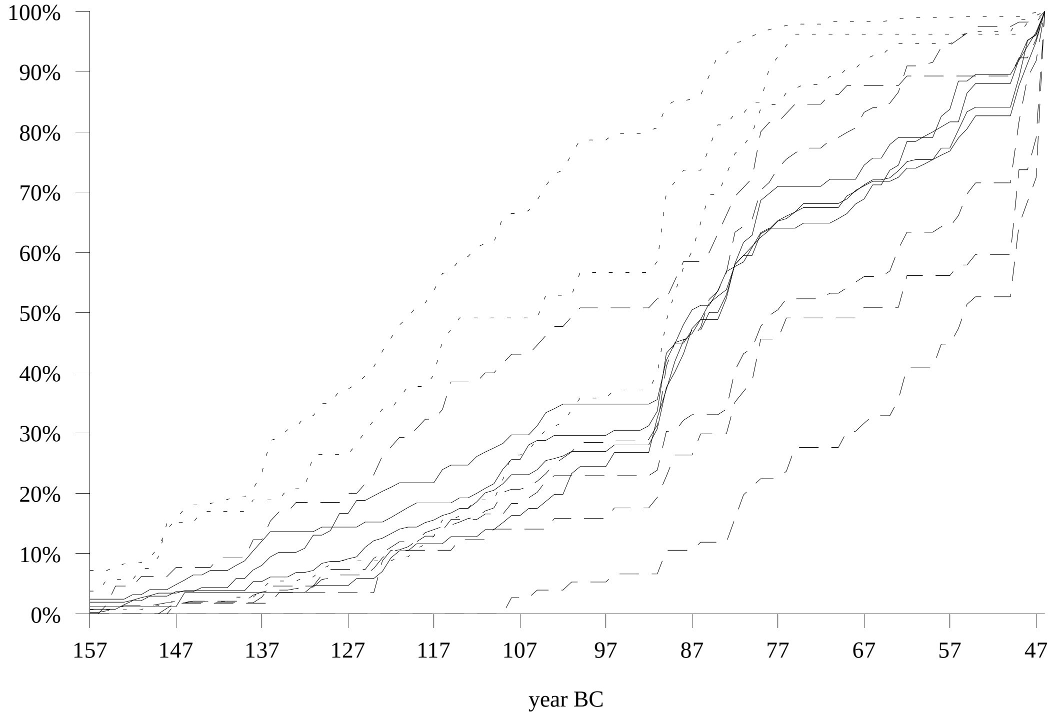


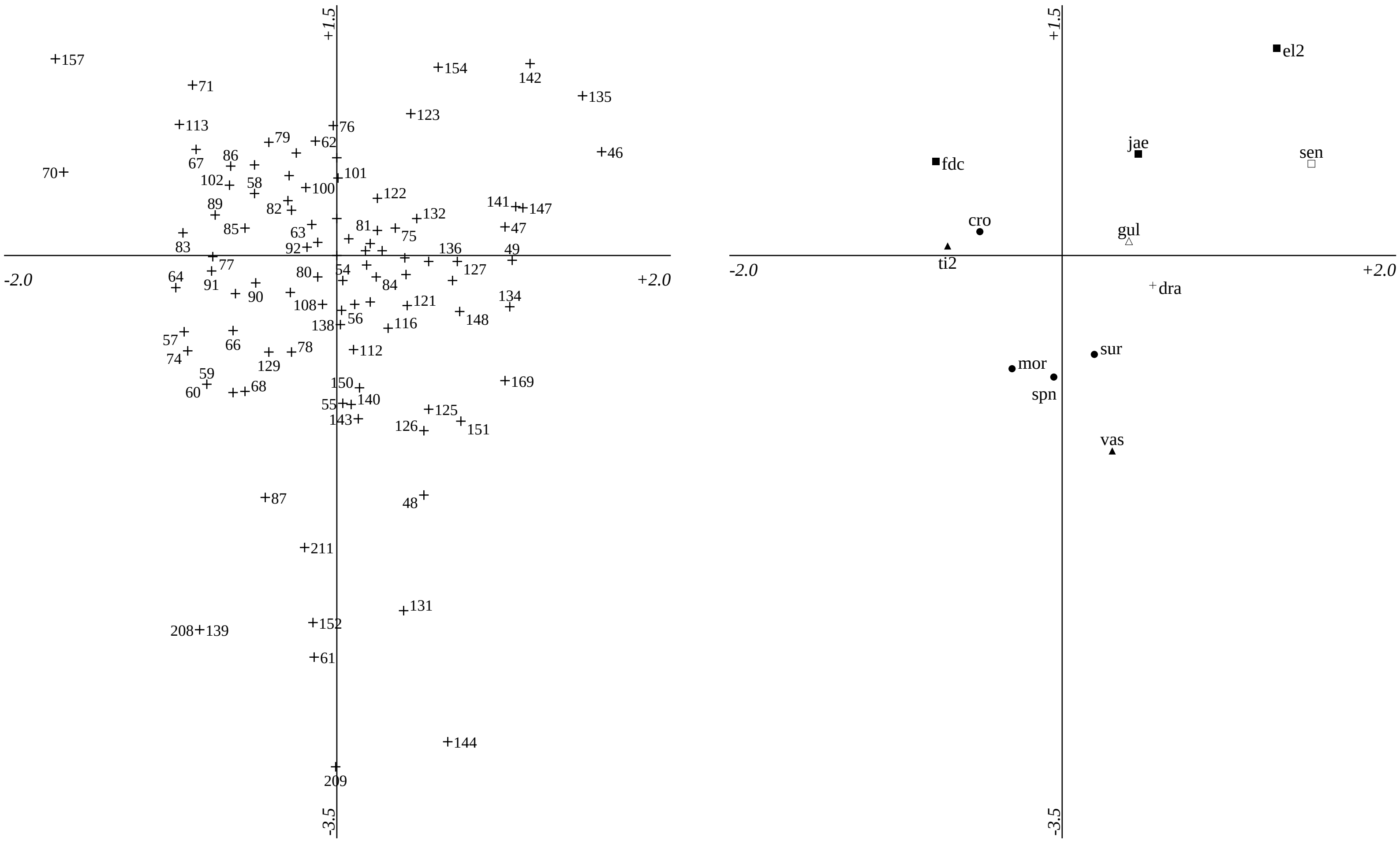
Figure 8.8: Cumulative percentage curves for 12 hoards closing 46 BC. Solid lines: hoards from Italy; dashed lines: hoards from the Iberian peninsula and the former Yugoslavia; dotted lines: hoards from Romania and Bulgaria.

We can conclude that the gradient revealed by the first two principal axes, and the cumulative percentage curves, is one in the age structure of hoards. This age structure is not a simple reflection of the find spots of hoards, although some spatial factors clearly are present. Italian hoards are all similar, Iberian hoards are more variable and occur above and below the Italian pattern, Romanian and Bulgarian hoards tend to have more old coin, and coin from the 90–80s BC. At a more detailed level, there seems to be no relation between the detailed geographical position of, for example, the Italian hoards and their dispersion along the second axis. The Iberian peninsula hoards are likewise unrelated to their detailed geographical position. El Centenillo and Jaén are the closest geographically but not on the CA maps.

Following Creighton (1992a) I shall term hoards with large quantities of older coin, relative to other hoards of the same date, ‘archaic’ in structure, those with large quantities of new coin, ‘modern.’

The first two principal axes discussed above represented 49.3% of the variance in the data. The third axis represents another 10%. The species and sample maps for the second and third axes are presented in Figs. 8.9a–8.9b. An initial glance at the species map shows a ball of points at the centre of the plot with a number of outliers in all directions. The second principal axis of inertia was described above. The third does not seem to show any clustering or trend of years.

The sample map has two notable features. Firstly, the similarity of three of the four Italian hoards is continued. More importantly, *all* the Iberian peninsula hoards are at the top of the third



(a) Species map: data points are years of issue.

(b) Sample map: data points are hoards. ● Italy; ■ Spain; □ Portugal; ▲ Romania; △ Bulgaria; + Yugoslavia.

Figure 8.9: Maps from CA of hoards closing in 46 BC omitting Érd, see Table 8.1. Second (horizontal) and third axes of inertia.

hoard	157	142	154	71	135	123	113	total	%
EL2					1	3		4 / 57	7.0
JAE		1	2	1	1	2		7 / 65	10.7
FDC	1		1	5		7	2	16 / 387	4.1
SEN								0 / 76	0.0
CRO	1			1		1		3 / 86	3.4
GUL		1	3	2	2	12	2	22 / 459	4.7
TI2				2			2	4 / 148	2.7
DRA				1		1		2 / 109	1.8
SUR					1	1		2 / 138	1.4
MOR								0 / 125	0.0
SPN						1		1 / 264	0.3
VAS						1		1 / 53	1.8

hoard	48	87	131	152	139	61	144	total	%
EL2								0 / 57	0.0
JAE								0 / 65	0.0
FDC		1						1 / 387	0.2
SEN	3							3 / 76	3.9
CRO	2	1	1					4 / 86	4.6
GUL	2	1	1					4 / 459	0.87
TI2		4						4 / 148	2.7
DRA	8	1						9 / 109	8.2
SUR	5	3	3	1			1	13 / 138	9.4
MOR	4	3		1	1			9 / 125	7.2
SPN	16	11	1	1		1		30 / 264	11.3
VAS	1		3				1	5 / 53	9.4

Table 8.3: Number of coins for seven *active* years at the positive (top table) and negative end of the third principal axis of inertia from CA of 12 hoards in data set `48bctest.dat`. Hoards and years ordered as given on the axis.

(vertical) axis. They are not closely spaced on the map due to their wide spacing on the second (horizontal) axis. It seems unlikely that such a group would be entirely due to chance.

To look at this more closely Table 8.3 was constructed for the seven active years at the extremes of the axis. These years do not form a block of dates. According to Crawford (1974) all coins from these years were minted in Rome. As can be seen, some of the years are unique and thus occur at the extremes of the axis. Such a pattern would normally be interpreted as being due to chance, especially given the sparseness of the data set. However, the occurence of the four otherwise variable Iberian hoards at one, and three Italian hoards at the other, end of this axis seems too suggestive to be ignored. In Table 8.3 Sendinho da Senhora has none of the years associated with the positive end of axis three. Its position on this axis must be due to a similarity of its profile over the whole range of years. This suggests some broader patterning is possible.

Greenacre (1993, p. 173) provides a method for testing the significance of a principal axis. In this case, the χ^2 value for the third axis[6] is not significant at the 0.05 level, although it is close to

[6] $\chi^2 = \lambda \times n$ where λ is the eigenvalue for the principal axis and n is the number of coins in the analysis. For the third axis this is 0.091 × 1922 = 174.9. This value is then compared to a table of critical values (Pearson & Hartley 1976,

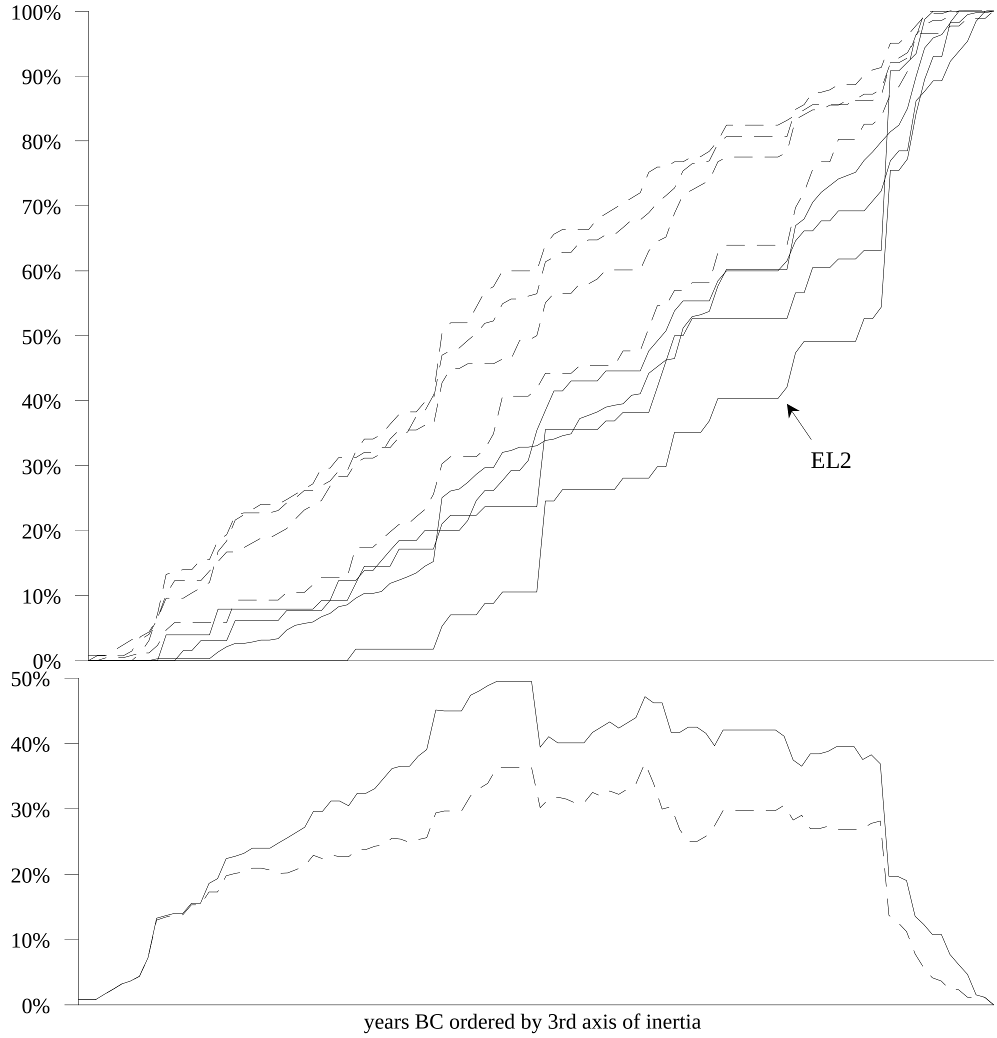


Figure 8.10: Upper plot: hoards from data set `48bctest.dat` with species (`date_from`) ordered according to the third principal axis of inertia derived from CA. Solid lines: hoards from the Iberian peninsula; dashed lines: hoards from Italy. Lower plot, maximum difference between topmost and bottommost lines of top plot, including (solid line) and excluding (dashed line) hoard EL2.

the critical figure for the 0.1 level.[7]

Cumulative percentage curves were again plotted, but this time the order of the species on the *x* axis was that of the third principal axis (Fig. 8.10). All Italian hoards appear at the top of the plot. The extreme lower line is not now Sendinho da Senhora but El Centenillo (EL2). The hoard from Crotone (CRO, lowest dashed line) now seems more similar to the Spanish material. The lower part of Fig. 8.10 gives the maximum difference between the lines. As can be seen, roughly half of the

Table 51). Unfortunately, this table only gives values for a maximum table size of 10 by 200. In this case we have a 12 by 106 table, and therefore we need to look at the value for 11 by 105 (columns−1, rows−1), *i.e.,* 11 by 105, degrees of freedom. However, reasonable estimates can be made by graphing the values given and extrapolating.

[7]The 0.05 (*i.e.,* 1 in 20, or 5%) level is often used in significance tests. There is nothing magic about this level. Strict adherence to the idea that somehow less than one chance in twenty is significant is common, despite most text books noting that this level is little more than convention. See Thomas (1978), Castleford (1991). It has led to the rejection of otherwise important results, *e.g.,* Williams (1993), *cf.* Kvamme (1990).

plot slowly rises, followed by a jagged, but approximately level plateau, and then a sudden drop. The rising line would suggest years which are marginally more associated with Italy, the plateau those years equally represented, and the fall off years more associated with Spain. However, the steepest part of this fall off is attributable to 46 BC which was noted as being associated with two Spanish hoards on the first principal axis.

How meaningful the third axis in this analysis is cannot yet be decided. A detailed analysis of other data sets to see if specific coin types are more associated with Spain when compared to Italy is beyond the scope of this thesis. The structure of the CHRR database would allow this analysis to be attempted.

The final stage of the analysis is to interpret the results in archaeological and numismatic terms. Interpretation of the this, and the following analyses, is given in section 8.4.

The purpose of the above set of analyses was to demonstrate how CA can be used in the analysis of coin hoards, and how the results can be interpreted.

8.2.5 Principal Components Analysis and CA — an empirical comparison

Correspondence analysis is only one multivariate technique which could be used for the analysis of this type of data. Before proceeding with the detailed analysis I wish to consider one alternative method — principal components analysis (Shennan 1988, 245–270, Baxter 1994, 48–99). In a review of the package MV-ARCH (Wright 1989) posted to the *Archaeological Information Exchange*[8] I noted that it was difficult to remove units or variables from an analysis. Wright (*pers. comm.*) replied:

> In the case of Correspondence Analysis, I have to say that I find it worrying that so much effort is spent on circumventing the results given by the straightforward version…
>
> … The essence of the method is dual scaling… [it] highlights two types of structure in a matrix: (a) the large occurence of an (elsewhere generally rare) attribute at a site that has very few attributes, and (b) the small occurence of an (elsewhere generally common) attribute at a site that is rich in attributes… It would be better to use Principal Components Analysis of the square roots of percentage frequencies, extracting the eigenvectors from a covariance matrix of unstandardised variables. In other words, I wonder why you choose CA when what you want to see is the structure of the main body of the data…

This raises a number of points:

1. The nature of the joint plots in CA is one of its attractions. PCA biplots (Baxter 1992a), when there are many variables, are visually more difficult to interpret as the arrows make for a confusing diagram.

2. The suggested method introduces the problem of compositional data[9] (Aitchison 1986) into the analysis when the data set is not inherently compositional.

[8] The AIE was an electronic mailing and discussion list run from Southampton, initially by S. P. Q. Rahtz, then by myself. It has now been replaced by the list ARCH-L.

[9] Compositional data are data with a constrained total, *e.g.*, percentages or proportions.

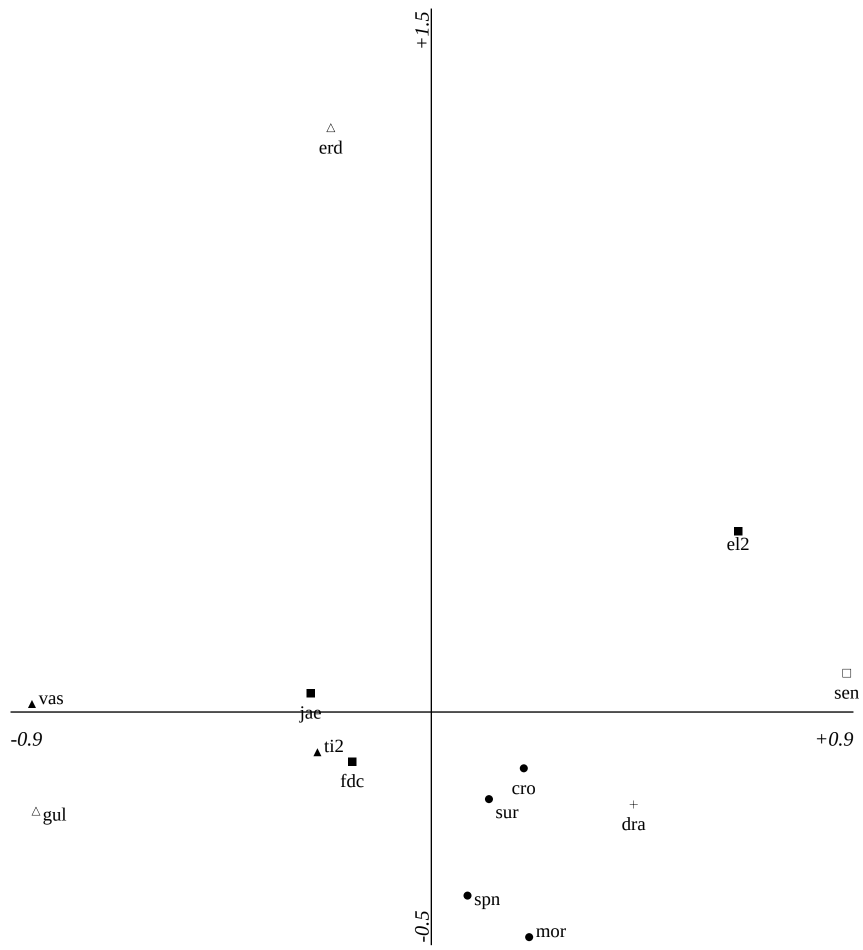


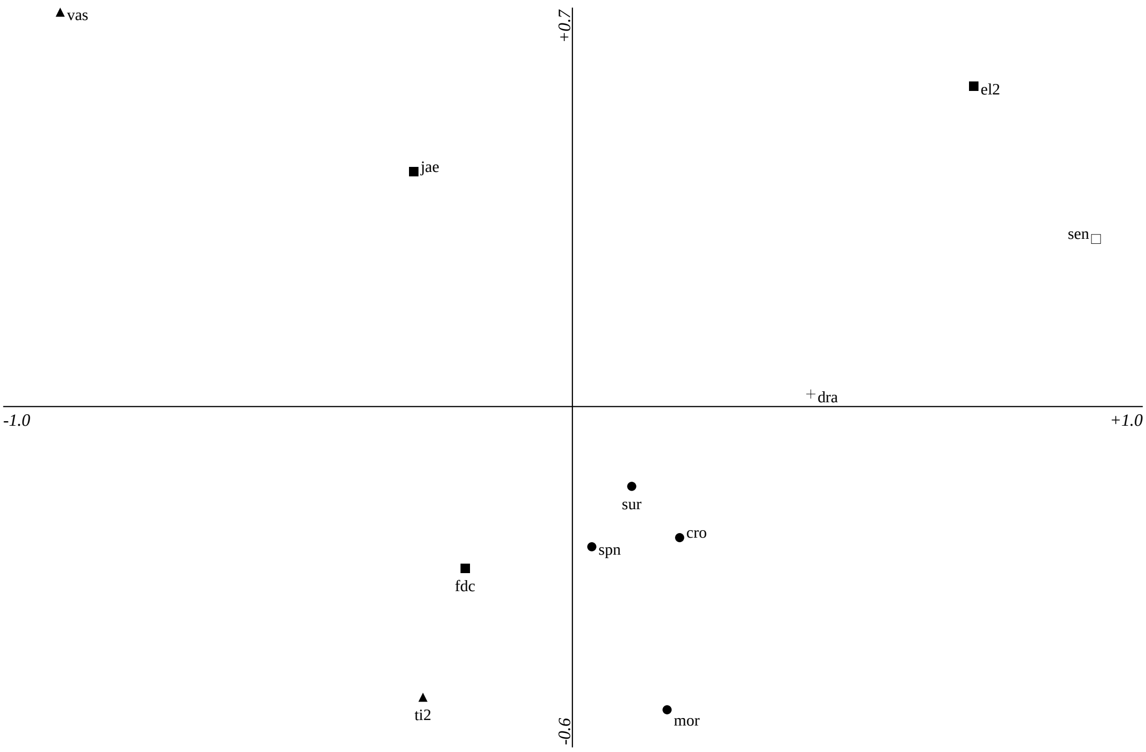
Figure 8.11: Object loading map from PCA of 13 hoards closing in 46 BC, see Table 8.1. Data points are coin hoards. Plot symbols as for Fig. 8.7. First (horizontal) and second principal components.

3. Both the initial analyses (showing ‘oddities’) and those showing variation in the main body of the data are of interest.

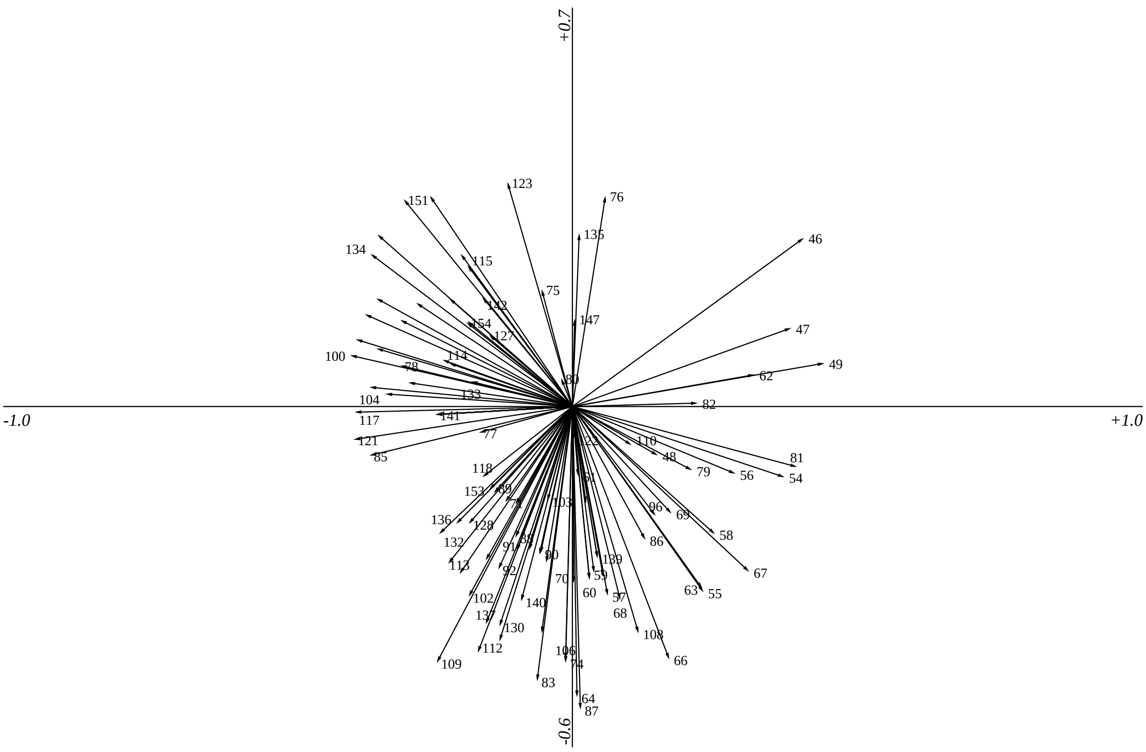
A comparison between Wright’s method and CA was undertaken using the same data as section 8.2.4. CANOCO was used. The eigenvalues *etc.* for analyses are given in Table 8.2.

Initially the 13 hoards closing in 46 BC were analysed. Fig. 8.11 shows the map of the object loadings. In this map the general pattern is similar to Fig. 8.5 in that the hoard from Érd dominates the second axis, although less strongly. More interpretable patterning of the remaining points, similar to Fig. 8.7, also exists. This is because the square roots of the values input into the analysis have been used. Such an option is also available in CA and would have had a similar effect. However, the positions of the hoards in Fig. 8.11 are still compressed on the second axis masking variation in the hoards.

Re-running the analysis omitting Érd results in Fig. 8.12. The object loading map (Fig. 8.12a) is now very similar to Fig. 8.7 if somewhat more spread out. However, the variable plot (Fig. 8.12b), presented in the standard style, is much less interpretable than Fig. 8.6. In PCA biplots the length



(a) Object loading map. Data points are coin hoards, symbols as for Fig. 8.7.



(b) Variable map. Each arrow represents a variable vector — see text for explanation.

Figure 8.12: Maps from PCA of hoards closing in 46 BC omitting Érd, see Table 8.1. First (horizontal) and second principal components.

of the arrow represents the approximate variances of the variables; the cosines of the angle between arrows their approximate correlation. Thus, two variables represented by arrows with an acute angle are highly correlated (Baxter 1992a). For many variables the result is very confused.

The order for hoards on the first axis is identical to CA apart from the Italian hoards although these are still tightly grouped on this axis. The order for years is also very similar. The order on the second axis is quite different although hoards above and below zero remain similar. The broad patterning of years is equally similar. The grouping of the Iberian peninsula hoards on the third principal axis of inertia (see page 158) is not repeated here.

In conclusion, the results of the PCA are not substantially different from those gained by CA. This is not suprising as CA can be viewed as a PCA of transformed data (Baxter 1991). Indeed, it would be worrying if the results were very different, suggesting unstructured data. The down-weighting of unusually abundant variables by using square roots of percentage frequencies could be achieved in CA. However, we wish to know about odd hoards and/or years as this is the prime method by which 'odd' hoards can be detected. The iterative use of CA or PCA is preferable as each analysis illustrates different aspects of the data. The CA species maps are easier to interpret when there are many variables. Working from the raw data seems generally preferable in this case to transformation to square root percentage frequencies. Although transformation of data is essential in many multivariate analyses, especially those on chemical compositions, it is not necessary here. I can see no inherent advantage in using PCA over CA in this case especially as CA is a technique specifically designed to analyse contingency tables.

8.2.6 A usable methodology

We have now defined a usable methodology for the examination of the data available. This is:

- Select a sub-set of hoards which have as limited a range of closing dates as possible, one year if enough hoards are available.
- Analyse the data using CA. When necessary, re-run the analysis omitting samples or species.
- Plot the hoards as cumulative percentage curves. Use the colour and 'plot series' features to explore possible patterns revealed by the CAs on screen.
- Describe the structure of hoards from the resultant maps in conjunction with the original data and/or cumulative percentage curve graphs.

When this process is complete an attempt can be made to interpret the patterns in numismatic and archaeological terms.

8.3 The analyses

8.3.1 Introduction

The 260 hoards available for analysis were divided into 22 groups. In some cases groups overlapped for comparison. In the following sections the results will be described and discussed, but more

			Eigenvalues					Cum. perc. variance expl.			
section	data set	analysis	1	2	3	4	tot. in.	1	2	3	4
8.3.2	fin147.dat	1	0.238	0.184	0.058	0.051	0.742	32.1	56.9	64.6	71.5
8.3.3	fin118.dat	1	0.281	0.118	0.086	0.070	0.848	33.1	47.0	57.2	65.4
8.3.4	fin105.dat	1	0.124	0.082	0.046	0.036	0.478	26.0	43.1	52.6	60.2
8.3.5	fin92.dat	1	0.461	0.137	0.090	0.061	0.918	50.2	65.1	75.0	81.7
		2	0.107	0.068	0.050	0.041	0.365	29.4	48.0	61.6	72.8
8.3.6	fin87.dat	1	0.481	0.182	0.143	0.125	1.256	38.3	52.8	64.2	74.2
8.3.7	fin80.dat†	2	0.255	0.158	0.142	0.104	0.887	28.7	46.5	62.5	74.2
8.3.8	fin78.dat	1	0.158	0.147	0.135	0.124	1.114	14.2	27.4	39.6	50.7
8.3.9	fin74.dat	1	0.103	0.057	0.030	0.028	0.427	24.1	37.4	44.4	50.9
8.3.10	fin72.dat	1	0.078	0.045	0.040	0.035	0.253	30.8	48.7	64.5	78.4
8.3.11	fin63.dat	2	0.186	0.053	0.040	0.033	0.446	41.7	53.6	62.6	70.1
8.3.12	fin56.dat	1	0.199	0.106	0.077	0.065	0.782	25.5	39.0	48.8	57.2
8.3.13	fin51.dat	1	0.122	0.100	0.081	0.062	0.687	17.7	32.2	44.0	53.0
8.3.14	fin46.dat	1	0.284	0.136	0.086	0.066	1.021	27.8	41.1	49.5	56.0
8.3.15	fin45.dat	1	0.537	0.128	0.094	0.068	0.903	59.4	73.6	84.0	91.5
8.3.16	fin42.dat	1	0.212	0.059	0.048	0.045	0.601	35.3	45.1	53.1	60.5
8.3.17	fin41.dat	1	0.413	0.268	0.164	0.154	1.426	29.0	47.7	59.2	70.0
8.3.18	fin39.dat	1	0.094	0.053	0.027	0.023	0.234	39.9	62.5	73.9	83.6
8.3.19	fin32.dat	1	0.866	0.328	0.247	0.155	1.669	51.9	71.5	86.3	95.6
8.3.20	fin29.dat	2	0.090	0.069	0.057	0.033	0.401	22.3	39.6	53.9	62.0
8.3.21	fin19.dat	2	0.165	0.144	0.137	0.121	1.025	16.1	30.1	43.5	55.4
8.3.22	fin15.dat	1	0.205	0.143	0.125	0.112	0.951	21.5	36.5	49.7	61.5
8.3.23	fin8.dat	1	0.229	0.160	0.137	0.127	1.015	22.6	38.3	51.8	64.3

Table 8.4: Eigenvalues and cumulative percentage variance explained for the first four axes of inertia from CA for datasets analysed in section 8.3 omitting analyses not fully discussed. *N.B.* 'tot. in.' is the *total inertia* for the data set. † Not including Torre de Juan Abed (JUA). For a discussion of this table see page 263.

concisely than the example above. For each analysis, appropriate tables and figures are given. The tables give the number of *denarii* in each hoard used in the analysis. Only well identified *denarii*, *i.e.*, those with a query code of 1, 5 or 6 (see Table 5.1), were used. The `end_date` was determined using *any* well identified coin with those query codes. Hoard names in inverted commas, such as 'Hoffman', are hoards with an inexact or unknown provenance. In the cumulative percentage graphs clarity has been attempted using line styles and labels. The interactive use of colour on screen allows patterning to be observed with greater ease. The eigenvalues and percentage variance explained figures from CANOCO for all these analyses are given in Table 8.4. In all cases the third, and sometimes the fourth axes of inertia were exaamined. Where these did not not reveal any significant information they have not been discussed (see also the discussion on page 263).

8.3.2 Hoards closing 147–118 BC

Data set `fin147.dat` contained 14 hoards closing in 147–118 BC (Table 8.5). They contained 2693 *denarii*. Years 211–158 formed 14% of the data set. In this analysis all species (years) were active. Fig. 8.13 is the cumulative percentage graph of this data; Figs. 8.14–8.15 are the maps from CA.

This data set covers a rather large period of time due to the small number of early hoards currently in the CHRR database and the CA of this data set is consequently dominated by the time sequence. Nevertheless, a number of interesting points can be made. Firstly, the three hoards closing in 125 BC all seem very similar indeed. They are plotted very close together in Figs. 8.15 and 8.13.

code	hoard	country	'end date'	'good total'
BAN	Banzi	Italy	130	124
FOS	Fossombrone	Italy	121	66
GER	Gerenzago†	Italy	118	49
JES	Jesi†	Italy	118	67
MAS	Maserà	Italy	125	1015
PAC	Pachino	Sicily	138	30
PET	Petacciato	Italy	141	224
ROM	Rome	Italy	147	113
S01	'West Sicily'	Sicily	146	36
SGI	San Giovanni Incarico	Italy	125	180
STO	Stobi	Yugoslavia	125	497
SY2	Syracuse	Sicily	136	59
TDS	Terranova di Sicilia†	Sicily	118	71
ZAS	Zasiok	Yugoslavia	120	162

Table 8.5: Hoards in data set `fin147.dat` used in CA discussed in section 8.3.2. † Also occurs in data set `fin118.dat`.

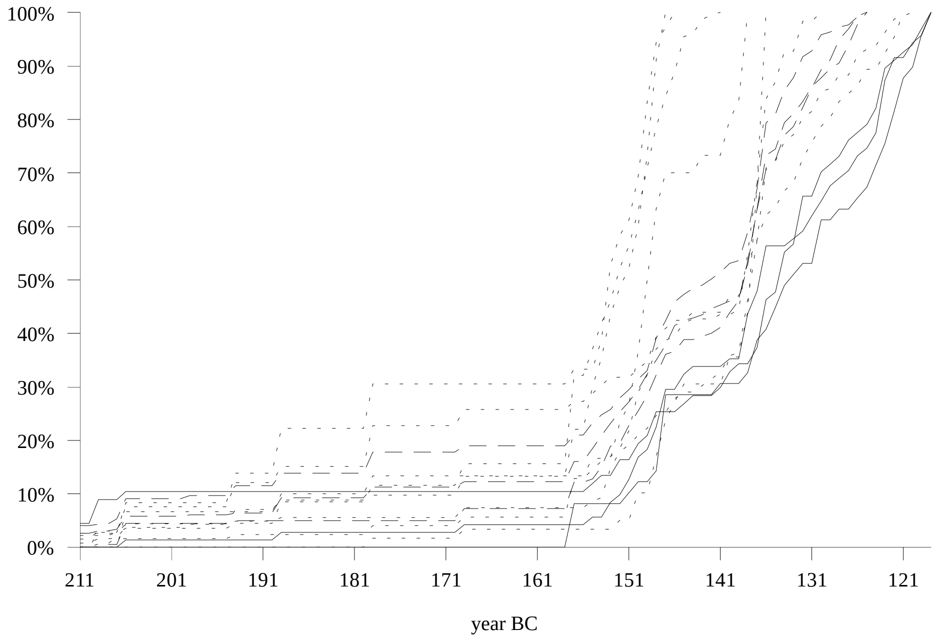


Figure 8.13: Cumulative percentage graph of hoards in data set `fin147.dat`. Dashed lines: hoards closing 125 BC; solid lines: hoards closing 118 BC; dotted lines: all others.

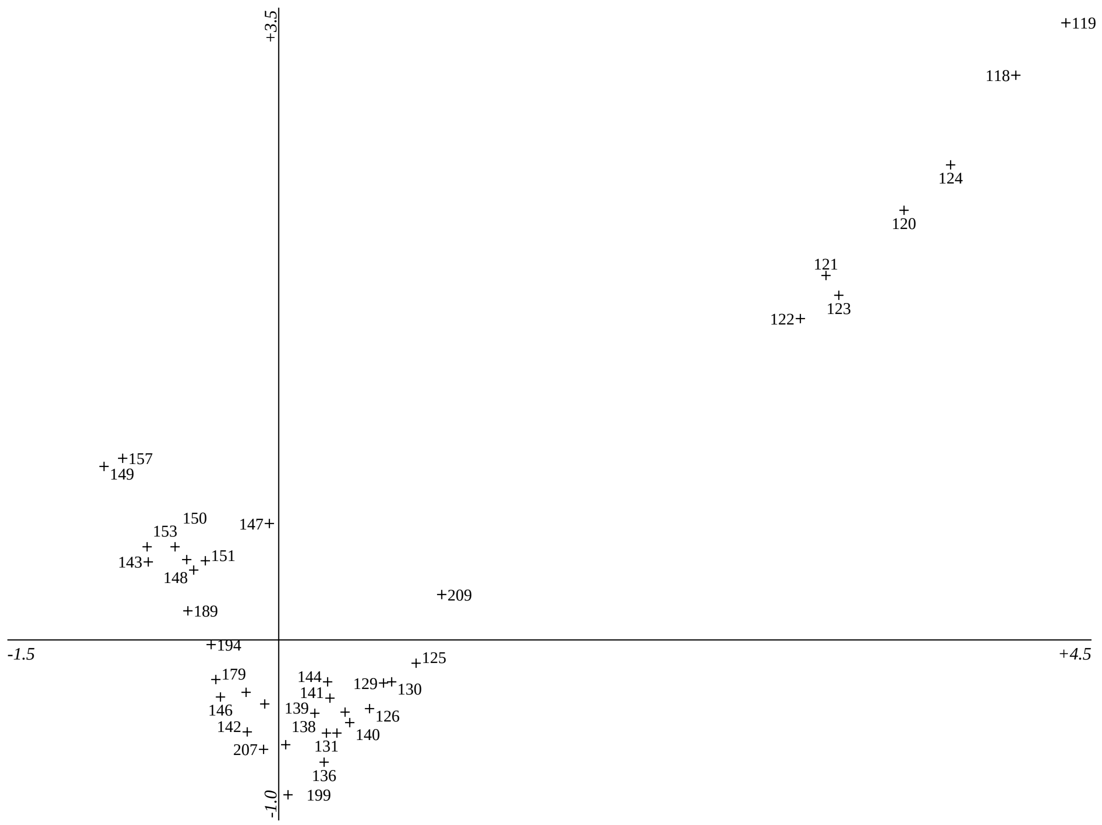


Figure 8.14: Species map from CA of data set `fin147.dat` discussed in section 8.3.2. Data points are years. First (horizontal) and second principal axes of inertia.

The three hoards from 118 BC seem equally similar in Fig. 8.13 but are more widely spaced in Fig. 8.15. If we compare each group of three using the Kolmogorov-Smirnov test (Shennan 1988, pp. 55–61) we find that none of the hoards from 118 BC are significantly different from each other, whereas the Maserà (MAS) is significantly different from Stobi and San Giovanni Incarico (STO & SGI).[10] The following points help to explain these results:

1. Hoard size.

   (a) The three hoards from 118 BC are much smaller than those from 125 BC.

   (b) Maserà is the largest hoard.

   The size of samples compared using significance tests has a major influence on the result (Shennan 1988, pp. 77–8). The larger the hoard, the more likely one is to have a significant result.

2. New years are added to the pool faster than old years fall out of circulation resulting in the hoards from 118 having coins from 124–118 *in addition* to *all* the others. Note that:

[10] GER v. TDS: $\text{Dmax} = 15.51$, $\text{Dmax}_{0.05} = 25.2$; GER v. JES: $\text{Dmax} = 14.05$, $\text{Dmax}_{0.05} = 25.6$; TDS v. JES: $\text{Dmax} = 10.56$, $\text{Dmax}_{0.05} = 23.2$; SGI v. STO: $\text{Dmax} = 6.26$, $\text{Dmax}_{0.05} = 11.8$; MAS v. STO: $\text{Dmax} = 9.43$, $\text{Dmax}_{0.05} = 7.4$; MAS v. SGI: $\text{Dmax} = 12.83$, $\text{Dmax}_{0.05} = 11.0$.

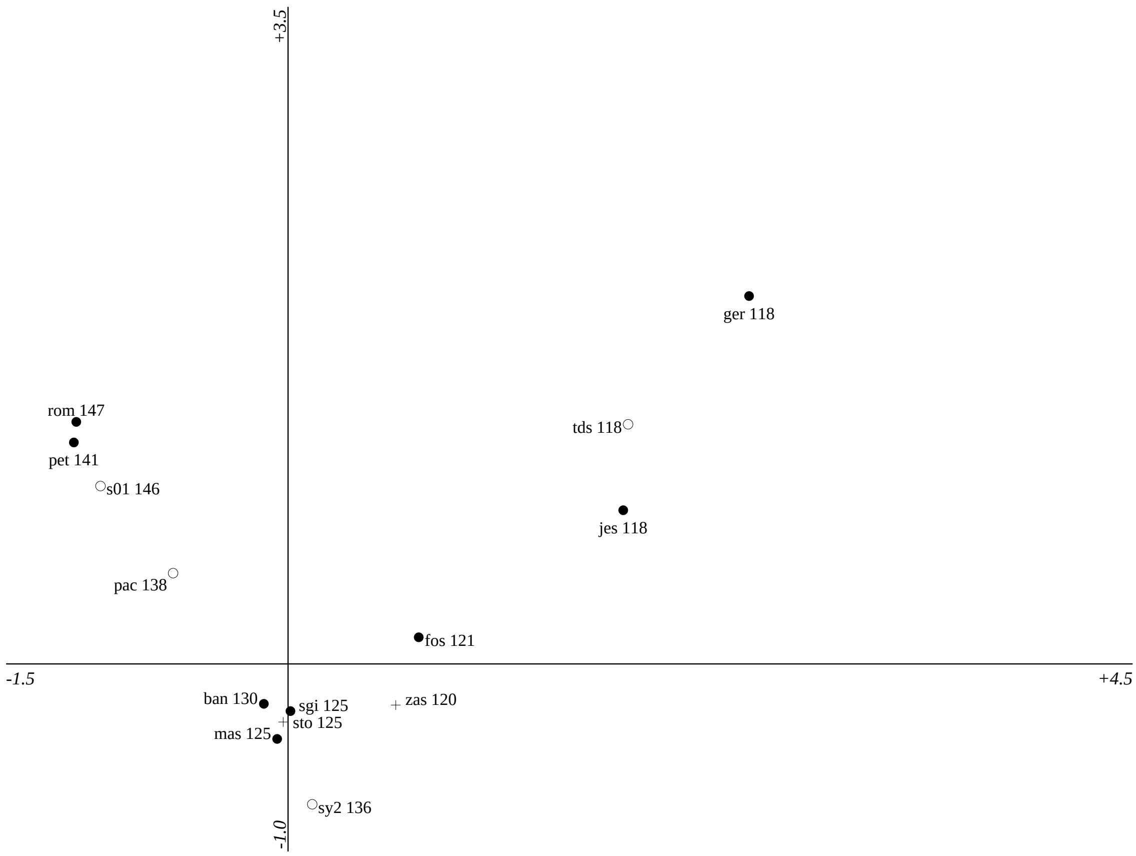


Figure 8.15: Sample map from CA of data set `fin147.dat` discussed in section 8.3.2. Data points are hoards, labels include the `end_date` for each hoard. • Italy; ∘ Sicily; + Yugoslavia. First (horizontal) and second principal axes of inertia.

(a) Coins from 124–118 form only 2.4% of the total data set (66/2963).

(b) Coins from 124–118 form 25.7% of the hoards from 118 BC (48/187).

This results in the CA giving more 'weight' to the variation in these few years compared to variation in years occuring in all hoards.

The pattern of the latest hoards being quite spread out on one extreme of a curve is a common feature of CA of hoard data, from a wide spread of years. The pattern was exaggerated here due to the factors listed above. Fig. 8.13 shows a very stepped profile up to 157 BC. This is a consequence of the comparatively poorly known dating of these early issues, which are assigned to wide date brackets. The steep rise in coinage levels after 157 is also notable, although it is possible that this is due to the dating scheme used.

In Fig. 8.15 the position of Petacciato (PET) nearer to Rome (ROM) than West Sicily (S01), despite their closing dates, is due to the similarity of the first two hoards over the *whole* of their profile. West Sicily has a large proportion of early coins compared to Rome or Petacciato. The small hoard from Pachino (PAC) also has a large proportion of early coins. From such a small sample it is difficult to draw definite conclusions but it would seem that early coins are better represented in Sicilian hoards than mainland Italy. A number of early issues were minted in Sicily (*e.g.*, RRC 68–

81; 211–209 BC) whereas all issues from 157–118 bar one[11] were, according to Crawford, minted in Rome.

Of the hoards from 118 BC the Jesi hoard (JES) has the most early coins. Otherwise, the three hoards are remarkably similar as noted above.[12] Likewise, the similarities between the hoards from 125 is also marked despite, for example, Maserà being in northern Italy, San Giovanni Incarico being south of Rome, and Stobi being in Yugoslavia. Unfortunately, archaeological interpretation of cross-period levels of similarity is extremely difficult (see Chapter 9 and Lockyear 1993a). Finally, the Yugoslav hoards from Zasiok and Stobi (ZAS & STO) do not appear particularly different from the Italian material.

8.3.3 Hoards closing 118–108 BC

Data set `fin118.dat` contained 14 hoards closing in 118–108 BC (Table 8.6). They contained 2051 *denarii*. Years 211–158 formed 4.4% of the data set. Fig. 8.16 is the cumulative percentage graph of this data; Fig. 8.17 is a location map of the Spanish hoards in this data set; Fig. 8.18 presents the maps from CA.

Half of this data set comes from Spain, the remainder from Italy and Sicily. The sample map (Fig. 8.18b) shows most of the Spanish hoards on the right of the plot, the majority of the Italian hoards on the left. Fig. 8.16 also shows that the Spanish hoards mainly have a 'modern' profile compared to Italy. The Spanish hoards, however, mainly date from the end of the period:

'end date'	118	117	116	115	114	113	112	111	110	109	108
Italy	3	1	1		1		1				
Spain				1		1	2		1	1	1

This fact in itself is significant. In all hoards from Spain, except Baix Llobregat (LLO), coins from 118–108 BC account for 35–20% of the hoard. Of the Italian hoards, Taranto (TR1) has 15%, but the others have only 5–0.5%.[13] It is unlikely that this pattern is merely fortuitous and it would seem that coins of this period are particularly associated with Spain. Even the latest of the Italian hoards, Borgonuovo (BRG) has only 0.5% of its coins from 118–108 BC.

Within the Spanish material, their order on the first axis is not determined by their `end_date`. This indicates that within the period from *c.* 115–108 BC there is variation in the age profiles not related to date alone. There may be a geographical factor at work. Taking the order of the hoards on the first axis from right to left, the second, third and fourth hoards (SEG, LAB & SAR) come from north-east Spain (Gerona). The fifth and sixth hoards (EL1 & PZ1) come from south central Spain (Cordóba). Counter to this, the first hoard (CO1) occurs with the second group and the last Spanish hoard (LLO) with the first group — see Fig. 8.17.

The position of Baix Llobregat (LLO) in both Figs. 8.16 and 8.18a makes it appear similar to Italian hoards, apart from a relative lack of coins of 118 BC, which characterises most Spanish hoards, — see below. This similarity is mainly because all have very few coins of 116–109 BC.

[11] The issue from Narbo (Narbonne), RRC 282, 118 BC.
[12] For years 211–158: JES: 7 coins, 10.5%; TDS: 3 coins, 4.2%; GER: no coins.
[13] Coins from 118–108 in Spanish hoards: CO1 35%; SEG 35%; SAR 25%; LAB 20%; EL1 18%; PZ1 20%; LLO 5%. In Italian hoards: TR1 15%; MAD 5%; BEV 4%; GER 4%; TDS 4%; JES 3%; BRG 0.5%.

code	hoard	country	‘end date’	‘good total’
BEV	Bevagna	Italy	117	721
BRG	Borgonuovo	Italy	112	215
CO1	Villanueva de Córdoba	Spain	113	127
EL1	El Centenillo	Spain	110	71
GER	Gerenzago†	Sicily	118	49
JES	Jesi†	Italy	118	67
LAB	La Barroca	Spain	112	69
LLO	Baix Llobregat	Spain	109	112
MAD	Maddaloni	Italy	116	283
PZ1	Pozoblanco	Spain	115	79
SAR	Sarriá	Spain	108	48
SEG	Segaro	Spain	112	43
TDS	Terranova di Sicilia†	Sicily	118	71
TR1	Taranto	Italy	114	96

Table 8.6: Hoards in data set `fin118.dat` used in CA discussed in section 8.3.3. † Also occurs in data set `fin147.dat`.

The second axis is dominated by the Pozoblanco hoard (PZ1). Examination of the species map and the cumulative percentage graph (Figs. 8.18a & 8.16) show this hoard to have high numbers of coins of 119 and 118 BC.[14] This can be clearly shown in two five number summaries:[15]

119 BC	#14		
	M7h	5.1	
	H4	2.5	6.9
	1	0	20.2

118 BC	#14		
	M7h	1.9	
	H4	1.4	4.1
	1	0	17.7

In both cases the upper extreme is the value for the Pozoblanco hoard. The coins from 118 BC in that hoard were minted at Narbo — a Roman colony in SW France (Fig. 8.17). However, an examination of Fig. 8.18a shows that apart from this hoard, coins from 118 BC are more associated with Italian hoards than Spanish material.[16] Pozoblanco lies in south central Spain whereas other hoards, *e.g.,* Segaro, lie much closer to Narbo. Pozoblanco also has the highest proportion of the other four species which stand out on the second axis (144, 133, 127 & 120). This hoard is clearly unlike others from either Spain or Italy in some details of its profile.

8.3.4 Hoards closing 105–97 BC

Data set `fin105.dat` contained 19 hoards closing in 105–97 BC (Table 8.7). They contained 4897 *denarii*. Years 211–158 formed 3.2% of the data set. Fig. 8.19 presents cumulative percentage graphs of this data; Fig. 8.20 presents the maps from CA.

[14] 119 BC: 16 coins, 20.25%; 118 BC: 14 coins, 17.7%.

[15] Five number summaries are a quick method of showing the distribution of values in a data set. It shows the number of cases (marked #), the depth of the median (marked M), the depth of the 'hinges' or quartiles (marked H) and the extremes (marked 1). Tukey (1977, p. 33) gives a detailed explanation.

[16] Coins of 118 BC in Spanish hoards: LLO & SEG 0 coins; EL1 1 coin, 1.4%; LAB 1 coin, 1.4%; CO1 2 coins, 1.6%; SAR 2 coins, 4.2%; PZ1 14 coins, 17.7%. Coins of 118 BC in Italian and Sicilian hoards: BRG 0 coins; MAD 5 coins, 1.8%; TR1 2 coins, 2.0%; BEV 20 coins, 2.8%; JES 2 coins, 3.0%; GER 2 coins, 4.0%; TDS 3 coins, 4.2%.

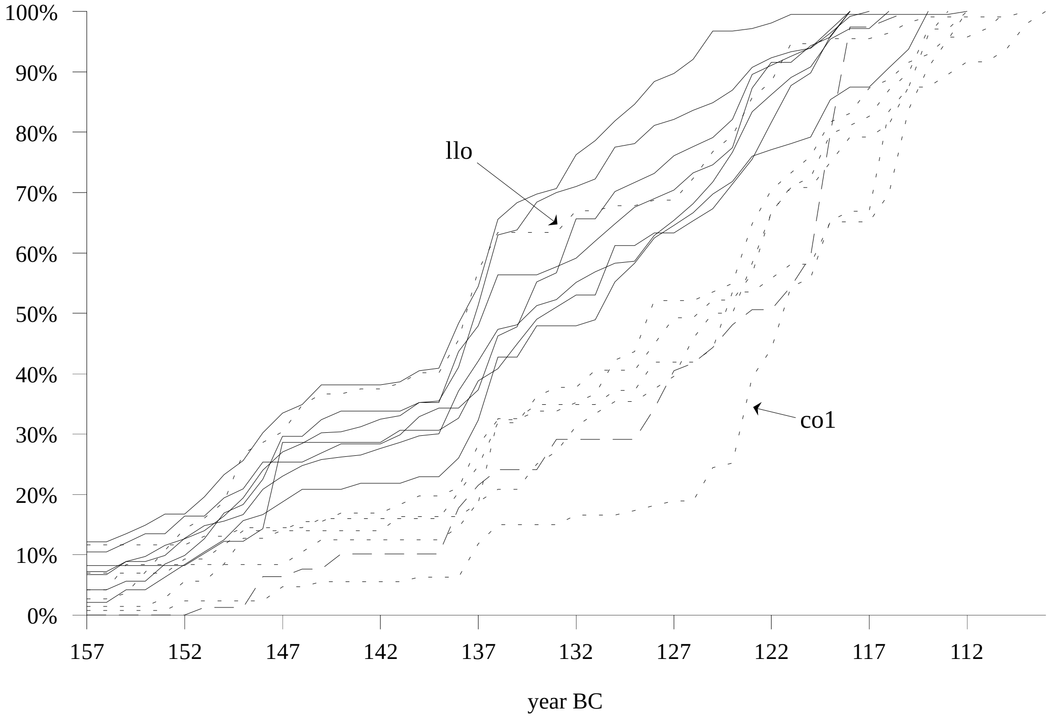


Figure 8.16: Cumulative percentage graph of hoards in data set `fin118.dat`. Solid line: hoards from Italy and Sicily; dotted line: hoards from Spain; dashed line: the Pozoblanco hoard (PZ1).

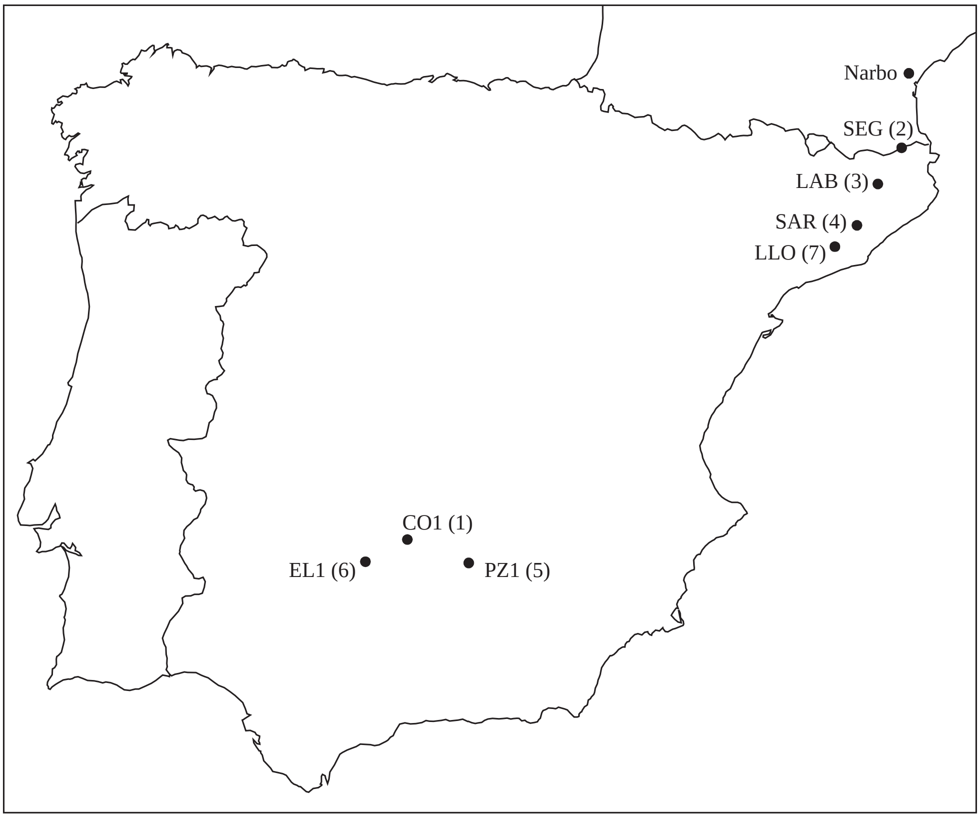
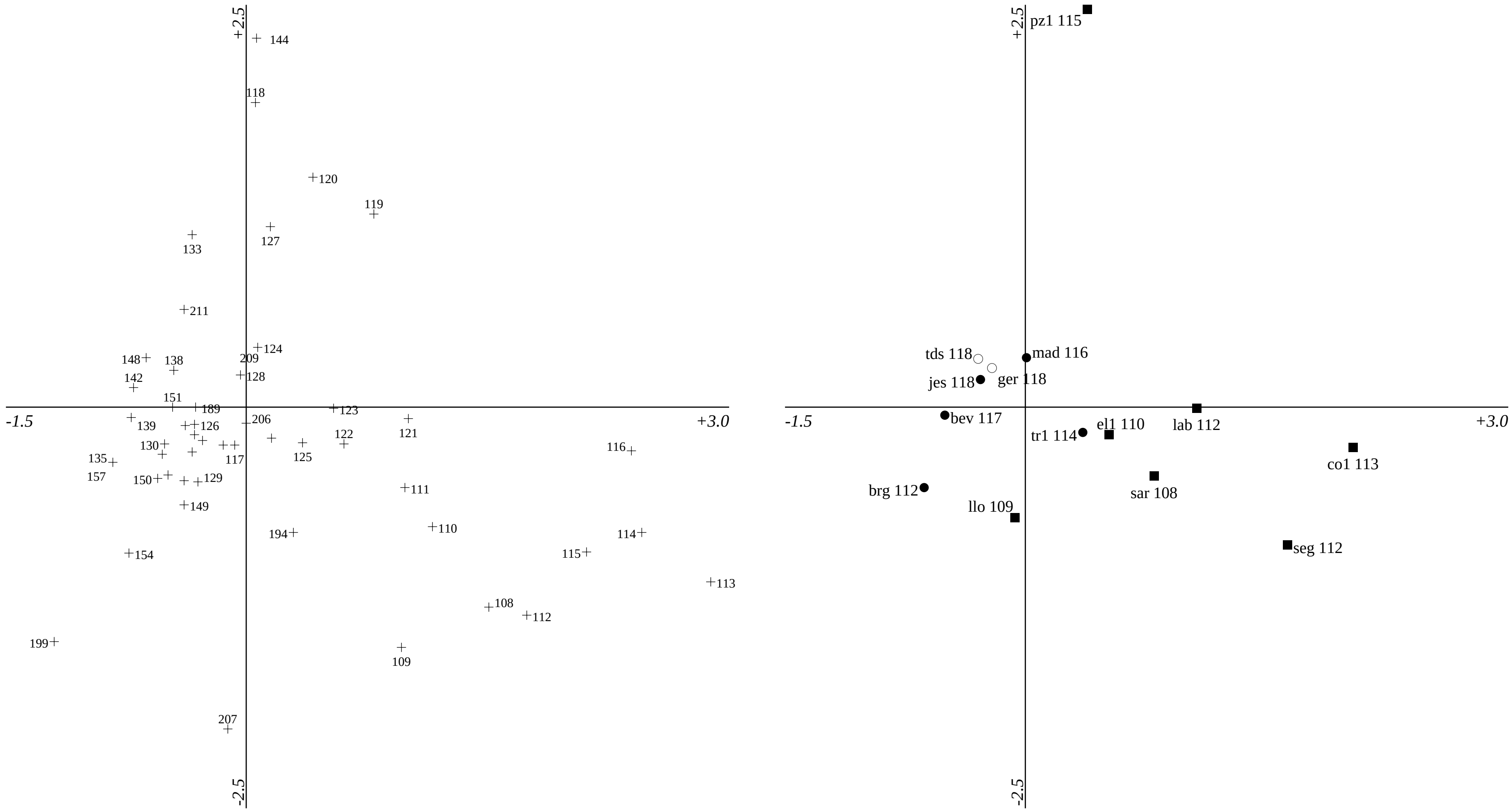


Figure 8.17: Location of coin hoards from Spain in dataset `fin118.dat`. Numbers refer to the hoard's position on the first axis of inertia. The location of the Narbo colony is also given.



(a) Species map: data points are years.

(b) Sample map: data points are hoards, labels include the `end_date` for each hoard. ● Italy; ○ Sicily; ■ Spain.

Figure 8.18: Maps from CA of data set `fin118.dat` discussed in section 8.3.3. First (horizontal) and second principal axes of inertia.

code	hoard	country	'end date'	'good total'
AZN	Aznalcollar	Spain	104	35
CG2	Cerignola	Italy	100	96
COG	Cogollos de Guadix	Spain	104	83
CRG	Crognaleto	Italy	97	137
CSL	Cástulo	Spain	101	47
ELE	Elena	Italy	101	59
GDM	Gioia dei Marsi	Italy	97	220
IAV	Idanha-a-Velha	Portugal	100	1340
IMO	Imola	Italy	100	500
JUA	Torre de Juan Abad†	Spain	105	476
LOR	San Lorenzo del Vallo	Italy	102	299
MNF	Manfria	Sicily	103	32
OLM	Olmeneta	Italy	100	397
ORC	Orce	Spain	100	72
PAT	Paterno	Sicily	100	149
PNH	Penhagarcía	Portugal	104	103
RCN	Ricina	Italy	101	271
RIO	Río Tinto	Spain	102	44
SEL	Santa Elena	Spain	101	537

Table 8.7: Hoards in data set `fin105.dat` used in CA described in section 8.3.4. †Also occurs in data set `fin80.dat`.

There are no hoards with over 30 'good' *denarii* closing 107–6 BC; hence the gap between this data set and the previous one. For 107 BC this is due to no coin type having a `date_from` of that date. There are no *denarii* dated to after 100 BC in the data set. The two hoards with an `end_date` of 97 BC contain *quinarii* of this date which have been excluded from the analysis. Only two issues of *denarii* are dated by Crawford to the period 99–93 BC.[17] It is always possible that a hoard was concealed or lost at some unknowable period after the 'closing' date of the hoard. In this data set there is an increased likelihood of this being true, especially for the six hoards closing in 100 BC.

The hoard from Torre de Juan Abad (JUA) is included in this data set and `fin80.dat` (section 8.3.7). This was done to enable us to examine the problem of extraneous coins. In RRCH Crawford lists this hoard (RRCH 189) as having 480 coins and closing with the issue of L. Thorius Balbus (RRC 316/1). The hoard had been catalogued by Crawford and was used in RRCH, Table XI. No mention was made of extraneous coins (*cf.* Córdoba, RRCH 184). When the hoard was published (Vidal Bardán 1982) two of the 478 coins listed were of a later date.[18] These were said to be 'logically' not part of the hoard (Vidal Bardán 1982, p. 80)[19], *i.e.*, they are thought to be extraneous. As can be seen from Fig. 8.20 this hoard, excluding those two later coins, does not appear as unusual and occurs within a group of Iberian peninsula hoards. The problem of extraneous coins will be discussed below (page 261).

Of the 19 hoards 9 come from the Iberian peninsula, 10 from Italy and Sicily. As with the previous data set, the distribution over time is not even:

[17] RRC 334/1, ?97 BC; RRC 335/1a–10b, ?96 BC.

[18] Nos. 477 & 478, RRC 366/1a, 82–1 BC, and 383/1, 79 BC.

[19] "Los denarios números 477 y 478 datados en los años 82–81 y 79 aC., respectivamente, quedan aislados y separados de los denarios anteriores, y lógicamente son una intromisión no aceptable en el tesorillo."

end_date	105	104	103	102	101	100	97
Italy			1	1	2	4	2
Spain	1	3		1	2	2	

The previous data set had a concentration of Spanish hoards in the second half of its date range, this set in the first half. As might be expected, the Italian and Sicilian hoards have, generally, a more modern age profile (Fig. 8.19).

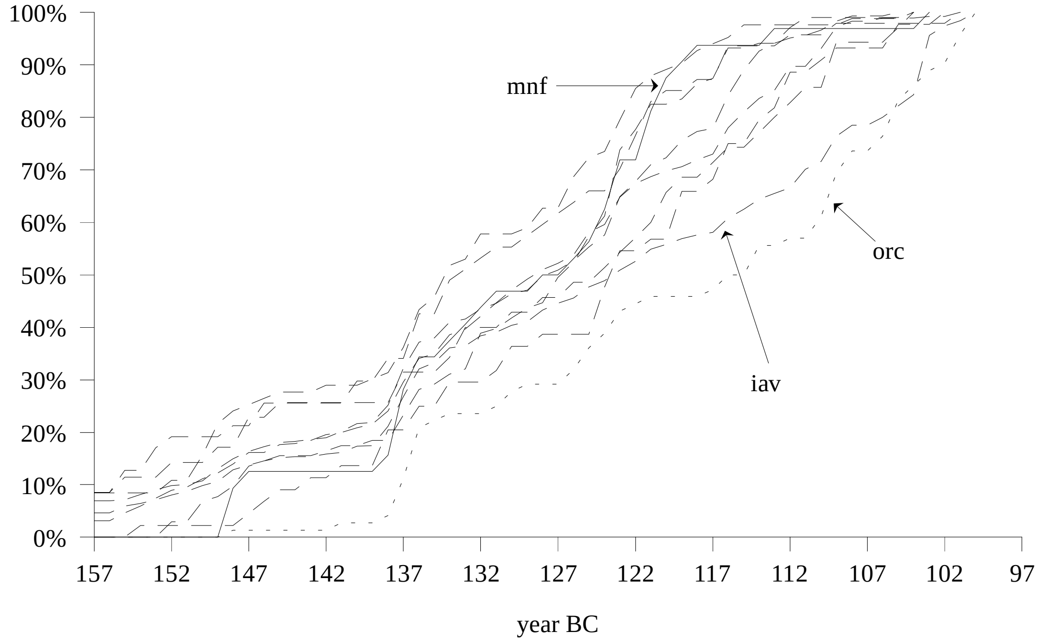
An examination of the species map (Fig. 8.20a) reveals a concentration of late years at the positive end of the first axis. The majority of active years prior to 111 BC have negative scores on the first axis. The date distribution of hoards by country is reflected in the sample map (Fig. 8.20b) where the Italian hoards mainly cluster together, as do the Iberian peninsula hoards. Manfria (MNF) appears with the Iberian peninsula hoards partly due to its early closing date; Orce (ORC) lies within the Italian group due to its late closing date. Although four of five hoards closing 105–3 BC appear at the negative end of the first axis, patterning by `end_date` in the rest of the sequence is quite mixed.

No Italian hoards in the database date to 111–104 BC. The Iberian hoards discussed in the previous section had very modern profiles mainly due to coin dated from 118–108 BC which accounted for between 15–35% of the hoards (excluding Baix Llobregat). It was decided to see if this association held true for this data set. To do this the number of coins of a given period were expressed as a percentage of the total number of coins from 211 to the last date of that period. For example, Ricina (RCN) has 271 'good' *denarii*. Of those, 234 date from 211–108 BC; 53 of those date from 116–108 BC and form 22.6% of the sub-total. These sub-totals were calculated for various periods for all hoards. The results can be displayed as five figure summaries — see Fig. 8.21. As can be clearly seen, all attempts to show that coins of *c.* 116–104 BC are more associated with Iberia, in this data set, fail. This is paradoxical when compared to the results of the previous section and the general distribution of hoards by `end_date`. The earliest hoard from Italy, Manfria (MNF), has only two coins dating after 118 BC (6.25%) and is very odd in its profile. The next hoard, San Lorenzo (LOR), has almost 40% from after 118 BC. This does not help explain why hoards from 118–108 BC in Spain do have a large proportion of coins of this date, whereas hoards from 105–100 BC do not, even after discounting coins from after 105 BC. Although a number of exciting possibilities exist the most likely explanation is that Crawford's sequence of coin types at this period is incorrect. The absolute dates for some issues has been disputed. For example, the Narbo issue (RRC 282) could be dated to 114 BC (Mattingly 1969). This could be solved by an analysis at the level of types rather than years which is out of the scope of this thesis.

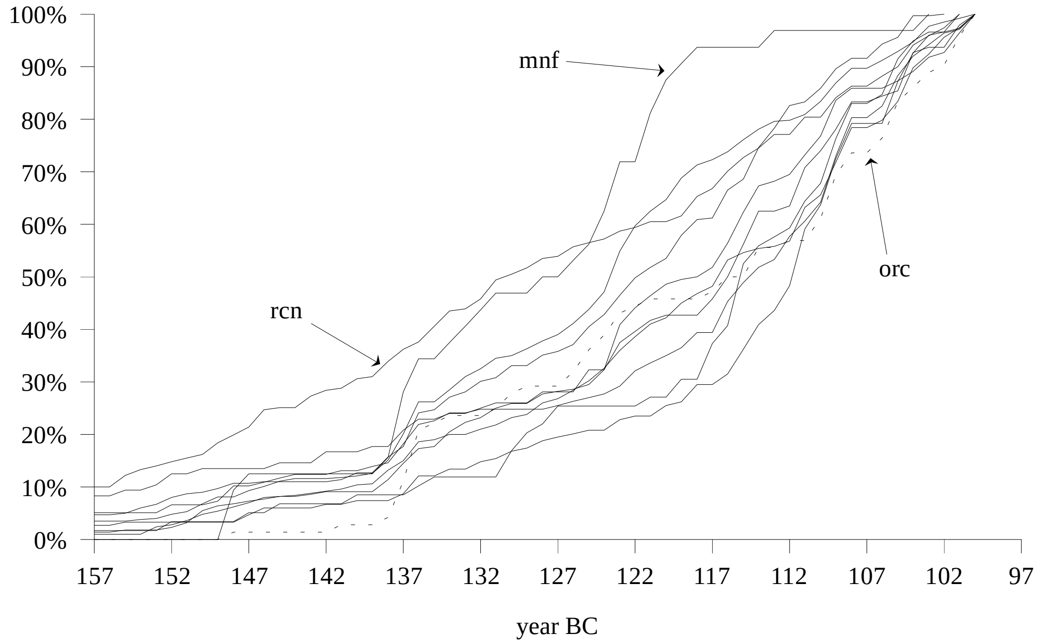
The position of Idanha-a-Velha (IAV) on the sample map (Fig. 8.20b) is largely due to coins from 103 BC which account for 11.27% of this hoard. No other hoard has more than 3.36%.[20] In Fig. 8.19 the line for IAV cuts across many of the other lines at this date, emphasising its uniqueness.

In summary, the Italian/Sicilian and Iberian hoards generally fall into two groups in all maps and plots but this seems explicable in terms of the `end_date` of hoards. However, the exact relative

[20]Coins of 103 BC: AZN, COG, CSL, JUA, LOR, PNH & RIO: no coins; SEL: 2 coins, 0.4%; CG2: 1 coin, 1.0%; ELE: 1 coin, 1.7%; RCN: 5 coins, 1.8%; CRG: 3 coins, 2.2%; IMO: 13 coins, 2.6%; GDM: 6 coins, 2.7%; ORC: 2 coins, 2.8%; OLM: 12 coins, 3.0%; MNF: 1 coins, 3.1%; PAT: 5 coins, 3.6%; IAV: 151 coins, 11.3%.

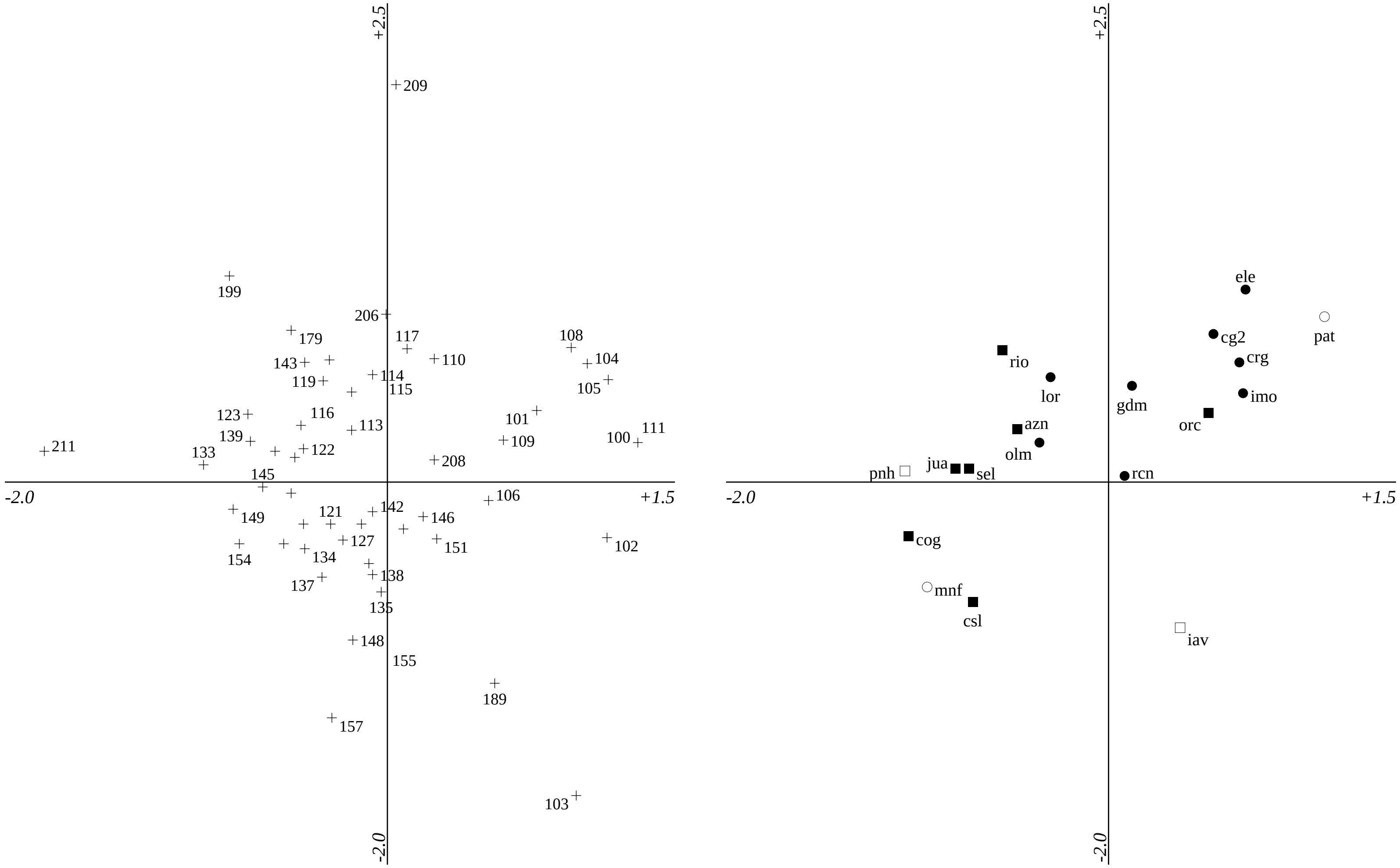


(a) Iberian peninsula plus Manfria (MNF)



(b) Italy and Sicily plus Orce (ORC).

Figure 8.19: Cumulative percentage graphs of hoards in data set `fin105.dat`. Solid lines: hoards from Italy and Sicily; dashed lines: hoards from Spain; dotted line: Orce.



(a) Species map: data points are years.

(b) Sample map (left): data points are hoards. ● Italy; ○ Sicily; ■ Spain; □ Portugal.

Figure 8.20: Maps from CA of data set `fin105.dat` discussed in section 8.3.4. First (horizontal) and second principal axes of inertia.

Coins of 116–104 expressed as percentage of coins of 211–104

Italy	#10			Spain	#9		
M5h		43.09		M5		26.18	
H3	20.02		57.14	H3	12.62		30.23
1	3.23		68.12	1	6.02		45.16

Coins of 116–108 expressed as percentage of coins of 211–108

Italy	#10			Spain	#9		
M5h		39.10		M5		24.24	
H3	22.65		50.91	H3	11.76		25.95
1	3.23		62.71	1	4.88		35.85

Coins of 111–104 expressed as percentage of coins of 211–104

Italy	#10			Spain	#9		
M5h		26.70		M5		9.23	
H3	17.11		50.91	H3	2.91		17.14
1	0.00		62.71	1	2.17		33.87

Figure 8.21: Five figure summaries — see text for details.

sequence of types appears to be in doubt and until further work has been performed on this problem a more detailed interpretation of the pattern from this, and the previous section would be premature.

8.3.5 Hoards closing 92–87 BC

Data set `fin92.dat` contained 11 hoards closing in 92–87 BC (Table 8.8). They contained 2922 *denarii*. Years 211–158 formed 3.08% of the data set. Fig. 8.22 is the cumulative percentage graph of this data; Figs. 8.23–8.25 are the maps from CA.

During the period covered by this data set the Social War was fought (91–89 BC; Scullard 1982, pp. 63–8). During the war, and for a few years after, the Roman mint issued a huge number of coins. This greatly affects the structure of coin hoards.

In the CA, the only two hoards from 87 BC dominate the sample map (Fig. 8.23b) and similarly, years 97–87 BC dominate the species map (Fig. 8.23a). On the first axis of inertia, these years are almost perfectly seriated with only 96 BC out of sequence. Only one issue is dated to '?96 BC', RRC 335. This analysis suggests that it could be placed after the only issue from 92 BC, RRC 336. Note that it is the *sequence* which could be changed on the basis of this analysis — it tells us nothing about *absolute* dates. The second axis is dominated by 87 BC at its positive end and 97–88 at its negative.

Both the 'Italy' and Alife hoards (CAH & ALI) have large proportions of coins of 97–87 BC as suggested by the first axis and this is shown in Fig. 8.22. Within this the Alife hoard has relatively more coin of 87 BC compared to the 'Italy' hoard.[21]

A second CA omitting hoards Alife and 'Italy' was performed. In the sample map (Fig. 8.25) the closing dates have been represented using plot symbols. The hoards are almost perfectly seriated

[21] Coins of 97–87 BC: ALI: 65 coins, 80.2%; CAH: 168 coins, 79.6%; all other hoards 1.9–10.3%. Coins of 87 BC: ALI: 24 coins, 29.6%; CAH: 7 coins, 3.3%.

code	hoard	country	'end date'	'good total'
ALI	Alife†	Italy	87	81
AN2	Ancona	Italy	90	100
CAH	'Italy'†	Italy	87	211
CLA	Claterna	Italy	92	53
CRP	Carpena	Italy	92	51
FUS	Fuscaldo	Italy	90	811
HF1	'Hoffmann'	Italy	90	132
MDI	Monteverde di Fermo	Italy	92	44
MTR	Cergnano (Mortara)	Italy	91	300
NOC	Nociglia	Italy	92	55
SYR	Syracuse	Sicily	88	1084

Table 8.8: Hoards in data set `fin92.dat` used in CA discussed in section 8.3.5. †Also occur in data set `fin87.dat`.

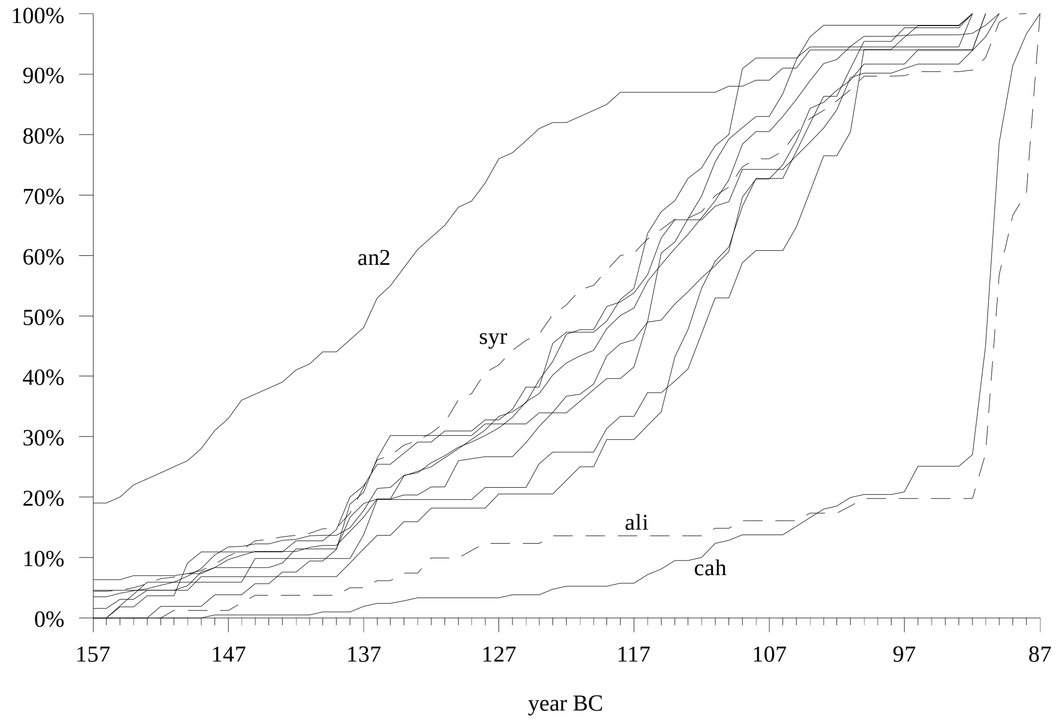
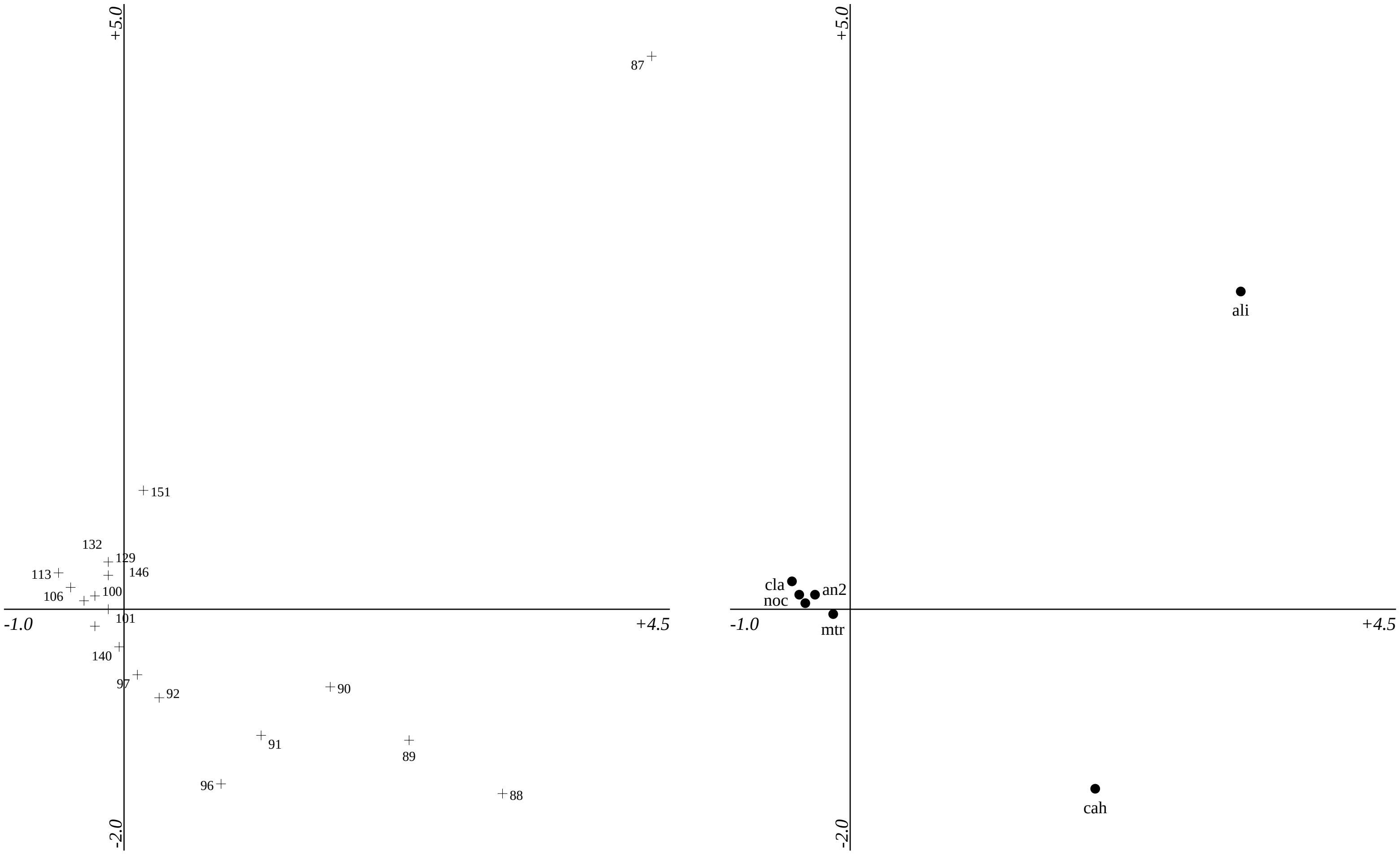


Figure 8.22: Cumulative percentage graph of hoards in data set `fin92.dat`. Dashed lines: as labeled.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. N.B. a number of hoards, including SYR, are not plotted. All are in the group at the origin.

Figure 8.23: Maps from first CA of data set `fin92.dat` discussed in section 8.3.5. First (horizontal) and second principal axes of inertia.

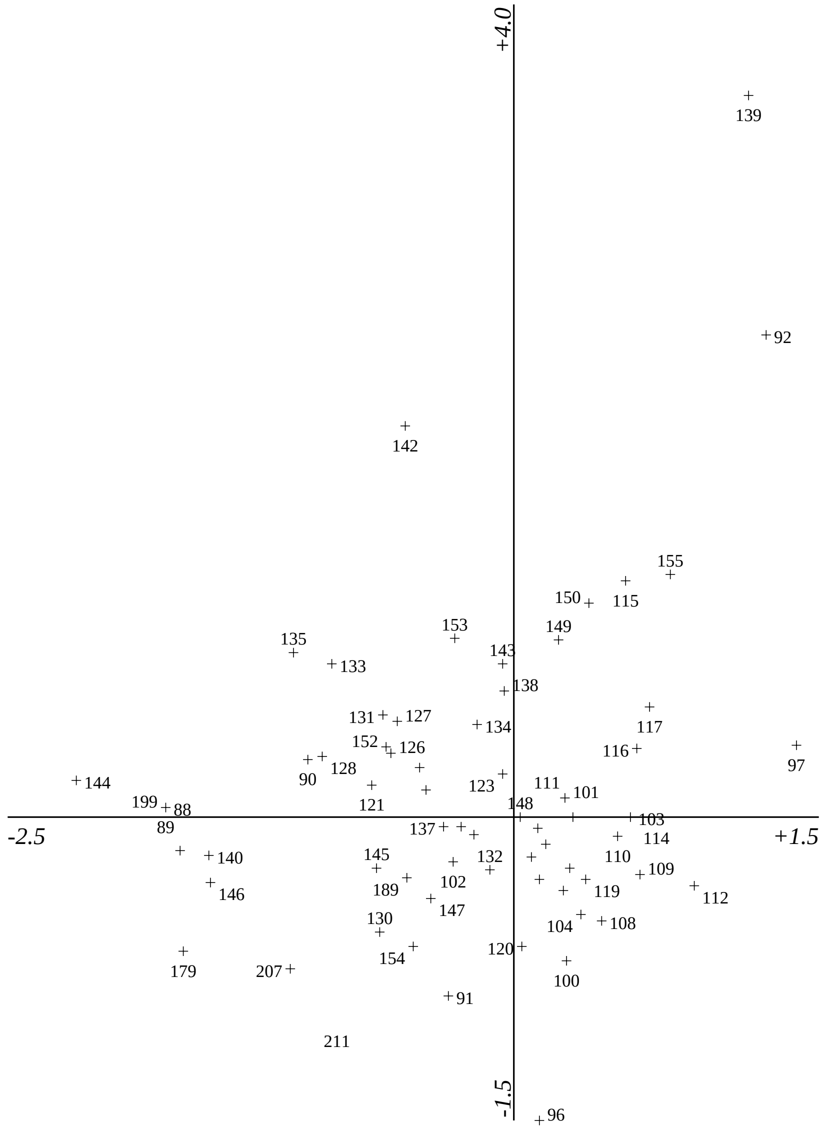


Figure 8.24: Species map from second CA of data set `fin92.dat` discussed in section 8.3.5. Data points are years. First (horizontal) and second principal axes of inertia.

on the first axis. Only the Syracuse and Ancona hoards (SYR & AN2) are out of sequence. Fig. 8.22 shows that the Ancona hoard is extremely odd. It bears little resemblance to other hoards in this data set. The data for Ancona has problems which may account for this odd structure.[22] The Ancona hoard does not *dramatically* stand out in Fig. 8.25 because years 211–158 were passive. These years account for 16% of the hoard and causes its odd profile in Fig. 8.22. The Syracuse hoard (SYR) is rather archaic in structure for a hoard closing in 88 BC. The data for Syracuse is extremely good so its unusual structure *could* be because it is the only Sicilian hoard. The remaining seven hoards in Fig. 8.22 are extremely similar.

[22] This hoard (RRCH 169), and Ancona (AN1, RRCH 344, see section 8.3.12) are part of the American Numismatic Society collection. Crawford, when examining these hoards prior to publication of RRCH, felt that there were in fact

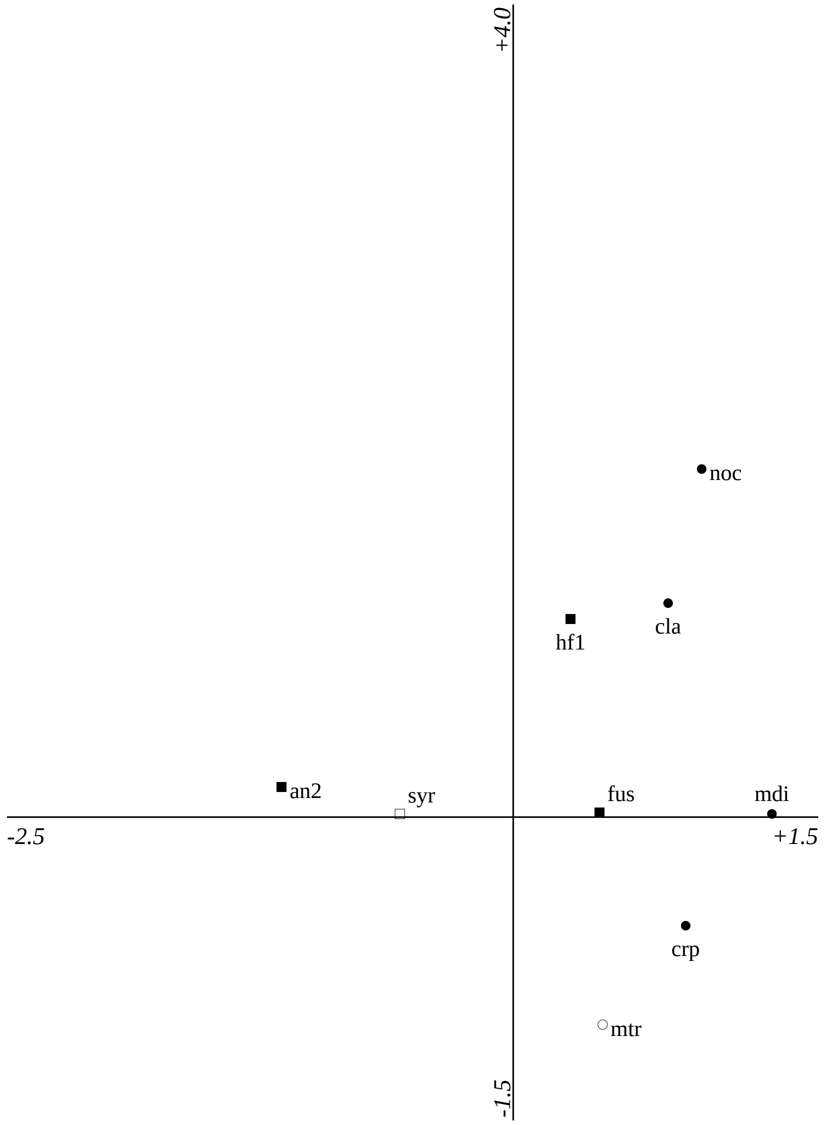


Figure 8.25: Sample map from second CA of data set `fin92.dat` discussed in section 8.3.5. Data points are hoards. • hoards closing 92 BC; ○ hoard closing 91; ■ hoards closing 90; □ hoard closing 88. First (horizontal) and second principal axes of inertia.

The species map (Fig. 8.24) seems confused at first sight. The order of years 97–88 is the same as before[23] but they are interspersed throughout the other species. This is because two of the hoards with the latest closing dates (AN2 & SYR) also have the most archaic structure, and are thus more associated with a selection of both the early and late years compared to other hoards.

two hoards and split them up accordingly. (Some twenty-five or more years later it is unsuprising that Crawford is now uncertain *exactly* why, but thinks it was probably due to patination, and the 'structure' of the two lots, Crawford *pers. comm.*) Subsequently, a further coin was added to AN2 moving its date from 124–92 (RRCH 169) to 90 BC (computer listing from ANS in MHC archive). Recently, however, Metcalf (*pers. comm.* 1993) can find no evidence in the documentation for these coins which supports this division.

[23]The fact that the species go from right to left in this map, and left to right in Fig. 8.23a is of no significance.

The CA shows that apart from coins of 211–158 BC, the Ancona hoard is archaic, but does not have an exceptional structure, unlike Érd (see page 154). On the third axis (not shown) it is at the positive extreme but does not stand a long way clear. It seems most likely that this hoard is in fact two — an early hoard which accounts for the bulk of the pre-157 coinage, and a later hoard dating to *c.* 90 BC. As a result of making years 211–157 passive in the CA, Ancona is not shown as being excessively odd. It is, however, still the most archaic hoard suggesting that the earlier hoard probably dates some time after 157 BC.

The second axis is also difficult to interpret. The pattern detected is a contrast between three hoards at the positive end of the axis (NOC, CLA & HF1) and two hoards at the negative end (MTR & CRP). The remaining four hoards do not fit the pattern and thus have scores near to zero on this axis. Looking at the species map we can see there are a number of outliers — these are rare species. For example, there are only three coins of 139 BC in the data set. Looking at the main body of points we can see a trend for coins of 109–100 BC to occur at the negative end of the axis. Looking at the cumulative percentage graph on screen shows that hoards MTR and CRP have very similar profiles with relatively more coins of 109–100 BC.

8.3.6 Hoards closing 87–81 BC

Data set `fin87.dat` contained 12 hoards closing in 87–81 BC (Table 8.8). They contained 2536 *denarii*. Years 211–158 formed 0.01% of the data set. Fig. 8.26 is the cumulative percentage graph of this data; Figs. 8.27–8.28 are the maps from CA and Fig. 8.29 a location map.

The sample map (Fig. 8.28) shows a clear horseshoe curve. This curve is not a straightforward time gradient: hoards from 82–81 BC occur in the middle of the curve, and hoards from 86 BC near both ends. The species map (Fig. 8.27) shows most years lying on a similar curve with a few anomalies, notably 92, 101 and 81 BC. Most years post-105 lie at the positive end of the first axis with the exception of 85, 84 and 82 BC. On the second axis, years 86–81 lie at the negative end, most years in the 90s BC about the origin, and older years at the positive end. The first axis therefore represents a contrast between hoards with large numbers of coins of post-105 BC, especially coins of the 90s, compared to older coins. The second axis represents large numbers of coins of 86–81 BC compared to older coins. The anomalous position of 92 and 101 BC is due to hoards at either extreme containing coins of these years, but hoards in the middle of the curve do not.[24]

Fig. 8.26 shows the Pantelleria hoard (PNT) to be unusual. This hoard contained a high number of unidentifiable pieces (44/88), some fragmentary and some, according to Crawford, imitations of *denarii* (Crawford archive). This, and the fact that Pantelleria is a small island between Sicily and Tunisia, could account for its odd and archaic structure. The CA places this hoard near to Berchidda (BER, Fig. 8.28). As with Ancona (section 8.3.5) this is because their structures, *ignoring* years prior to 157 BC, are similar.

Four of the hoards in Fig. 8.26 have a very archaic structure and these are all placed at the left extreme of the curve on the sample map (Fig. 8.28; FSL, OLE, PNT & BER). The location map (Fig.

[24]92 BC: FSL: 5; CAH: 4; OLE: 1; PEI: 1; *cf.* BLC, CAR & CPL: 0. 101 BC: FSL: 3; CAH: 3; OLE: 1; PEI: 0; *cf.* BLC, CAR & CPL: 0.

code	hoard	country	‘end date’	‘good total’
ALI	Alife†	Italy	87	81
BER	Berchidda	Sardinia	82	1395
BLC	Bellicello	Sicily	81	35
CAH	‘Italy’†	Italy	87	211
CAR	Carovilli	Italy	82	40
CER	Cervia	Italy	82	44
CPL	Capalbio	Italy	81	59
DOM	Santa Domenica di Tropea	Italy	82	109
FSL	Fossalta	Italy	83	259
OLE	Oleggio	Italy	86	221
PEI	Peiraeus	Greece	86	42
PNT	Pantelleria	Nr. Sicily	85	40

Table 8.9: Hoards in data set `fin87.dat` used in CA discussed in section 8.3.6. † Also occur in data set `fin92.dat`.

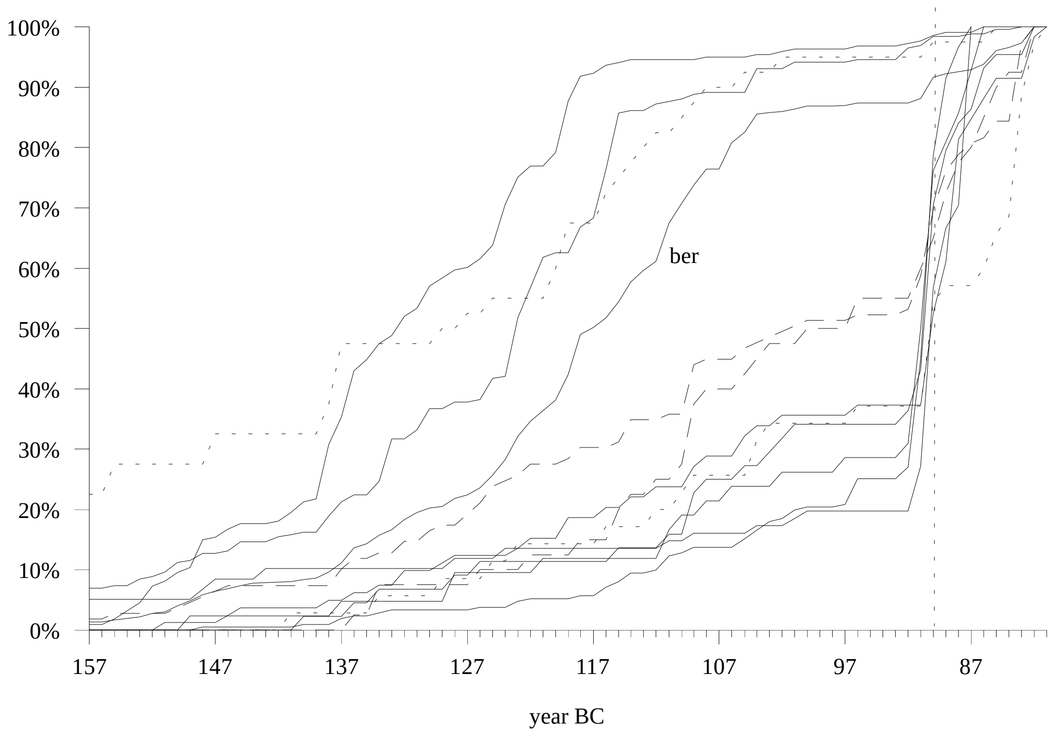


Figure 8.26: Cumulative percentage graphs of hoards in data set `fin87.dat`. Upper dotted line: Pantelleria; lower dotted line: Bellicello; dashed lines: Carovilli and Santa Domenica di Tropea. Vertical line: 90 BC.

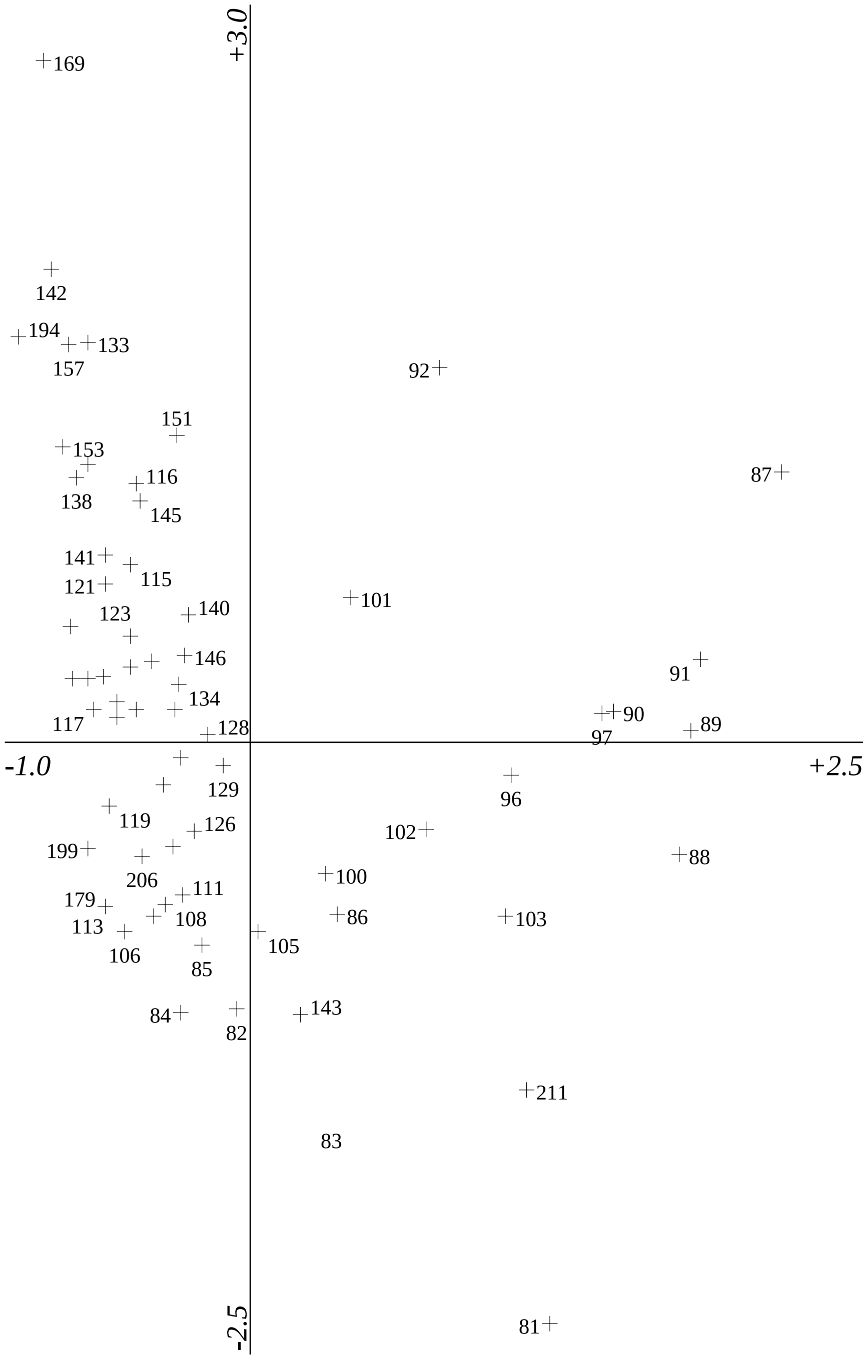


Figure 8.27: Species map from CA of data set `fin87.dat` discussed in section 8.3.6. Data points are years. First (horizontal) and second principal axes of inertia.

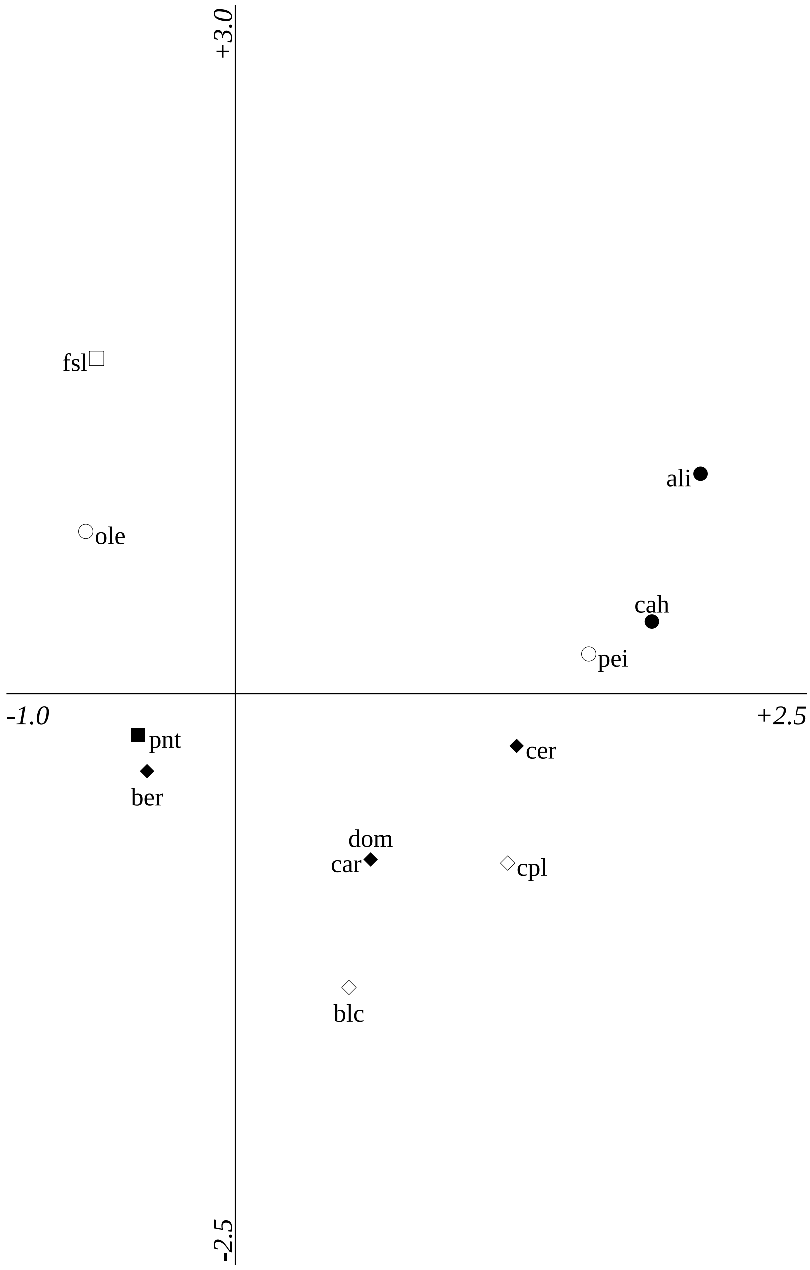


Figure 8.28: Sample map from CA of data set `fin87.dat` discussed in section 8.3.6. Data points are hoards. ● hoards closing 87 BC; ○ 86; ■ 85; □ 83; ⧫ 82; ◊ 81. First (horizontal) and second principal axes of inertia.

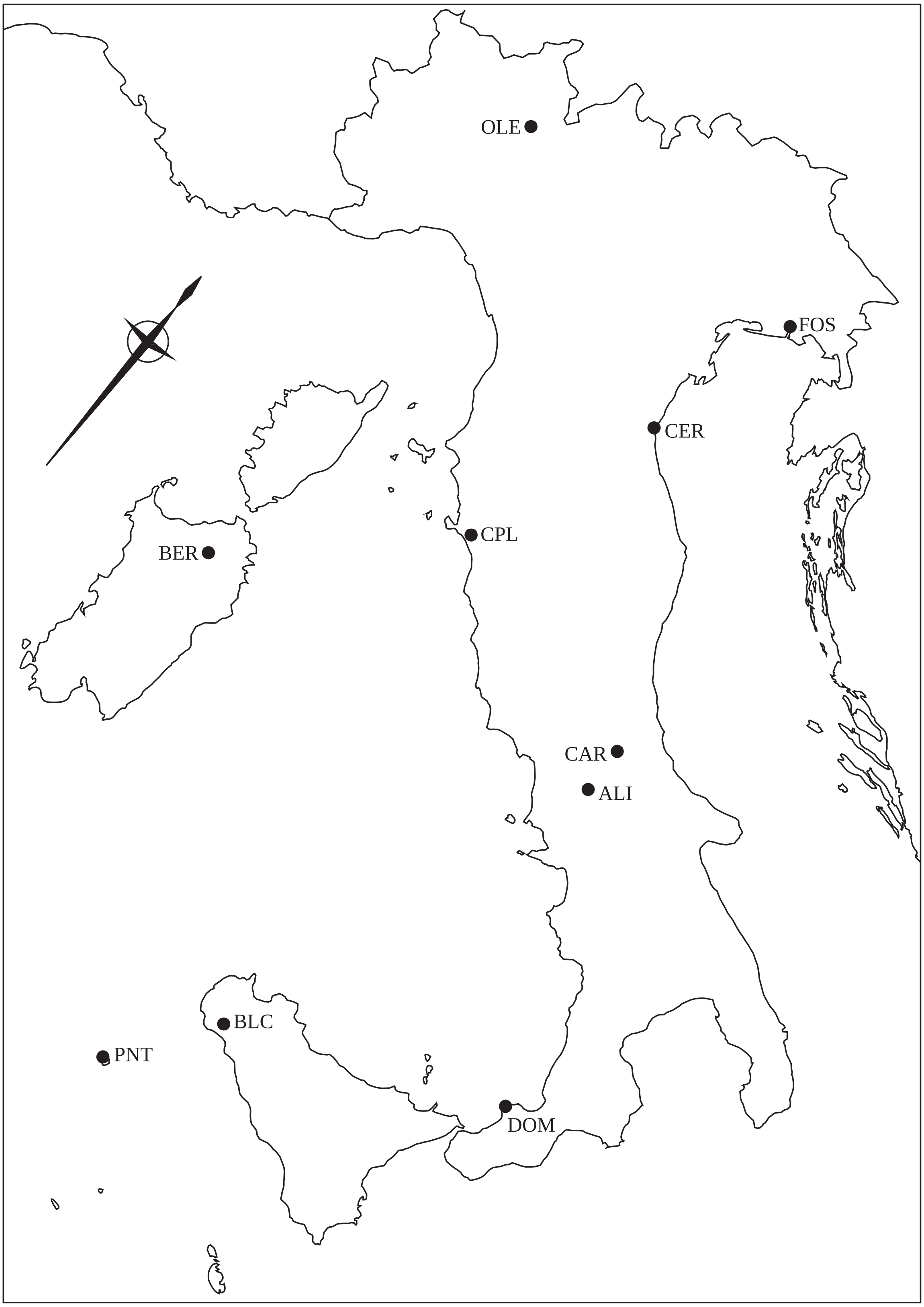


Figure 8.29: Location map of hoards in data set `fin87.dat`.

8.29) shows these four hoards on the edges of the distribution — in northern Italy, Sardinia and Isola Pantelleria. Carovilli and Santa Domenica di Tropea (CAR & DOM), marked as dashed lines in Fig. 8.26, have identical locations on the sample map. They are not, however, closely placed on the location map. Bellicello (BLC) which occurs at the extreme of the second axis, has large quantities of coins from 83 and 81 BC and has the most modern hoard structure. The remaining Italian hoards on the right of the horseshoe curve all occur in peninsular Italy.

This analysis is the first occasion when a geographical pattern has emerged within Italy. It shows that the large issues of 90–87 BC had circulated sufficiently within peninsular Italy and Sicily for their distribution to be comparatively even. In contrast, Sardinia, Isola Pantelleria and northern Italy had yet to receive substantial quantities of these coins. The hoard from Greece (PEI) was presumably collected from the peninsular Italian coinage pool before deposition in Greece.

8.3.7 Hoards closing 80–79 BC

Data set `fin80.dat` contained nine hoards closing in 80–79 BC (Table 8.10). They contained 1348 *denarii*. Years 211–158 formed 2.23% of the data set. Fig. 8.30 is the cumulative percentage graph and Fig. 8.32 is a location map.

Torre de Juan Abed (JUA) was included in this analysis in order to examine the problems of extraneous coins (section 8.3.4). As can be seen from Fig. 8.30 the hoard is quite anomalous in contrast to Fig. 8.19. See page 261 for further discussion. This hoard was therefore left out of the CA which left eight hoards with 870 *denarii*. Six *denarii* (0.7%) were from 211–158 and these were omitted from the analysis. Fig. 8.31 presents the maps from this analysis.

In Fig. 8.31b Bobaia (BOB) stands well away from all the other hoards. Comparing this to Fig. 8.30 it can be seen that this hoard has the most archaic structure of the eight remaining hoards. The Bobaia hoard (Chirilă & Iaroslavschi 1987–1988) is the earliest hoard from Romania with a significant number of *denarii*.[25] It was a mixed hoard, containing *denarii*, tetradrachms of Thasos and drachms of Apollonia and Dyracchium.

Examining the order of the hoards on the first axis and comparing to Fig. 8.30 we can see that those at the positive end are the most archaic hoards, those at the negative end the most modern. In Fig. 8.31a most years from 92 BC onwards have a negative score on this axis. The second axis is less clear but seems to largely reflect differences between the most archaic Italian hoard, Fragagnano (FRA) and Bobaia. For example, Bobaia has the only two coins of 135 BC, one of two coins of 101, 145 and 148 BC *etc.* Conversely, Fragagnano has the only coins of 120 and 97 BC. This is a very sparse data set due to the small size of all the hoards in the analysis, and this has resulted in the second axis mainly representing variation in rare years between two hoards.

The ‘modernity’ of the Italy and Palestrina hoards (IT4 & PL1) is mainly due to issues from 82–79 BC. They account for over 40% of the total of those hoards. The issues from 90–88 BC which

[25]Currently (October 1994) 13 hoards in the CHRR database come from Romania and date before 79 BC. Of these, only Iclanzel (ICL; Chirilă & Grigorescu 1982) has more than six ‘good’ *denarii*, and it only has 18. It was said to have about 100 coins but how many of these were *denarii* and how many other types of coin is not known. Seven hoards including Bobaia have an `end_date` of 79 BC but the others have less than 30 ‘good’ *denarii*.

code	hoard	country	'end date'	'good total'
AMA	Amaseno	Italy	79	123
BOB	Bobaia	Romania	79	41
FRA	Fragagnano	Italy	79	86
IT4	'Central Italy'	Italy	79	140
JUA	Torre de Juan Abad†	Spain	79	478
MNT	Montiano	Italy	79	56
PL1	Palestrina	Italy	80	64
RIZ	'Rizzi'	?	79	215
SPO	Spoleto	Italy	79	145

Table 8.10: Hoards in data set `fin80.dat` used in CA analyses in section 8.3.7. † Also occurs in data set `fin105.dat`.

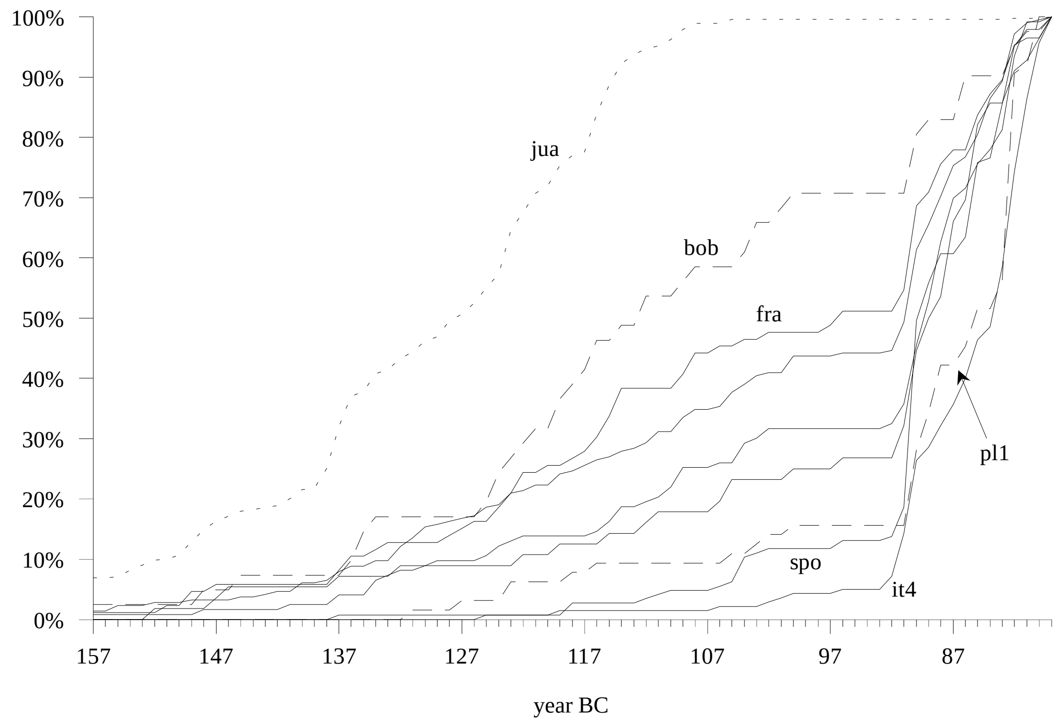
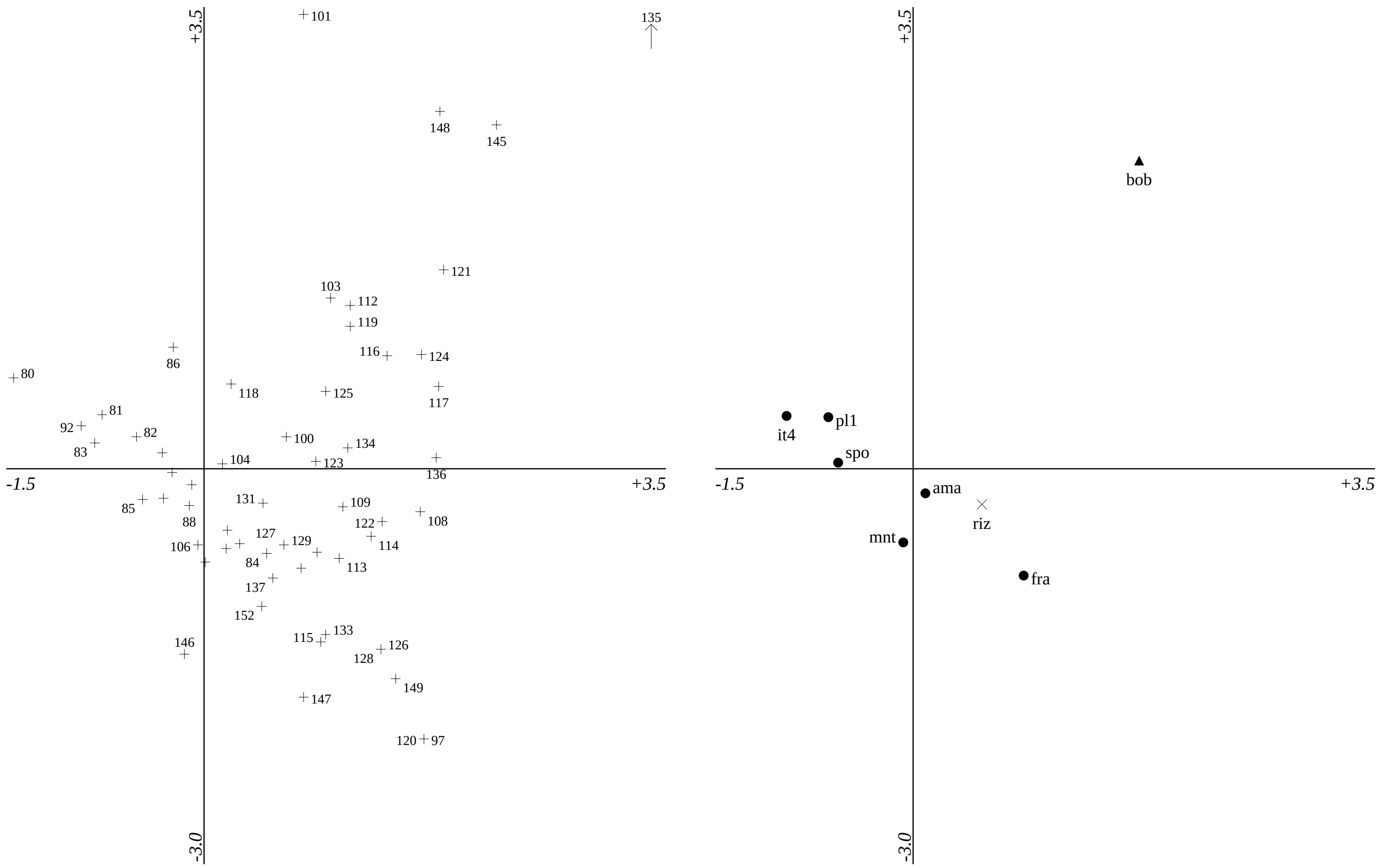


Figure 8.30: Cumulative percentage graphs of hoards in data set `fin80.dat`. Dotted and dashed lines as marked.



(a) Species map: data points are years. Year 135 lies at 3.4, 5.88.

(b) Sample map: data points are hoards. ● Italy; ▲ Romania; × unknown, probably Italy.

Figure 8.31: Maps from CA of data set `fin80.dat` omitting JUA as discussed in section 8.3.7. First (horizontal) and second principal axes of inertia.

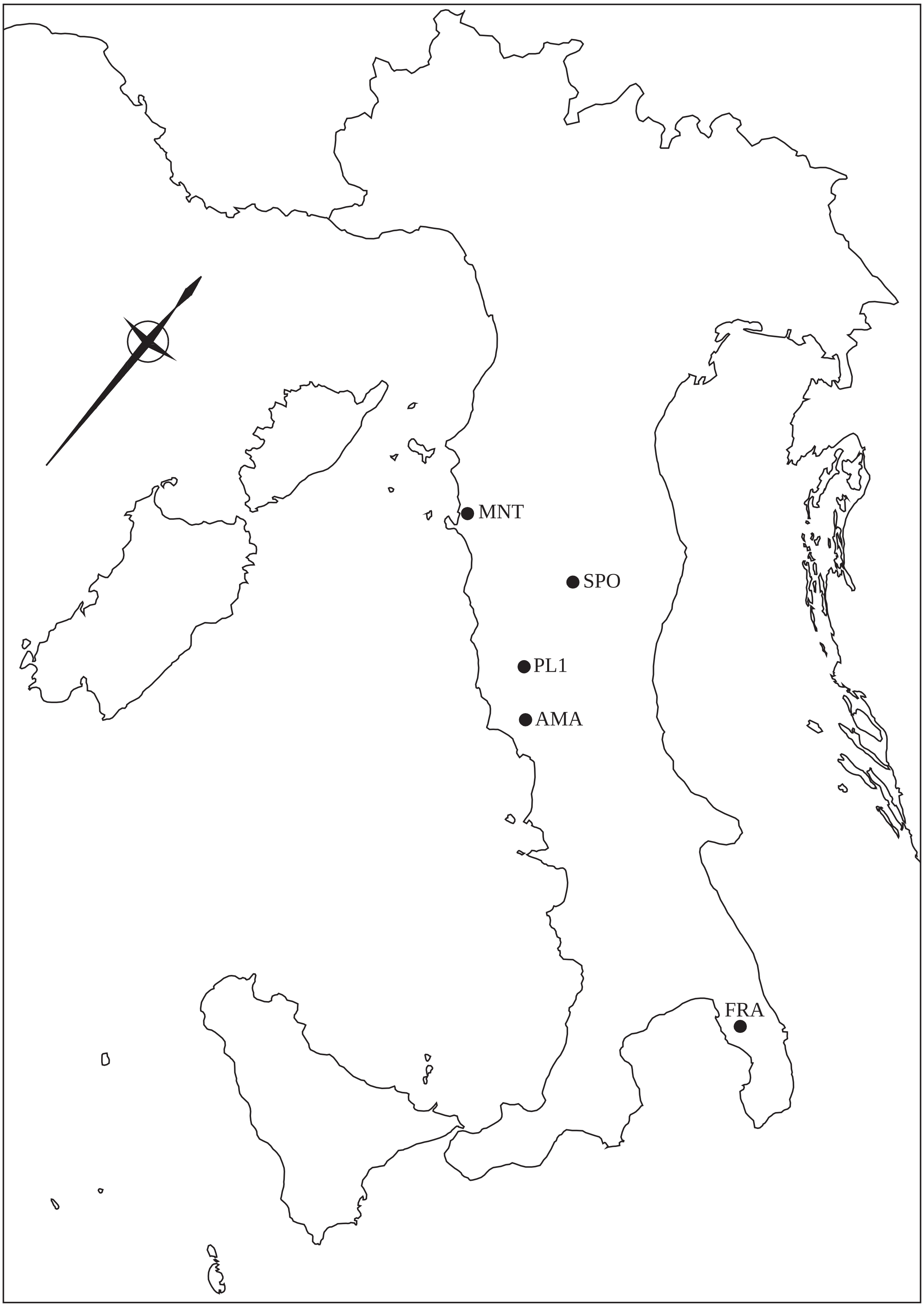


Figure 8.32: Location map of Italian hoards in data set `fin80.dat`.

accounted for so much of the variation in previous data sets now all lie near the origin of the map (Fig. 8.31a) suggesting that their distribution in the global coinage pool is now much more even.

Only five of the Italian hoards have secure locations. This is too few to draw definite conclusions but it is suggestive that the most modern of these (PL1) lies closest to Rome, the most archaic (FRA) furthest from Rome (Fig. 8.32).

8.3.8 Hoards closing 78–75 BC

Data set `fin78.dat` contained 13 hoards closing in 78–75 BC (Table 8.11). They contained 704 *denarii*. Years 211–158 formed 2% of the data set and were omitted from the CA. Fig. 8.33 is the cumulative percentage graph of this data; Fig. 8.34 presents the maps from CA.

This data set has a very small number of *denarii* despite containing 13 hoards. This leads to a sparse matrix in which 56% of cells have a zero entry. Fig. 8.33 shows that all the 13 hoards have a very similar curve, especially in comparison to Figs. 8.30 and 8.26. This similarity is all the more remarkable when the small sample sizes are taken into account. However, within this, there does appear to be a tendency for Romanian hoards to have a slightly archaic profile, and other non-Italian hoards to have a slightly more modern profile.

The species map (Fig. 8.34a) shows a wide spread of years. There is a general concentration of years nearer to the origin with a cloud of outliers. Comparing this to the sample map (Fig. 8.34b) and the database we can see that most of these outliers are rare or unique years. For example, years 135 and 141 only occur in Cornetu (COR), 140 in Mihai Bravu (MBR), 117 in Zătreni (ZAT), 151 in San Mango (MAN) *etc.* The application of a significance test to the first two axes results in both *not* being significant at the 0.05 level.[26] This leads one to consider this analysis as showing nothing more than random variations in a sparse data set. However, the sample map (Fig. 8.34b) does show grouping in the hoards according to findspot as was suggested by Fig. 8.33. We must, therefore, conclude that although the axes are dominated by rare years, the position of the hoards, generally much nearer the origin than the species, reflects broader similarities between hoards, and that the Romanian hoards are generally more similar to each other than to most other Italian hoards, and *vice versa*. The over-riding impression is, however, of remarkable homogeneity.

It is noteworthy that in both this, and the previous data set, year 135 *only* occurs in Romanian hoards.[27] In the next data set there are only two small Romanian hoards, neither with a coin of 135. Also, there are many large hoards Italian hoards. However, of those hoards in the next data set which do have coins of 135, only one has more than 1%.[28]

8.3.9 Hoards closing in 74 BC

Data set `fin74.dat` contained 22 hoards closing 74 BC (Table 8.12). They contained 6716 *denarii*. Years 211–158 formed 1.64% of the data set and were omitted from the CA. Fig. 8.35

[26] $\chi^2 = \lambda \times n$. In this case $n = 690$. First axis $\lambda = 0.158$ therefore $\chi^2 = 109$. Second axis $\lambda = 0.147$ therefore $\chi^2 = 101$. Critical value at the 0.05 level for a 13×68 table is > 147.9, the critical value for $p = 10; \nu = 70; \alpha = 0.05$.

[27] BOB: 2 coins, 4.9%; COR: 3 coins, 2.3%.

[28] BDR: 1 coin, 1.5%.

code	hoard	country	'end date'	'good total'
ADM	Alba di Massa	Italy	77	82
ALX	Alexandria	Romania	77	32
COR	Cornetu (Căpreni)	Romania	75	128
INU	Inuri	Romania	77	37
ION	Montalbano Ionico	Italy	75	45
KER	Kerassia	Greece	78	47
MAL	Maluenda	Spain	78	32
MAN	San Mango sul Calore	Italy	75	81
MBR	Mihai Bravu	Romania	75	56
NER	Neresine, Lussino Island	Yugoslavia	78	42
NOY	Noyer	France	78	51
RAN	Randazzo	Sicily	77	30
ZAT	Zătreni	Romania	75	41

Table 8.11: Details of hoards in data set `fin78.dat` used in CA discussed in section 8.3.8.

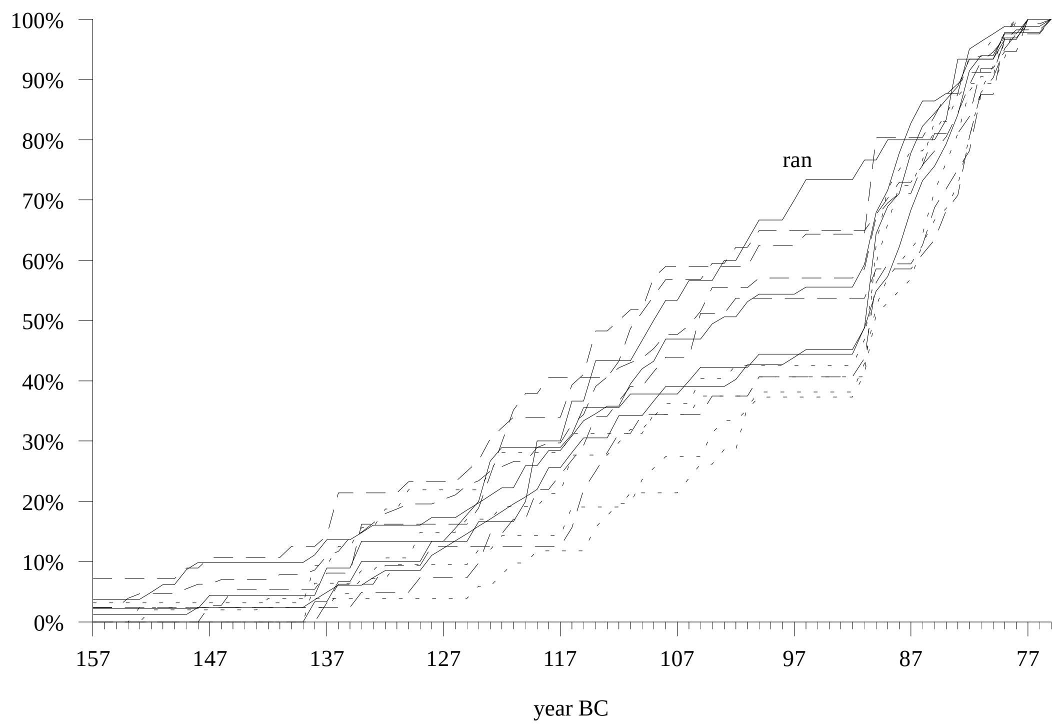
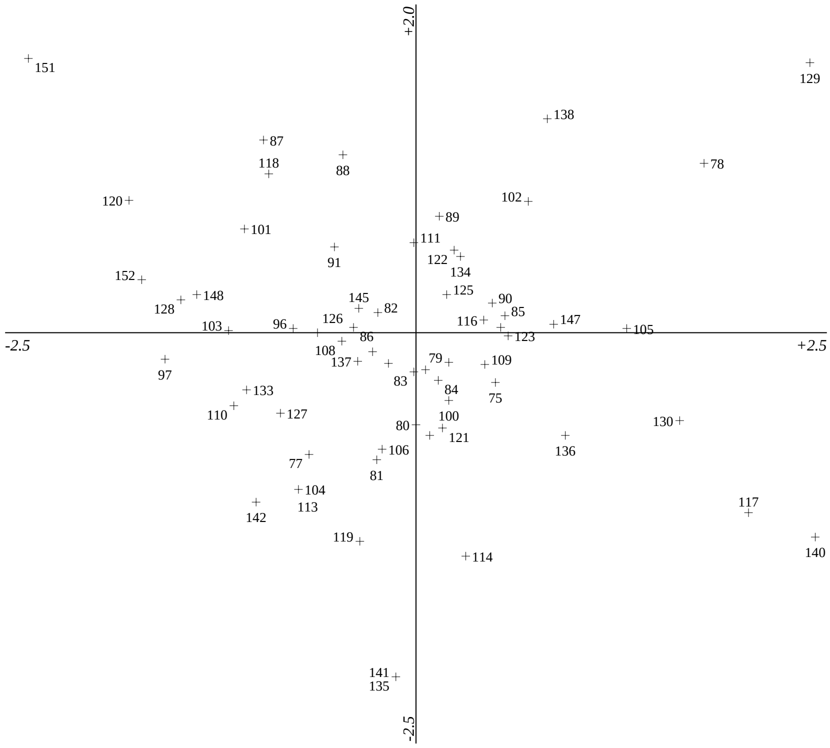
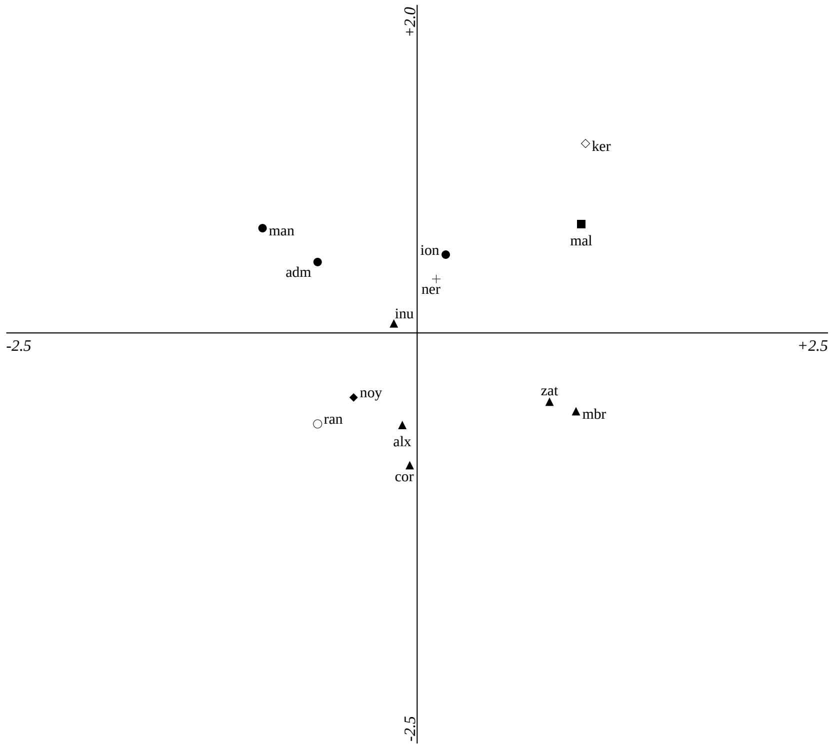


Figure 8.33: Cumulative percentage graph of hoards in data set `fin78.dat`. Solid lines: Italy; dashed lines: Romania; dotted lines: other.



(a) Species map: data points are years.



(b) Sample map: data points are hoards. ● Italy; ○ Sicily; ■ Spain; ▲ Romania; ⧫ France; ◊ Greece; + Yugoslavia.

Figure 8.34: Maps from CA of data set `fin78.dat` discussed in section 8.3.8. First (horizontal) and second principal axes of inertia.

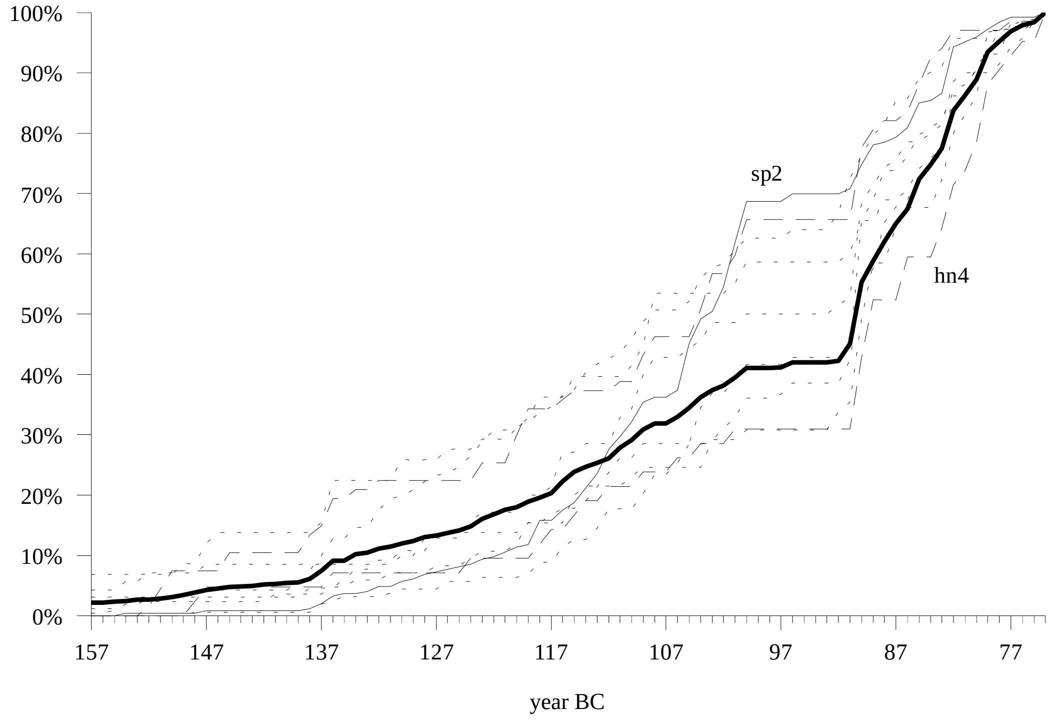
code	hoard	country	'end date'	'good total'
BDR	Barranco de Romero	Spain	74	65
CAB	Cabeça da Corte	Portugal	74	158
CDR	Castro de Romariz	Portugal	74	70
COS	Cosa	Italy	74	1999
CTR	Canturato	Italy	74	50
HN4	Hunedoara IV	Romania	74	42
IT2	'Italy'	Italy	74	47
JDI	Jdioara	Romania	74	67
LIC	Licodia	Sicily	74	120
MAC	Maccarese	Italy	74	1212
MAR	Rio Marina	Elba	74	43
ORI	Oristà	Spain	74	58
PEY	Peyriac-sur-Mer	France	74	91
PIC	Potenza Picena	Italy	74	439
PL2	Palestrina	Italy	74	357
PON	Pontecorvo	Italy	74	942
POO	Poio	Portugal	74	211
RIG	Rignano	Italy	74	92
SMB	Las Somblancas	Spain	74	84
SP2	'Spain'	Spain	74	246
SUC	Sučurac	Yugoslavia	74	165
TUF	Tufara	Italy	74	158

Table 8.12: Hoards in data set `fin74.dat` used in CA discussed in section 8.3.9.

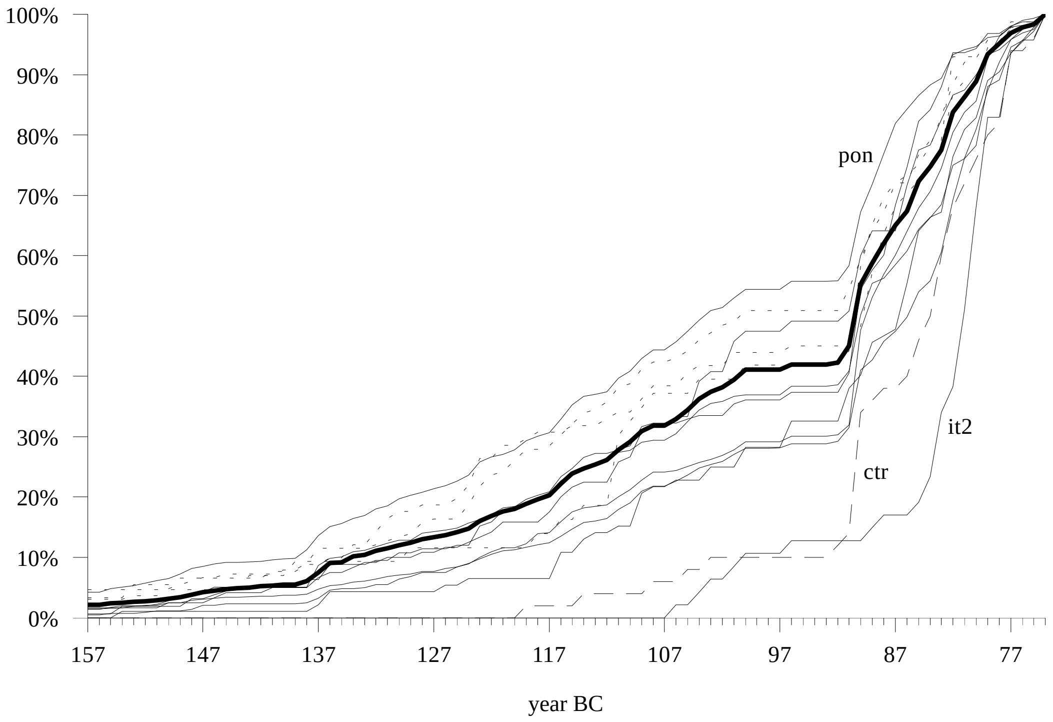
presents cumulative percentage graphs. In both the Cosa hoard is shown as a thicker line to act as a visual 'anchor' between the two graphs. Figs. 8.36–8.37 are the maps from CA.

The species map (Fig. 8.36a) shows years 86–74 have positive scores on the first axis. Years 157–100 mainly have negative scores on this axis with the 130s and 120s BC having more extreme values. The sample map (Fig. 8.36b) shows 'Italy' (IT2) and Canturato (CTR) at the positive end of the first axis, and Poio (POO), Jdioara (JDI) and 'Spain' (SP2) at the negative end. The 'Italy' hoard appears to be an outlier from the main group. An examination of Fig. 8.35 shows this hoard to have an exceptionally modern age profile. Unusually, it has a steeply rising curve from the mid-80s BC.

Comparing the other hoards in sample map (Fig. 8.36b) with Fig. 8.35 shows that a hoard's position on the first axis generally reflects its age profile. The first axis therefore represents the type of gradient encountered before, contrasting hoards with an archaic or modern structure. Comparing the relative positions of hoards in the sample map 8.36b and 8.35 to Cosa (COS), we can see that there is a moderate tendency for Italian hoards to be more modern than Cosa (six to three) and for non-Italian hoards to be more archaic (three to nine). However, the degree of 'archaicness' or 'modernity' is not large compared to, for example, Fig. 8.26. Eight of the ten Italian/Sicilian hoards have remarkably similar structures. Pontecorvo (PON) is the most archaic, and Canturato, a small hoard, is modern. The hoards from Elba, France and Yugoslavia (dotted lines, MAR, PEY & SUC) are archaic compared to Cosa. Hoards from Spain, Portugal and Romania are either similar to, or more archaic than the Italian material. There is no trend for the Portuguese material to be

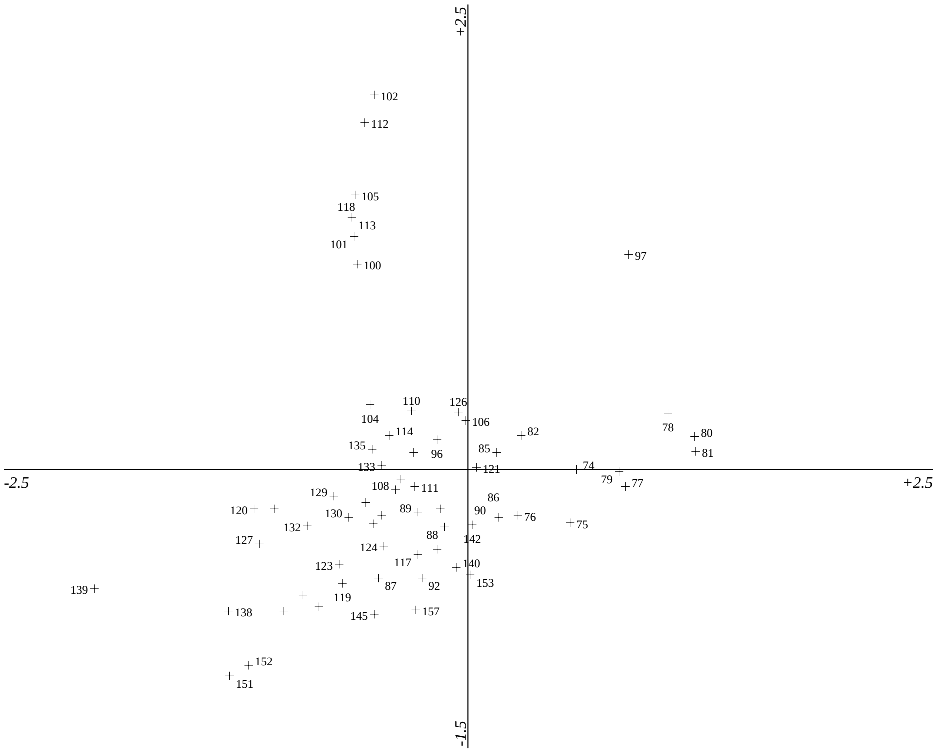


(a) Thick solid line: Cosa hoard; dotted lines Iberian peninsula (except SP2); thin solid line: SP2; dashed lines: Romania.

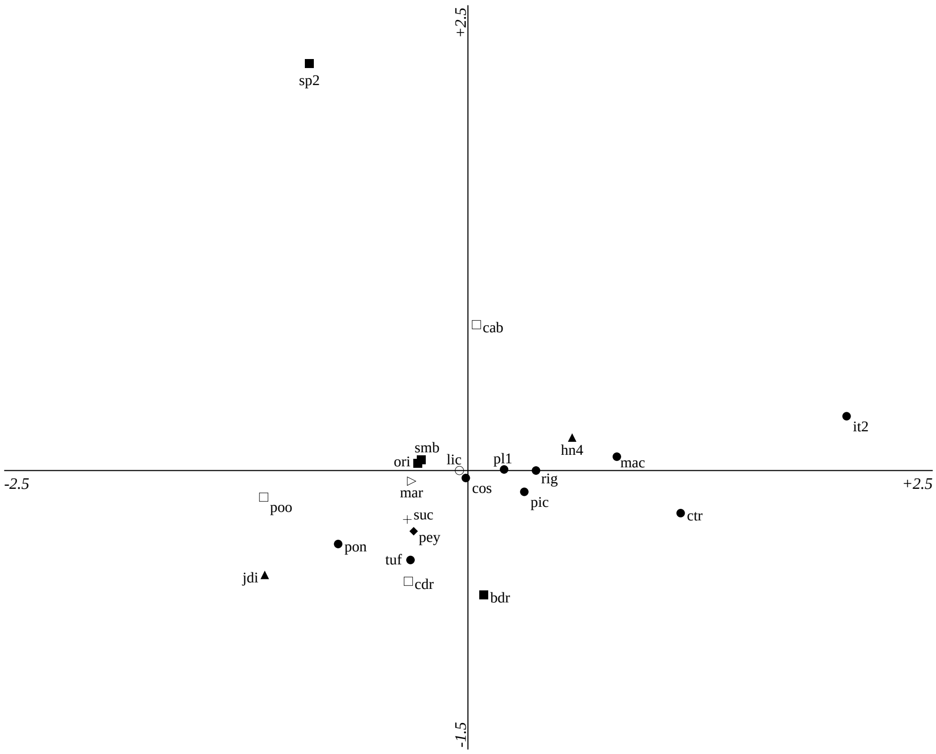


(b) Thick solid line: Cosa hoard; solid lines Italy (except CTR); dashed line: CTR; dotted lines: France, Elba and Yugoslavia.

Figure 8.35: Cumulative percentage graphs of hoards in data set `fin74.dat`.

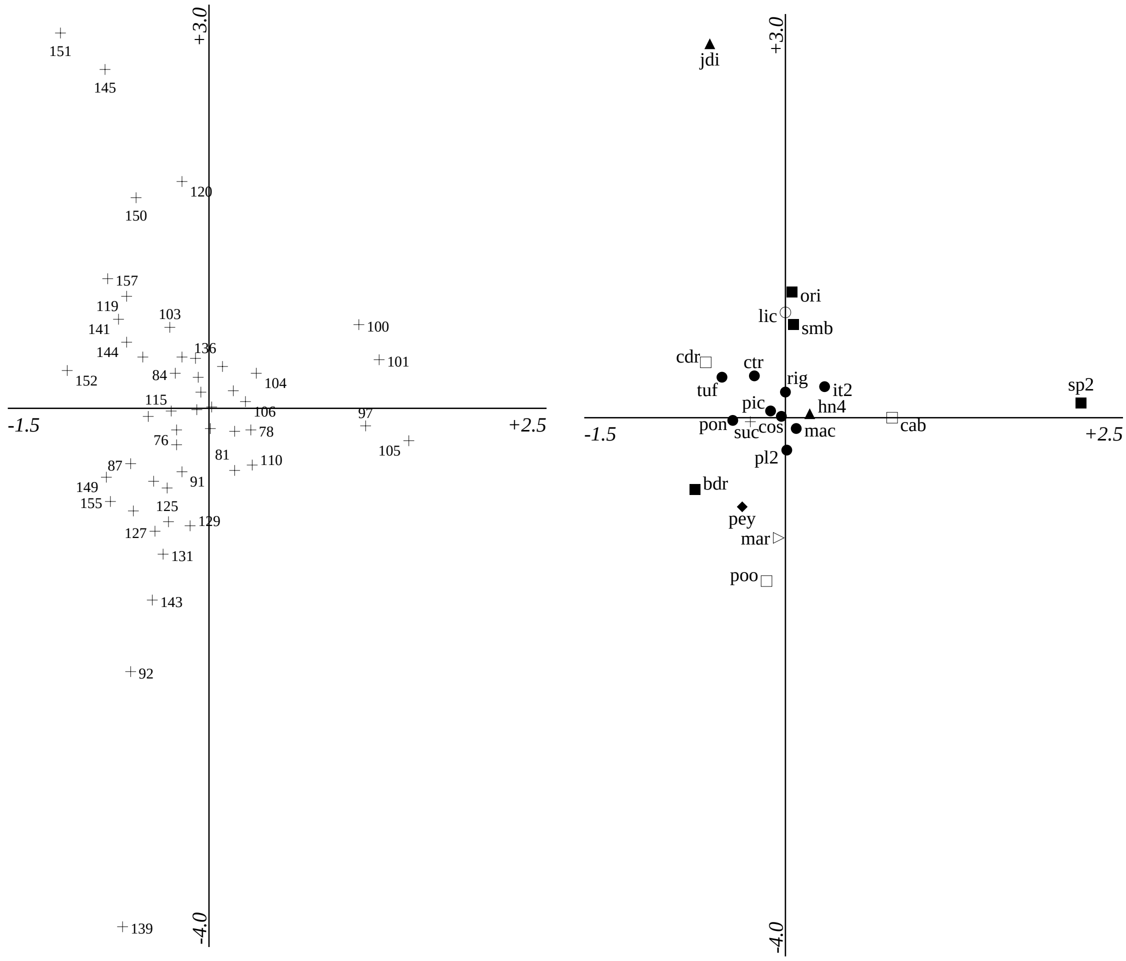


(a) Species map: data points are years.



(b) Sample map: data points are hoards. ● Italy; ○ Sicily; ■ Spain; □ Portugal; ▲ Romania; ⧫ France; + Yugoslavia; ▷ Elba.

Figure 8.36: Maps from CA of data set `fin74.dat` discussed in section 8.3.9. First (horizontal) and second principal axes of inertia.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ○ Sicily; ■ Spain; □ Portugal; ▲ Romania; ◆ France; + Yugoslavia; ▷ Elba.

Figure 8.37: Maps from CA of data set `fin74.dat`. Second (horizontal) and third principal axes of inertia.

more archaic than the Spanish. From Romania, Hunedoara IV (HN4) is very similar to the Italian material; Jdioara (JDI, Fig. 8.35a dashed line) is archaic.

The second axis is dominated by 8 years at its positive end (Fig. 8.36a). The sample map suggests that these years are associated with the hoard 'Spain' (SP2). They account for 36.6% of this hoard compared to 17.7% for Cabeça da Corte, 7.3% for Cosa and 4.7% for Maccarese (CAB, COS & MAC). This hoard is clearly exceptional. Fig. 8.35 shows this hoard's age profile cutting across all the others between 118 and 97 BC. The second axis can therefore be said to be representing the oddity of one hoard, 'Spain.'

The 'Italy' hoard was thought to be abnormal on the basis of the diversity analysis performed in Lockyear (1992, pp. 54–59). The critique of the type of diversity analysis used (Ringrose 1993) led to the abandonment of this method. The 'Italy' and 'Spain' hoards are suspect and it is likely that their exceptional structure is a result of unknown post-recovery factors.

An examination of the third axis results in the archaic nature of the Jdioara hoard being highlighted (Fig. 8.37). Also, all nine Italian hoards cluster tightly in the center of the plot along with Hunedoara and Sučarac (HN4 & SUC). Further CAs omitting hoards such as ‘Spain’ and Jdioara did not reveal any further patterning. It is a feature of CA of hoards that when they are very similar with no systematic patterning, an axis will tend to highlight a single hoard for minor differences. The second axis tends to highlight another, and so on. Removal of a hoard from the data set and re-running CA results in the axes being ‘promoted’, *i.e.*, the hoard highlighted in the second axis originally is now highlighted on the first and so on — see page 263.

Summary

All the hoards appear remarkably similar with the exception of about three hoards. Two of these appear unreliable, (‘odd’), and are unprovenanced: ‘Italy’ and ‘Spain’ (IT2 & SP2). The remaining hoard (CTR) is small and not exceptionally odd. Italian hoards are generally very similar with generally more modern age profiles than elsewhere. Iberian peninsula hoards are more varied, but with little relation to geographical position. One Romanian hoard (JDI) is the most archaic, but not exceptionally so. Hunedoara is very similar to Italian hoards.

8.3.10 Hoards closing 72–69 BC

Data set `fin72.dat` contained seven hoards closing in 72–69 BC (Table 8.13). They contained 2764 *denarii*. Years 211–158 formed 2% of the data set and were passive in the CA. Fig. 8.38 is the cumulative percentage graph of this data; Fig. 8.39 presents the maps from CA.

Fig. 8.38 shows a remarkably homogeneous set of curves for this data set. Only the Tolfa hoard (TOL) stands out as having a comparatively ‘modern’ age profile despite closing at the start of the date range covered. The most archaic hoard is also an Italian one, Policoro (PLC). The Romanian and Spanish hoards are in the middle ground.

Only the first axis of inertia from CA was significant.[29] The species map (Fig. 8.39a) shows an unstructured cloud of points. It is very difficult to see any clear pattern but there may be a tendency for years in the 80s to occur to the right of the axis. The sample map (Fig. 8.39b) shows the most ‘modern’ hoard on the right, and the most archaic hoard on the left. This order *is not* a result of the closing dates of the hoards. Tincova (TIN), the only hoard closing in 69 BC, has a middle position. Policoro and Tolfa, the most archaic and modern hoards, both close in 72 BC.

The remarkable feature of this set of hoards is their similarity despite the fact that they were deposited at opposite ends of Europe.

8.3.11 Hoards closing 63–56 BC

Data set `fin63.dat` contained 13 hoards closing 63–56 BC (Table 8.14). They contained 7257 *denarii*. Years 211–158 formed 0.44% of the data set and were omitted from the CA. Fig. 8.40 presents two cumulative percentage graphs; Fig. 8.41 presents the maps from CA.

[29] $\chi^2 = \lambda \times n$. In this case $n = 2709$. First axis: $\chi^2 = 2709 \times 0.078 = 211.3$; second axis: $\chi^2 = 2709 \times 0.045 = 121.9$; critical value for a 7×79 table $135.4 (\alpha = 0.05)$; or $\approx 130.6 (\alpha = 0.1)$. Therefore first axis significant, second axis not significant at the 0.05 or 0.1 levels.

code	hoard	country	'end date'	'good total'
EMP	Alt Empordà	Spain	71	1122
OSS	Ossero	Italy	72	465
PLC	Policoro	Italy	72	302
SFI	Sfinţeşti	Romania	71	91
TIN	Tincova	Romania	69	135
TOL	Tolfa	Italy	72	238
VPT	Villa Potenza	Italy	71	411

Table 8.13: Hoards in data set `fin72.dat` used in CA discussed in section 8.3.10.

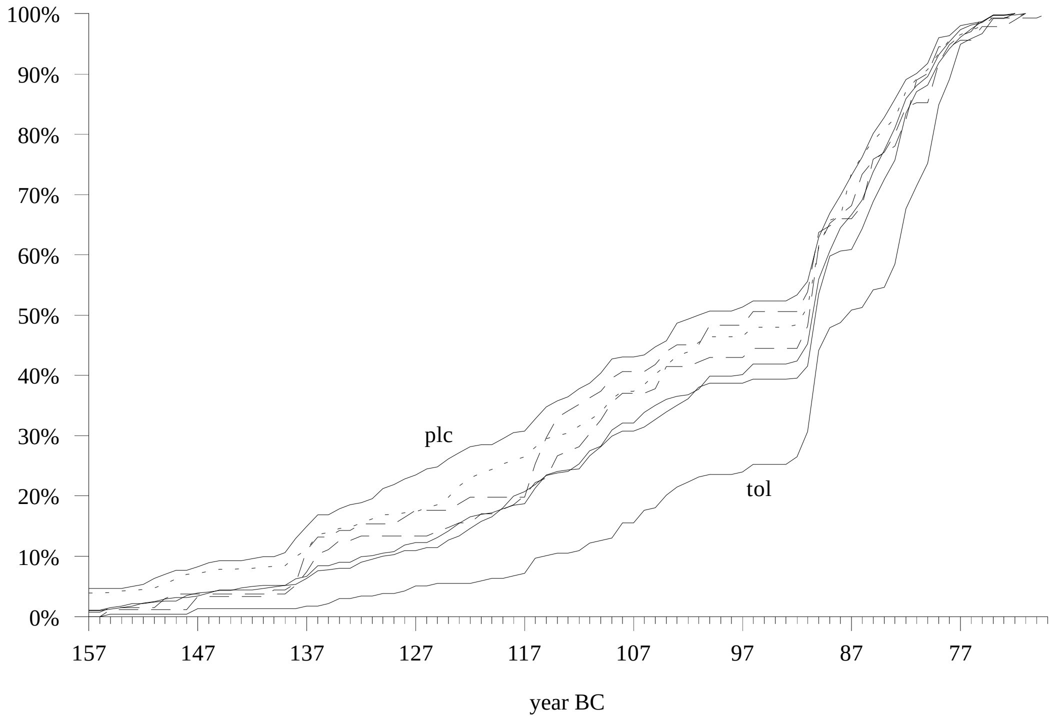
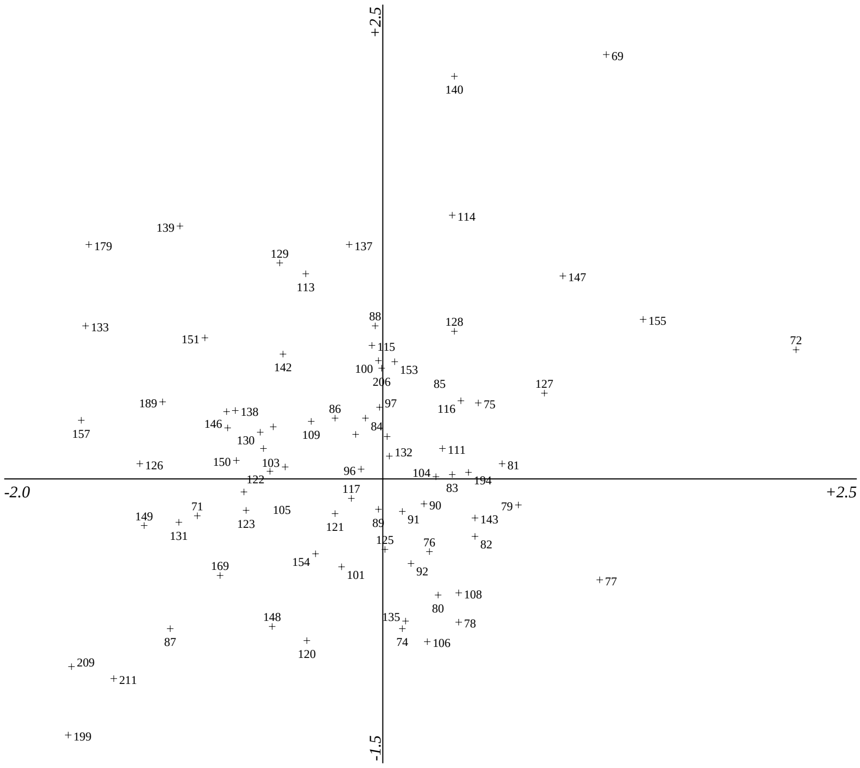
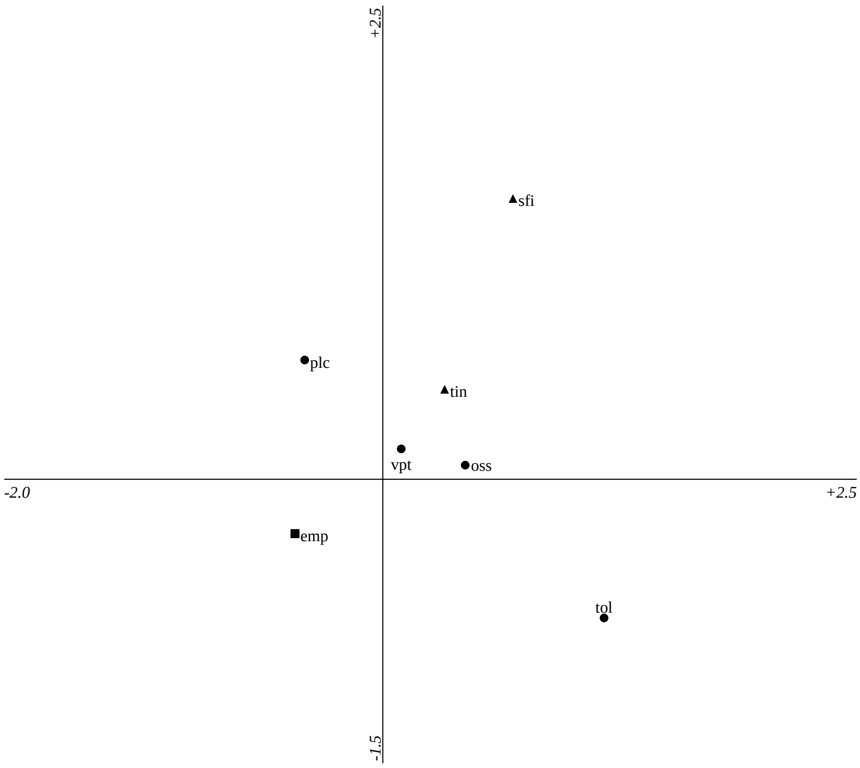


Figure 8.38: Cumulative percentage graphs of hoards in data set `fin72.dat`. Solid lines: Italy; dotted line: Spain; dashed lines: Romania.



(a) Species map: data points are years.



(b) Sample map: Data points are hoards. ● Italy; ■ Spain; ▲ Romania.

Figure 8.39: Maps from CA of data set `fin72.dat` discussed in section 8.3.10. First (horizontal) and second principal axes of inertia.

code	hoard	country	'end date'	'good total'
ALN	Alungeni	Romania	59	32
AMN	Amnaş†	Romania	56	155
BAZ	Baziaş	Romania	63	36
BON	Bonţeşti	Romania	62	36
DUN	Dunăreni†	Romania	56	128
FND	Frauendorf†	Romania	56	563
ICN	Icland†	Romania	56	33
KAV	Kavalla	Greece	58	59
LCR	Licuriciu	Romania	62	63
MES	Mesagne	Italy	58	5940
SMC	Somesul Cald†	Romania	56	115
STN	Stăncuţa	Romania	63	34
SUS	Sustinenza†	Italy	56	63

Table 8.14: Hoards in data set `fin63.dat` used in CA discussed in section 8.3.11. † Also occurs in data set `fin56.dat`.

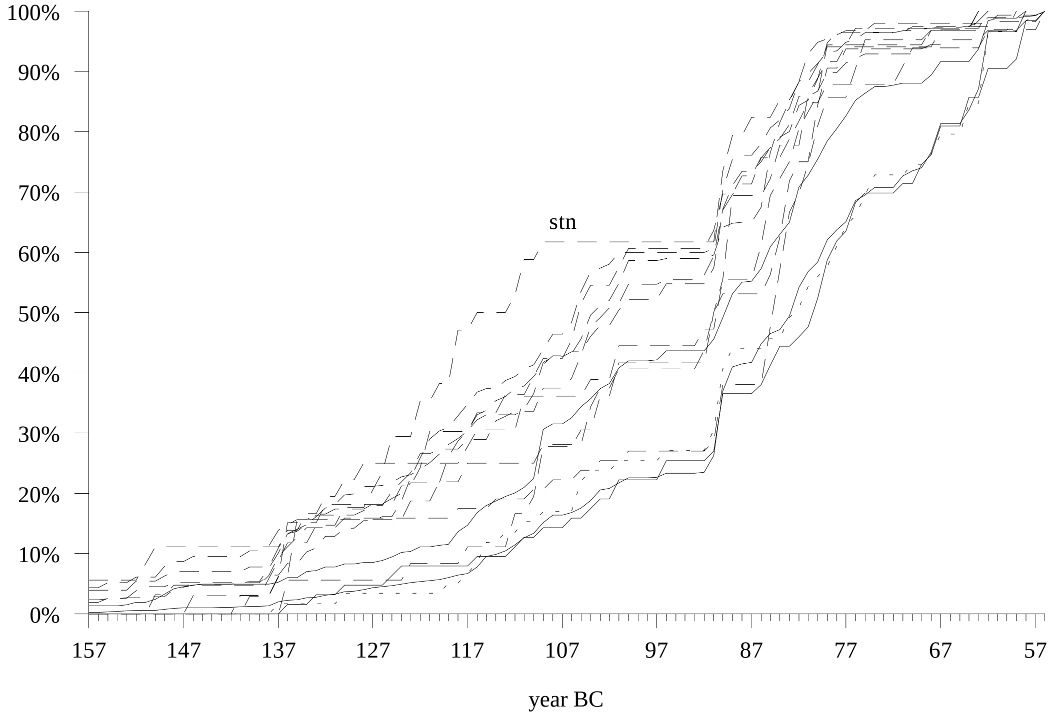
The maps from the first CA were dominated by 59 BC (not presented). This is a rare year with only two coins, one each in Alungeni and Sustinenza (ALN & SUS). As both hoards are quite small these coins formed a significant proportion of the hoard, and thus dominated the second axis of inertia. A second CA was therefore performed omitting 59 BC.

Examining the sample map from the second analysis (Fig. 8.41b) two points are clear. Firstly, whilst the Italian and Greek hoards all cluster around the origin, the Romanian hoards all have positive scores on the first axis. Secondly, the Romanian hoards are widely spread on the second axis. The positions of Mesagne, Sustinenza and Kavalla (MES, SUS, & KAV) suggest they should all be very similar. The species map (Fig. 8.41a) shows all years from 79–67 BC having negative scores on the first axis as well as many other years from 65 BC onwards, and from the 90s and 80s BC. Fig. 8.40 shows that these three hoards have the majority of the coins from this period, whereas all the Romanian hoards have an archaic structure and relatively few coins from 77 BC onwards. Thus the first axis represents archaic *v.* modern hoards with all the Romanian hoards being classified as archaic.

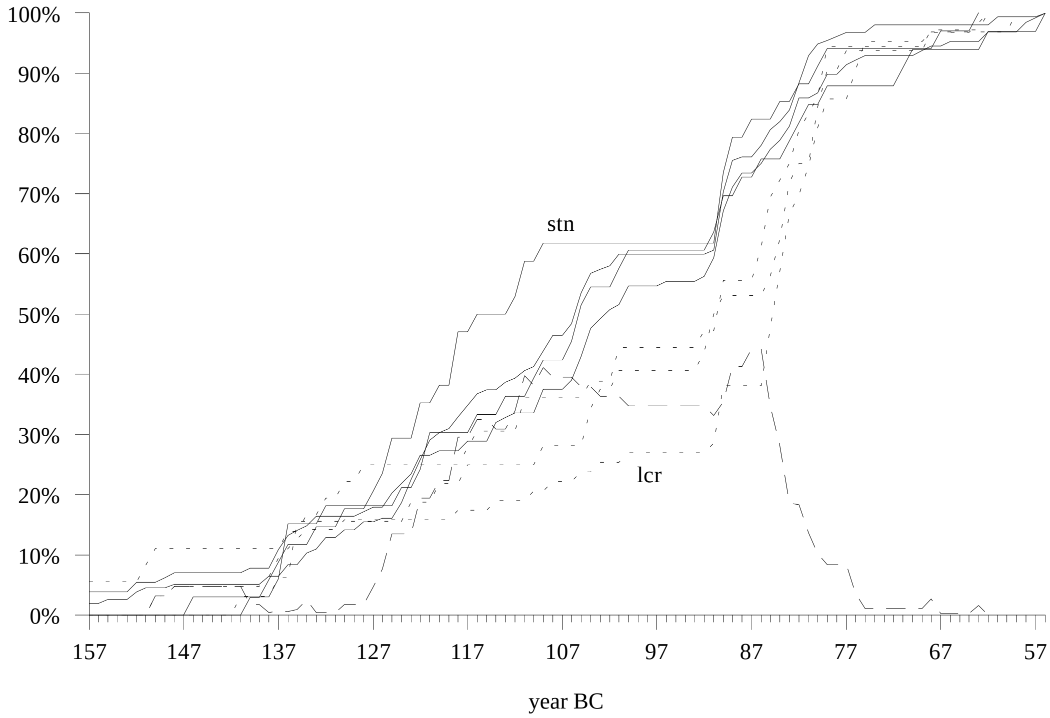
The position of Mesagne at the origin of Fig. 8.41b is due to its size, 5940 *denarii*, 82% of the data set. This has the effect, in CA, that all other hoards are placed in relation to Mesagne as that hoard will be the dominant contributor to the average row and column profiles.

The position of years 57 and 56 on the species map (Fig. 8.41a), in a area mainly associated with older species, is due to Mesagne closing in 58 BC whereas five Romanian hoards close in 56 BC. Two species have extreme positions. There is only one coin from 66 BC in the data set from the Dunăreni hoard which accounts for its extreme position. Only six coins date to 150 BC, but whereas the two coins in the Mesagne hoard form only 0.04% of the hoard, the two from Licuruciu form 3.18%, again resulting in its extreme co-ordinates.

In order to understand the second axis, seven Romanian hoards were plotted as a cumulative percentage graph (Fig. 8.40b). Licuriciu, Alungeni and Bonţeşti (LCR, ALN & BON) can be seen to have relatively modern profiles compared to Stăncuţa, Dunăreni, Amnaş and Icland (STN, DUN,

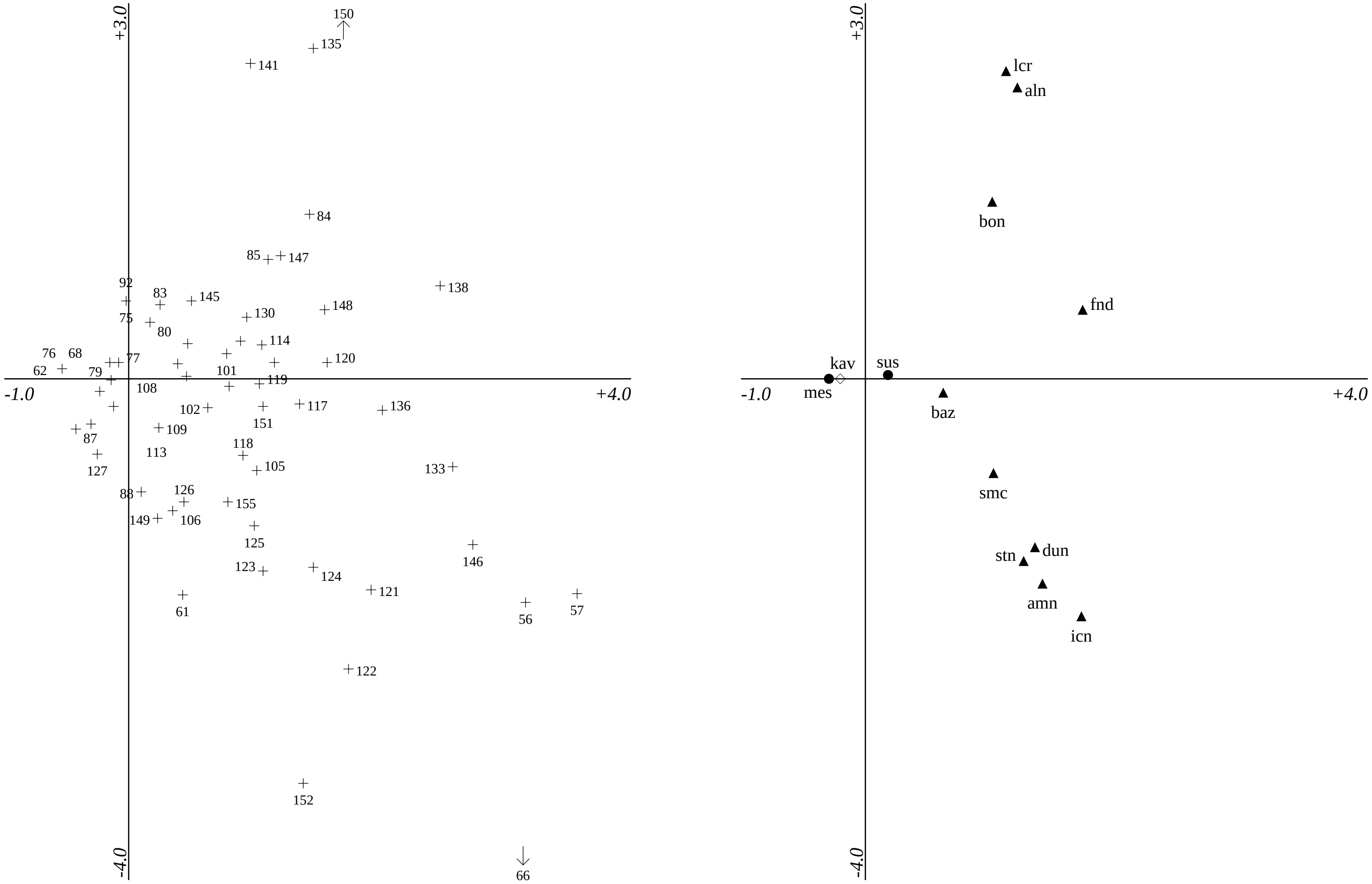


(a) All hoards. Solid lines: Italy; dotted line: Greece; dashed lines: Romania.



(b) Romanian hoards. Solid lines: STN, AMN, DUN & ICN; dotted lines: LCR, ALN & BON; dashed line: difference between Stancuta and Licuriciu (STN & LCR).

Figure 8.40: Cumulative percentage graphs of hoards in data set `fin63.dat`.



(a) Species map: data points are years. Species (years) 66 and 150 at 3.13, -5.83 and 1.7, 4.99 respectively.

(b) Sample map: data points are hoards. ● Italy; ▲ Romania; ◊ Greece.

Figure 8.41: Maps from CA of data set `fin63.dat` discussed in section 8.3.11. First (horizontal) and second principal axes of inertia.

AMN & ICN). The dashed line in Fig. 8.40b marks the difference between the cumulative curves for Stăncuţa and Licuriciu. Where the line falls sharply indicates years particularly associated with Licuriciu and the 'modern' hoards; *i.e.*, 85, 84 and 83 BC. Stăncuţa, in comparison, has relatively more coins where the line rises; *i.e.*, years 127–110 BC. For the other archaic hoards this rise is more spread out over years 127–*c.* 100 BC. The species map (Fig. 8.41a) reflects this. Although Stăncuţa is the most archaic hoard, it does not occupy an extreme position in the sample map (Fig. 8.41b) due to its early closing date of 63 BC.

The second axis therefore represents an archaic-modern hoard gradient within the Romanian material with years 85–3 BC being a prime cause of this gradient.[30]

Finally, it had been noted in section 8.3.8 that hoards from Romania contained more coins than might be expected of 135 BC. In this data set there are 14 coins of this year, 8 from Romanian hoards and 6 from Mesagne. However, the coins form only 0.1% of Mesagne whereas they form between 0 and 1.6% of all but one Romanian hoard; for Alungeni they form 9.4% (3 coins).

Summary

The Italian and Greek hoards are all very similar. They differ from the Romanian material in having many more coins from *c.* 80 BC onwards. The Romanian hoards are archaic compared to others, but within them there is a gradient from archaic to modern partly as a result of the uneven distribution of coins of 85–83 BC. There may be more coins of 135 BC in Romanian hoards than would be expected.

8.3.12 Hoards closing 56–54 BC

Data set `fin56.dat` contained 14 hoards closing 56–54 BC (Table 8.15). They contained 2613 *denarii*. Years 211–158 formed 1.2% of the data set and were omitted from the CA. Fig. 8.42 is the cumulative percentage graph; Fig. 8.43 presents the maps from this analysis.

The Ancona hoard (AN1) has no coinage of pre-109 which gives it a very modern structure. However, its profile is quite odd. As noted above (section 8.3.5 and footnote 22, page 182), this hoard has data quality problems and it has been omitted from Fig. 8.42. Removing the hoard from the CA had little effect on the overall result.

The sample map (Fig. 8.43b) reveals a bipartite split in the data with Romanian/Bulgarian hoards having negative scores on the first axis, and Italian/Greek hoards having positive scores. The species map (Fig. 8.43a) reveals most years post-80 BC also having a positive score. Thus the first axis again represents archaic *v.* modern. It is also a continuation of the pattern seen previously with Romanian, and now Bulgarian, hoards having an archaic structure when compared to elsewhere. This can also be seen in the line graph (Fig. 8.42).

The second axis of inertia (Fig. 8.43a) is dominated by some of the newest years at the positive end (66, 54, 55, 70, 57, 61, 67 *etc.*), and a mixture of new and old years at its negative end. This axis spreads out the years with a positive score on the first axis, but does not do so to the years with

[30] Years 85–3 as percentage of total: STN: 2.9%; ICN: 3.0%; SMC: 4.3%; AMN: 5.8%; DUN: 6.3%; BAZ: 8.3%; BON: 13.9%; FND: 17.6%; ALN: 18.8 %; LCR: 28.6%.

code	hoard	country	'end date'	'good total'
AMN	Amnaş†	Romania	56	155
AN1	Ancona	Italy	55	42
BUZ	Buzău	Romania	54	48
CLN	Călineşti	Romania	54	92
COM	Compito	Italy	55	929
DUN	Dunăreni†	Romania	56	128
FND	Frauendorf†	Romania	56	563
GRA	Grazzanise	Italy	54	256
ICN	Icland†	Romania	56	33
KAR	Karavelovo	Bulgaria	54	35
SDS	Sălaşul de Sus	Romania	54	103
SMC	Somesul Cald†	Romania	56	115
SUS	Sustinenza†	Italy	56	63
THS	Thessalonica	Greece	54	51

Table 8.15: Hoards in data set `fin56.dat` used in CA discussed in section 8.3.12. † Also occurs in data set `fin63.dat`.

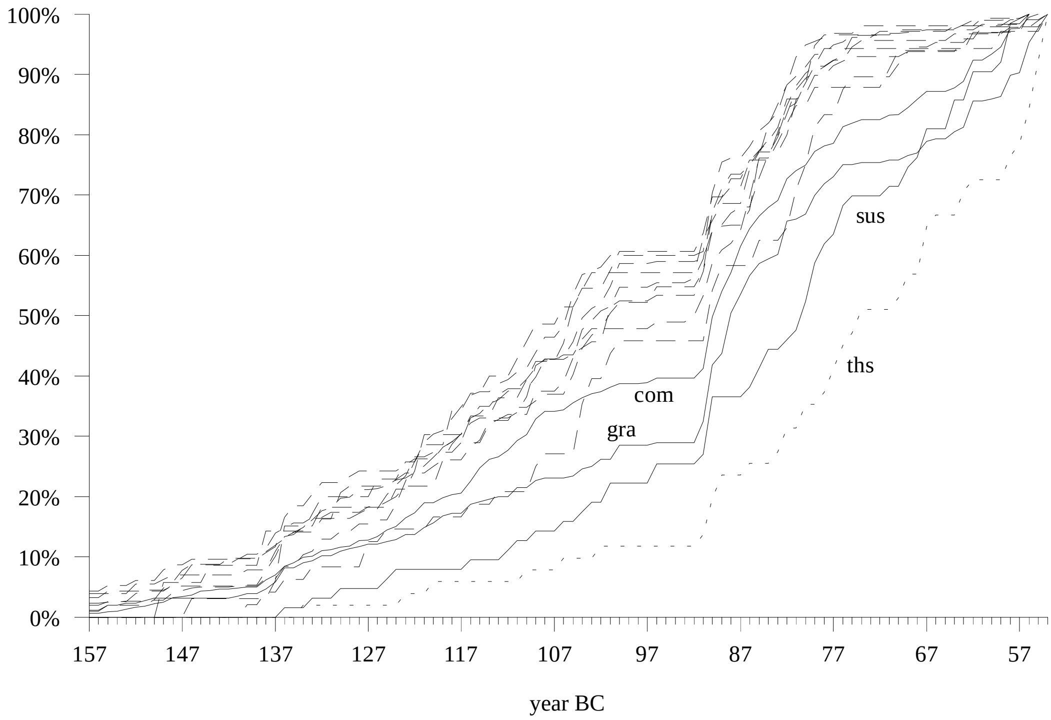
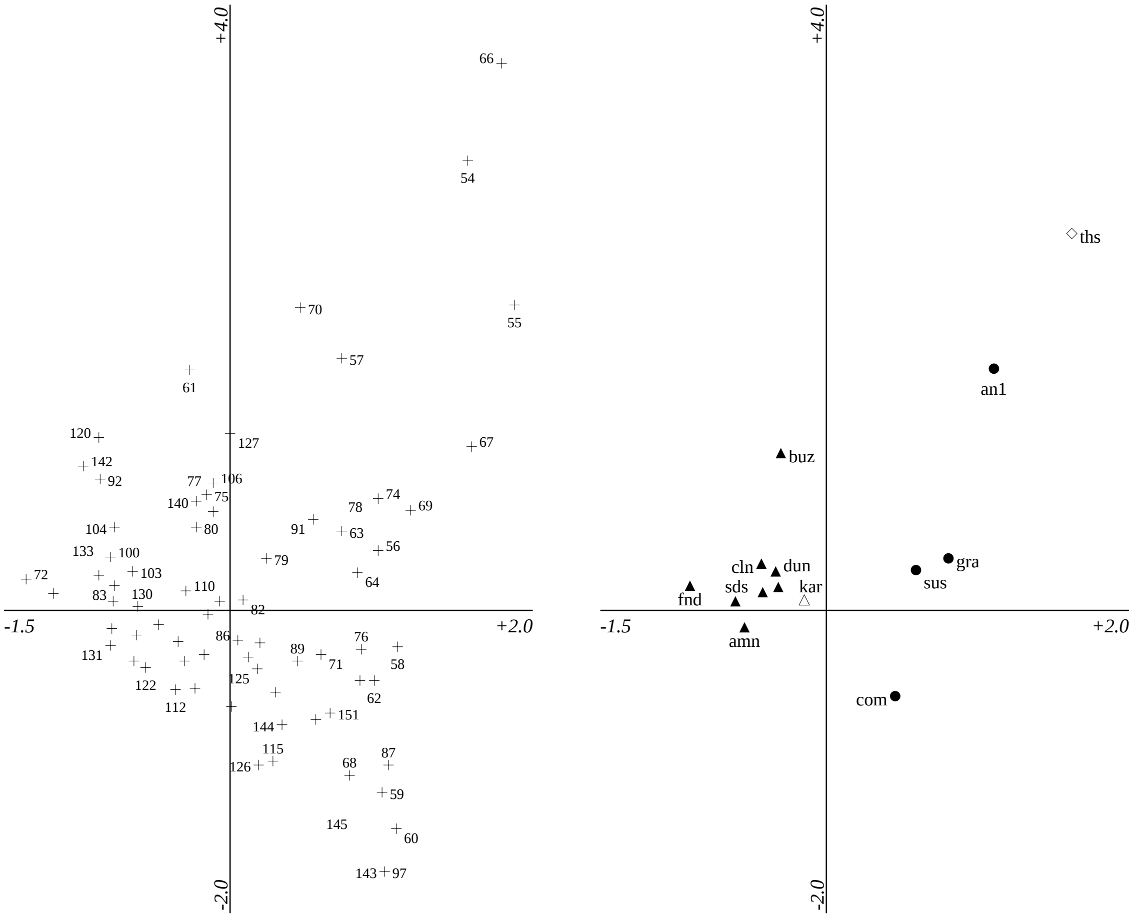


Figure 8.42: Cumulative percentage graphs of hoards in data set `fin56.dat`. Solid lines: Italy; dotted line: Greece; dashed lines: Romania and Bulgaria. NB: Ancona not plotted — see text.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ▲ Romania; △ Bulgaria; ◊ Greece.

Figure 8.43: Maps from CA of data set `fin56.dat` discussed in section 8.3.12. First (horizontal) and second principal axes of inertia.

a negative score on that axis. This is reflected in the sample map (Fig. 8.43b). The second axis therefore shows a modern–archaic gradient amongst the Italian and Greek hoards. It shows that Thessalonica (THS) has a highly modern profile within the Italian/Greek hoards, and comparatively, Compito (COM) has an archaic profile. This is a similar pattern to that revealed by the previous data set except that in this case it is the Romanian hoards which are highly similar.

The position of Buzău (BUZ) on the sample map reflects the fact that it is the least archaic of the Romanian hoards, but it still has relatively few coins of post-80 BC compared to the Italian and Greek hoards.

This data set still reveals a high degree of homogeneity with only the Greek hoard tending to stand out clearly.

8.3.13 Hoards closing 51–47 BC

Data set `fin51.dat` contained 15 hoards closing in 51–47 BC (Table 8.16). They contained 3598 *denarii*. Years 211–158 formed 1.3% of the data set and were omitted from the CA. Fig. 8.44 presents two cumulative percentage graphs; Fig. 8.45 presents the maps from CA.

code	hoard	country	'end date'	'good total'
ATH	Athens	Greece	49	47
BHR	'Bahrfeldt'	—	49	426
BRA	Brandosa	Italy	49	415
BRO	Broni	Italy	51	81
CAS	Casaleone	Italy	51	712
CR1	Carbonara	Italy	48	383
CUC	Cuceu	Romania	48	484
GRJ	La Grajuela	Spain	51	523
LOC	Locusteni	Romania	48	88
ODS	Orbeasca de Sus	Romania	48	137
P06	Padova	Italy	48	54
ROA	Roata de Jos	Romania	49	35
SAT	Satu Nou	Romania	49	125
TR2	Taranto	Italy	49	52
TRN	'Transylvania'	Romania	47	36

Table 8.16: Hoards in data set `fin51.dat` used in CA discussed in section 8.3.13.

The maps and graph for this data set reveal a pattern similar to that discussed for the previous data set. The Romanian hoards can be seen to all be archaic in structure (Fig. 8.44). They all have negative co-ordinates on the first axis (Fig. 8.45b). Similarly, many species prior to 80 BC have a negative score on this axis. The converse is true for the other hoards.

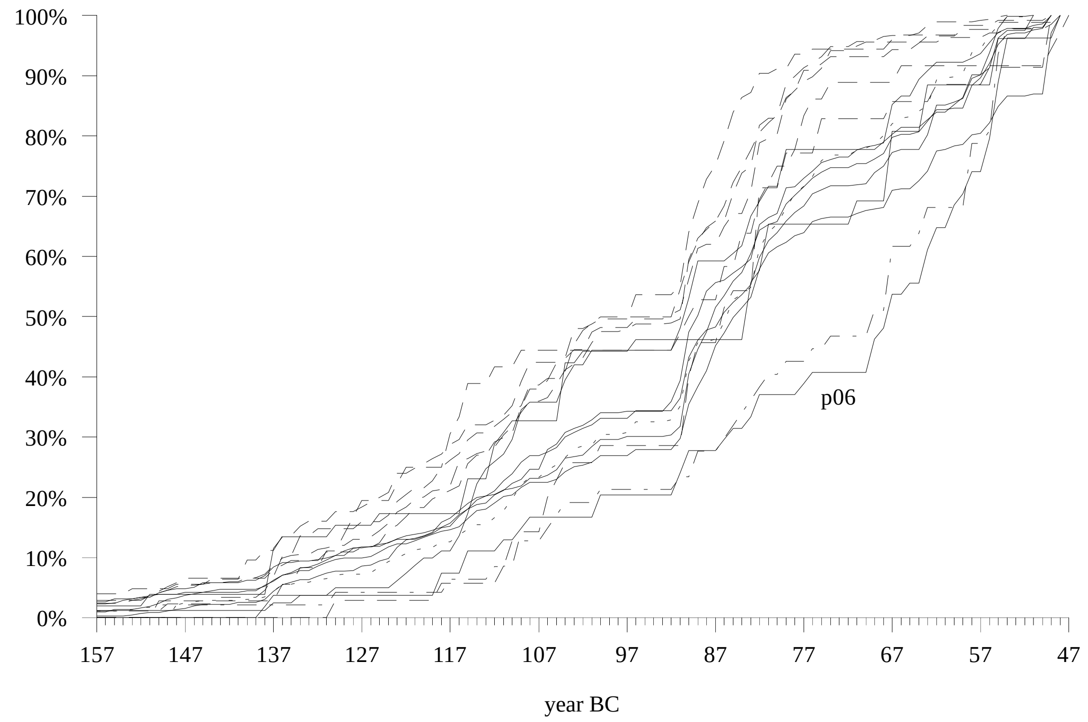
Romanian hoards all have a similar score on the second axis, whereas the non-Romanian hoards have a much wider spread (Fig. 8.45b). Padova and Athens (P06 & ATH) are at the negative end of the second axis, whereas Carbonara (CR1) is at the positive end. The cumulative percentage curve graph (Fig. 8.44a) shows Padova and Athens with very modern profiles. The species map (Fig. 8.45a) shows them to be particularly associated with the 60s and 50s BC. From the species map Carbonara (CR1) seems to be associated with years 48 and 49. The following quantifies the relationship:

	59–54 BC inc.	49–48 BC inc.
Athens (ATH)	29.8%	2.1%
Padova (P06)	27.8%	3.7%
Carbonara (CR1)	8.4%	13.1%

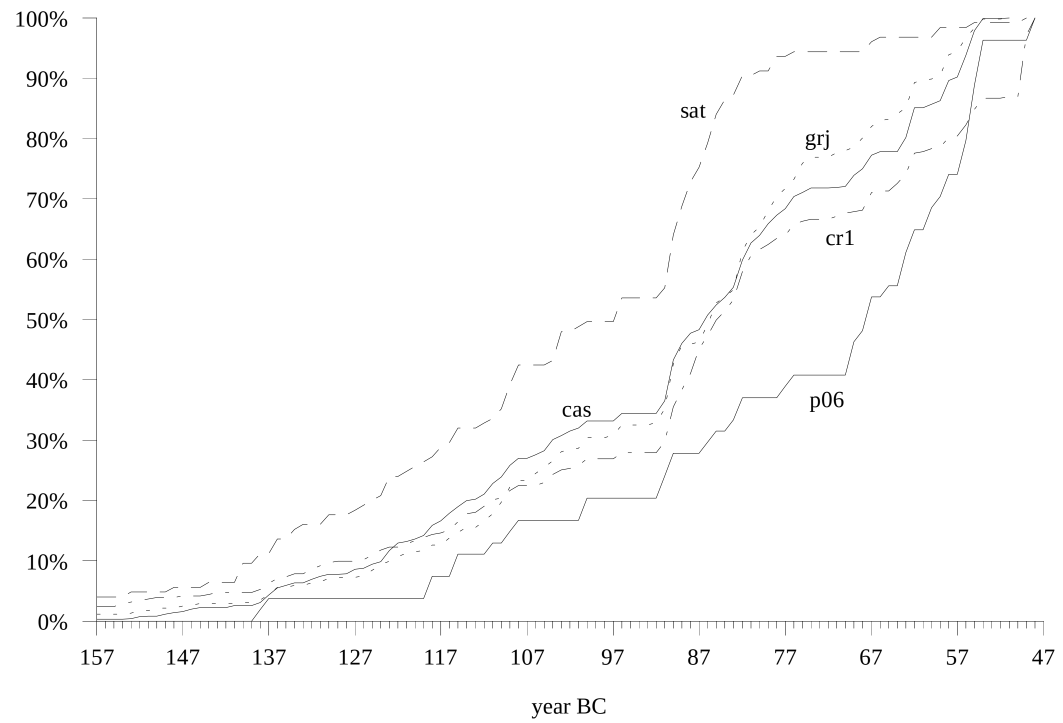
Therefore, Carbonara, despite not having a modern profile overall, has most coins of 49–48 BC. Conversely, the two most modern hoards, Athens and Padova, have relatively few coins of those years. Fig. 8.44b helps to illustrate the pattern. It is this pattern which the second axis in Fig. 8.45 is primarily highlighting.

The three hoards closing in 51 BC (BRO, CAS & GRJ) are all closely plotted on the maps. The similarity between the the Spanish hoard (La Grajuela, GRJ) and the Italian (*e.g.,* Casaleone, CAS) is further illustrated in Fig. 8.44b.

To summarise: the Romanian hoards are still archaic, although perhaps less markedly so than in the previous two data sets while the Spanish material appears identical to the Italian material of the same date. The Greek hoard is yet again distinctly modern in structure. Within the Italian material the representation of coins of 49–8 BC is uneven.

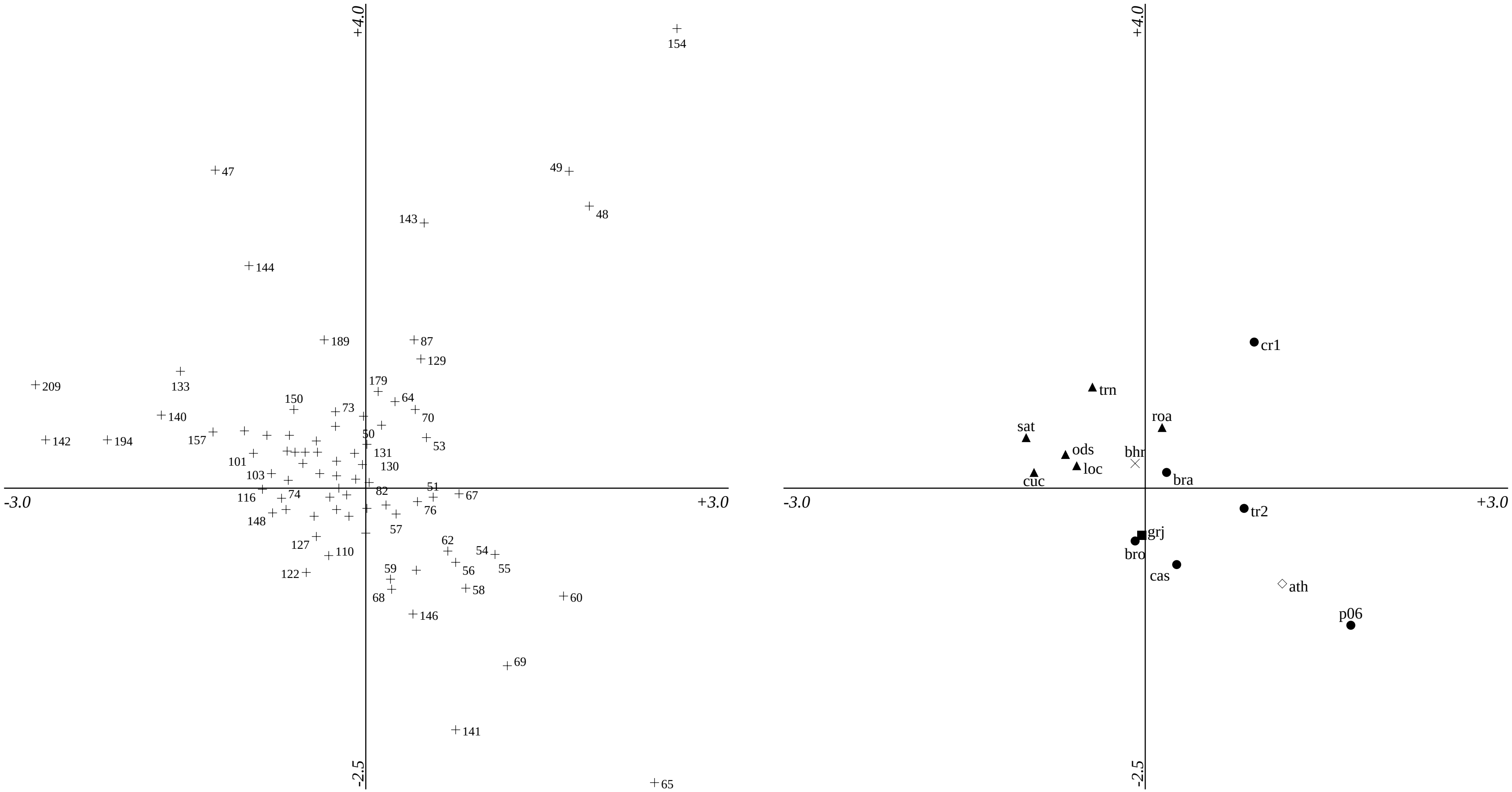


(a) All hoards: solid lines: Italy; dotted line: Spain; dashed lines: Romania; dot-dashed line: Greece.



(b) Selected hoards: lines as marked.

Figure 8.44: Cumulative percentage graphs of hoards in data set `fin51.dat`.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ■ Spain; ▲ Romania; ◊ Greece; × uncertain, probably Italy.

Figure 8.45: Map from CA of data set `fin51.dat` discussed in section 8.3.13. First (horizontal) and second principal axes of inertia.

code	hoard	country	‘end date’	‘good total’
CRO	Crotone	Italy	46	86
CST	Castelnovo†	Italy	46	394
DRA	Dračevica	Yugoslavia	46	109
ECL	Mirabella Eclano†	Italy	46	85
EL2	El Centenillo	Spain	46	57
ERD	Érd	Hungary	46	51
FDC	Fuente de Cantos	Spain	46	387
GUL	Gulgancy	Bulgaria	46	459
ILI	Ilieni†	Romania	46	108
ISS	Puy D’Issolu†	France	46	39
JAE	Jaén	Spain	46	65
MOR	Morrovalle	Italy	46	125
PLI	Policoro†	Italy	46	42
SEN	Sendinho da Senhora	Portugal	46	76
SIN	Sînvăsii†	Romania	46	43
SPN	Spoiano	Italy	46	264
SPR	Sprîncenata†	Romania	46	110
SUR	Surbo	Italy	46	138
TI2	Tîrnava	Romania	46	148
VAS	Văşad	Romania	46	53

Table 8.17: Hoards in data set `fin46.dat` used in CA discussed in section 8.17. NB: this is an enlarged version of data set `48bctest.dat`, † hoards not in that data set.

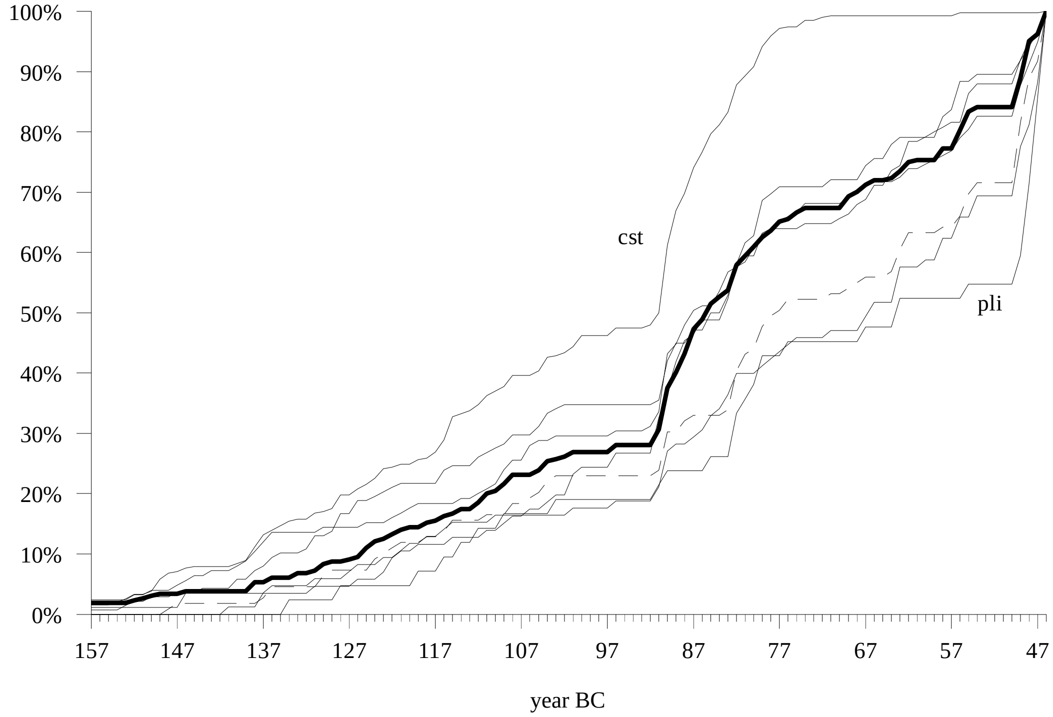
8.3.14 Hoards closing 46 BC

Data set `fin46.dat` contained 20 hoards closing in 46 BC (Table 8.17). This data set is an expanded version of that used in section 8.2.4. They contained 2839 *denarii*. Years 211–158 formed 1.9% of the data set and were omitted from the CA. Fig. 8.46 presents two cumulative percentage graphs; Fig. 8.47 presents the maps from CA.

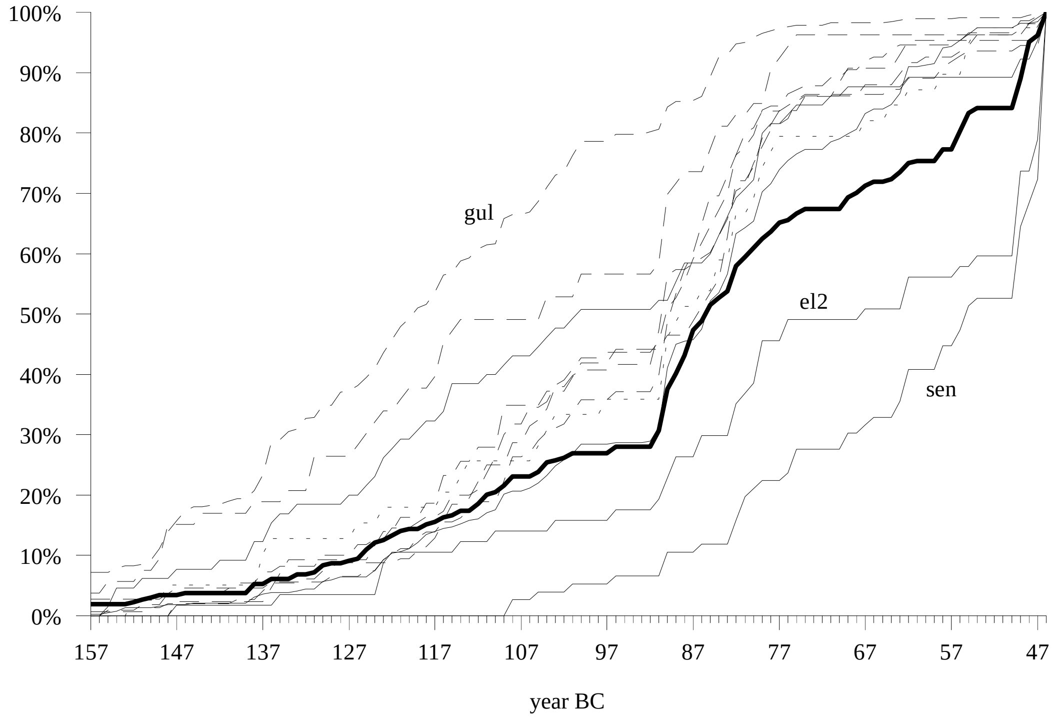
A detailed discussion of the CA of 13 of these hoards has been given is section 8.2.4. The additional 7 hoards have been marked (†) in Table 8.17. The oddity of Érd has already been noted (page 154) and this hoard was omitted from all the following analyses.

The addition of seven hoards did not substantially alter the relative positions of the twelve hoards previously analysed (Fig. 8.47b, *cf.* Fig. 8.7, page 157). The species maps show much greater detailed variation (Fig. 8.47a, *cf.* Fig. 8.6). At a general level, however, the pattern is very similar. The detailed variation is because these data sets have many cells with low counts. These maps do appear to be ‘externally stable’; *i.e.*, they do not change dramatically when extra objects are added (Greenacre 1993, pp. 172–3).

Three Italian hoards were added to this data set. It was a surprise to find that they did not join the group of four hoards discussed previously. Two hoards, Policoro and Mirabella Eclano (PLI & ECL) are in the top right quadrant with the hoards from Spain and Portugal that had a modern structure. The cumulative percentage graph (Fig. 8.46) shows these hoards to be quite similar to El Centenillo (EL2). Sendinho da Senhora (SEN) lies further to the positive extreme of the first axis due to its unusually high numbers of coins of the 40s BC.

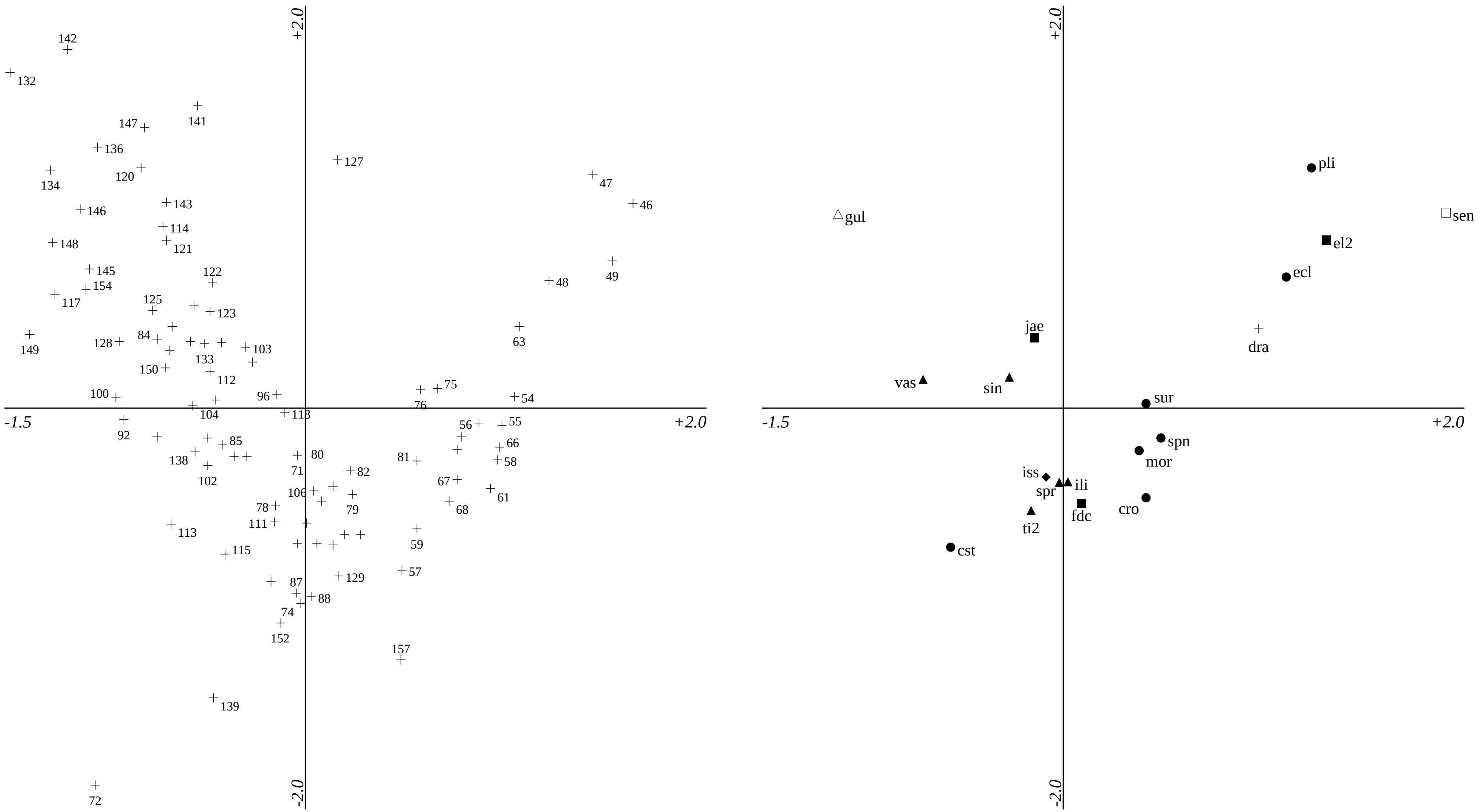


(a) Thick solid line: Spoiano (SPN); thin solid lines: Italy; dashed line: Yugoslavia (DRA).



(b) Thick solid line: Spoiano (SPN); thin solid lines: Spain and Portugal; dotted line: France; dashed lines: Romania and Bulgaria.

Figure 8.46: Cumulative percentage graphs of hoards in data set `fin46.dat`.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ■ Spain; □ Portugal; ▲ Romania; △ Bulgaria; ⧫ France; + Yugoslavia.

Figure 8.47: Maps from CA of data set `fin46.dat` discussed in section 8.3.14. First (horizontal) and second principal axes of inertia.

Castelnovo (CST) lies in the bottom left quadrant. This position suggests it has an archaic profile and Fig. 8.46 shows this to be the case. It is quite unlike any other Italian hoard and shows a greater similarity to Romanian hoards. This hoard has only three coins post 71 BC. It is likely that these are in fact 'extraneous' and that this hoard should be removed from the data set as discussed on page 261.[31] The odd position of 72 BC on the sample map is due to there only being two coins of that date, both from Castelnovo.

Three Romanian hoards were also added. Two of these are similar to the hoards from Tîrnava and Fuente de Cantos. These, along with the French hoard, now form a tight cluster of hoards on the map (hoards TI2, FDC, ILI, SPR, & ISS). The remaining Romanian hoard, Sprîncenata (SPR), is more archaic with a profile similar to Jaén and Văşad (JAE & VAS).

Summary

Four hoards from Italy are very similar and form a 'median' line to which others can be compared (SUR, SPN, MOR & CRO). Of the remaining Italian hoards, two have modern profiles with substantial quantities of coins from 40s BC (PLI & ECL) and one very archaic hoard (CST) which should probably be dated to 71 BC.

The hoards from the Iberian peninsula have a much wider spread with both very modern profile hoards (SEN & EL2), slightly archaic (FDC) and very archaic hoards (JAE). Romanian and Bulgarian hoards are archaic, varying from slightly so (*e.g.*, SPR) to very archaic (GUL, SIN & VAS).

8.3.15 Hoards closing 45–43 BC

Data set `fin45.dat` contained 7 hoards closing in 45–43 BC (Table 8.18). They contained 2080 *denarii*. Years 211–158 formed 0.5% of the data set and were omitted from the CA. Fig. 8.48 is the cumulative percentage graph of this data; Figs. 8.49 presents the maps from CA.

The species map (Fig. 8.49a) shows a clear horseshoe curve. The first axis has years from the early to mid-forties at its negative end and early years at its positive end. Years 65 and 60 which occur at the positive extreme are rare species. The sample map (Fig. 8.49b) shows Jegălia (JEG) at the positive end, four hoards grouped near zero, and the two Padova hoards (P03 & P07) at the negative end of the first axis. Fig. 8.48 confirms this tripartite division with Jegălia having a very archaic profile, the two Padova hoards having very modern profiles, and the rest being very similar to each other and mid-way between the two.

A detailed look at the species map shows that years 49–6 occur at the negative end of the first axis, not years 45–3 as might be expected. There are only 29 coins (1.39% of total) from 45–43 BC. This contrasts with 902 coins (43.37%) which date from 49–6 BC. Coins from 49–46 BC form 1.9% of the Jegălia hoard; between 19.1% (PAS) and 39.71% (VLL) of the middle group; and 40.59–87.59% of the two Padova hoards.

[31]The cluster analysis discussed in section 10.3 clearly groups this hoard with other Italian hoards of the late 70s BC thus adding weight to the argument that these coins are extraneous.

code	hoard	country	'end date'	'good total'
CAT	Cataluña	Spain	44	89
JEG	Jegălia	Romania	43	453
P03	Padova	Italy	43	34
P07	Padova	Italy	45	655
PAS	'Pasquariello'	Italy	43	105
POT	Potenza	Italy	43	404
VLL	Villette	France	45	340

Table 8.18: Hoards in data set `fin45.dat` used in CA discussed in section 8.3.15.

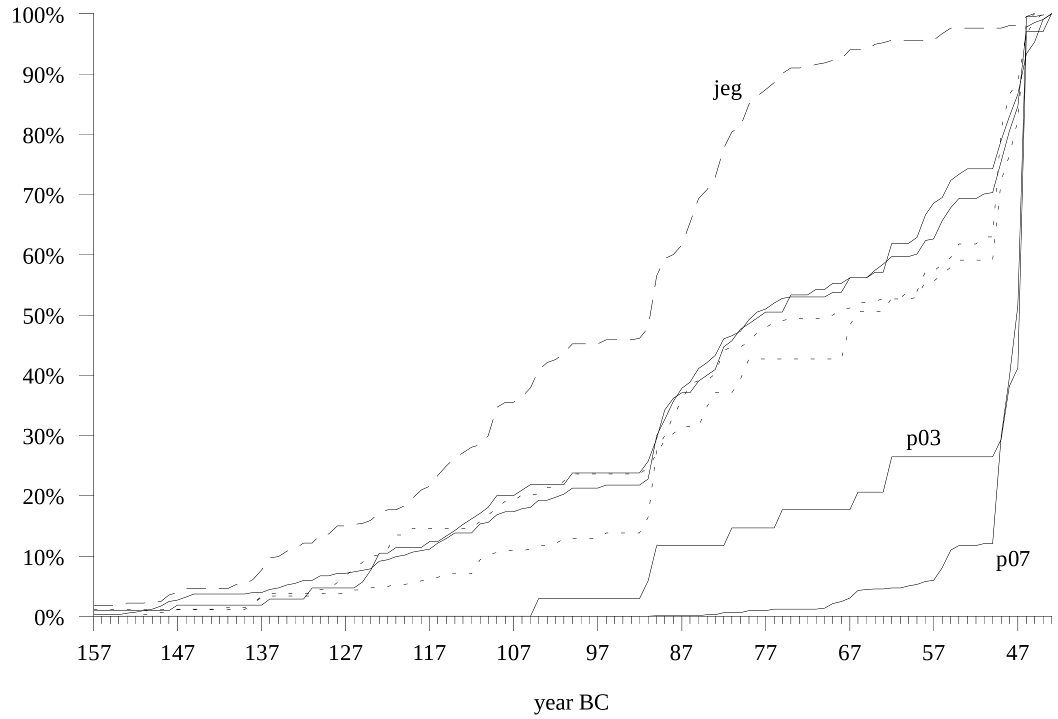
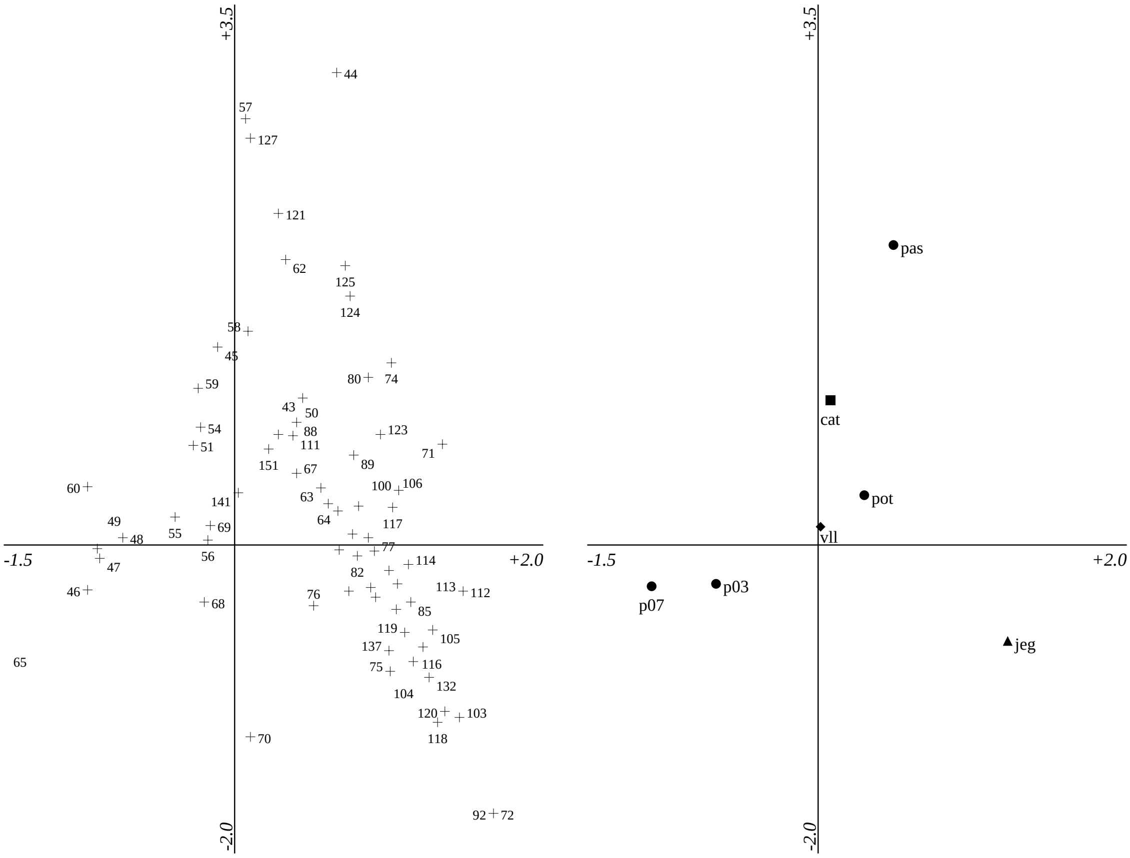


Figure 8.48: Cumulative percentage graphs of hoards in data set `fin45.dat`. Solid lines: Italy; dashed line: Romania; dotted lines: France and Spain.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ■ Spain; ▲ Romania; ⧫ France.

Figure 8.49: Maps from CA of data set `fin45.dat` discussed in section 8.3.15. First (horizontal) and second principal axes of inertia.

The interpretation of the second axis is less clear. The 'Pasquariello' hoard (PAS) is at the positive extreme. The species which stand clear at this end are generally quite rare. For example, there are only 8 coins of 44 BC of which four (3.8%) come from 'Pasquariello.' Of the other years it is difficult to discern a pattern. Coins from the 120s, 80s, and 70s BC appear both ends of the axis. Unlike the curve in the previous data set it is difficult to assign archaeological meaning to the second axis although it must represent a series of associations between species.

8.3.16 Hoards closing 42 BC

Data set `fin42.dat` contained 14 hoards closing in 42 BC (Table 8.19). They contained 4263 *denarii*. Years 211–158 formed 0.3% of the data set and were omitted from the CA. Fig. 8.50 is the cumulative percentage graph of this data; Fig. 8.51 presents the maps from CA.

The species map (Fig. 8.51a) initially appears to show little structure with no curve or distinct grouping apparent. There is, however, a tendency for years from 60s–40s to appear on the negative end of the first axis, other years at the positive. The second axis tends to have coins from the 80s, 60s and 50s at the negative end, coins from the 40s near to zero, and older coins at the positive end. Coins from the 70s are generally near to zero or at the positive end of the second axis.

code	hoard	country	'end date'	'good total'
ALV	Alvignano	Italy	42	2335
BOR	Borzano	Italy	42	582
BPT	Bran Poartă	Romania	42	59
CHI	Civitella in Val di Chiana	Italy	42	246
FA1	Fărcaşele I	Romania	42	81
FA2	Fărcaşele II	Romania	42	113
HAG	Haggen	Switzerland	42	61
ISL	Islaz	Romania	42	124
LIS	Lissac	France	42	52
MEN	Menoita	Portugal	42	97
NAG	Nagykágya	Romania	42	131
NB2	Nicolae Bălcescu	Romania	42	43
PIE	Piedmonte d'Alife	Italy	42	190
PRE	Prejmer	Romania	42	149

Table 8.19: Hoards in data set `fin42.dat` used in CA discussed in section 8.3.16.

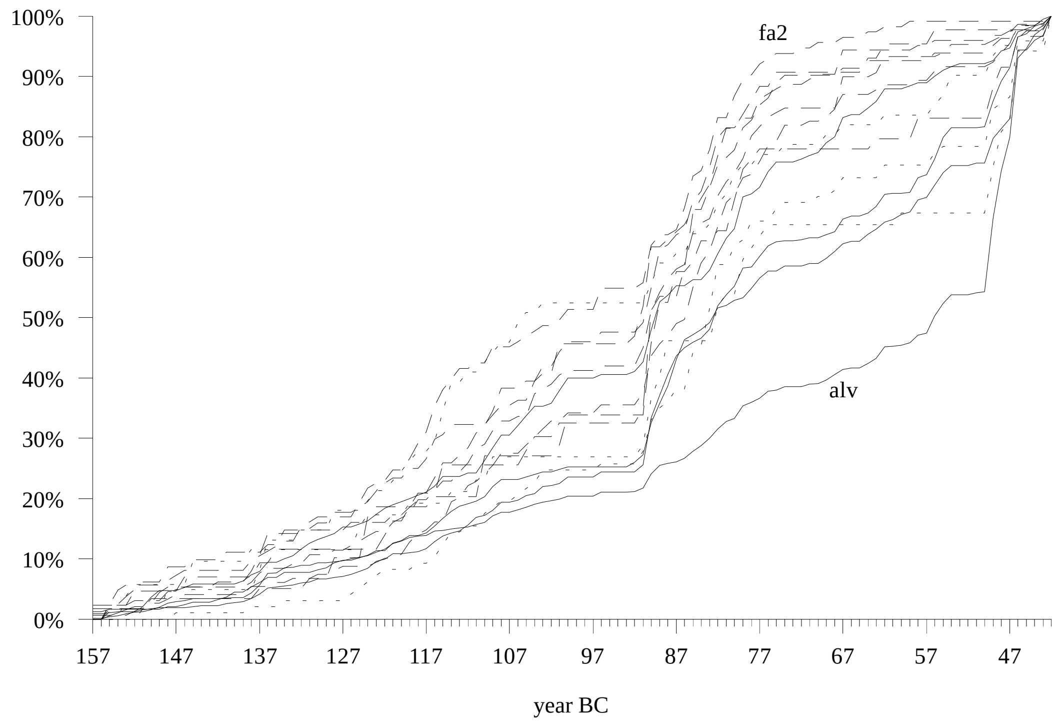
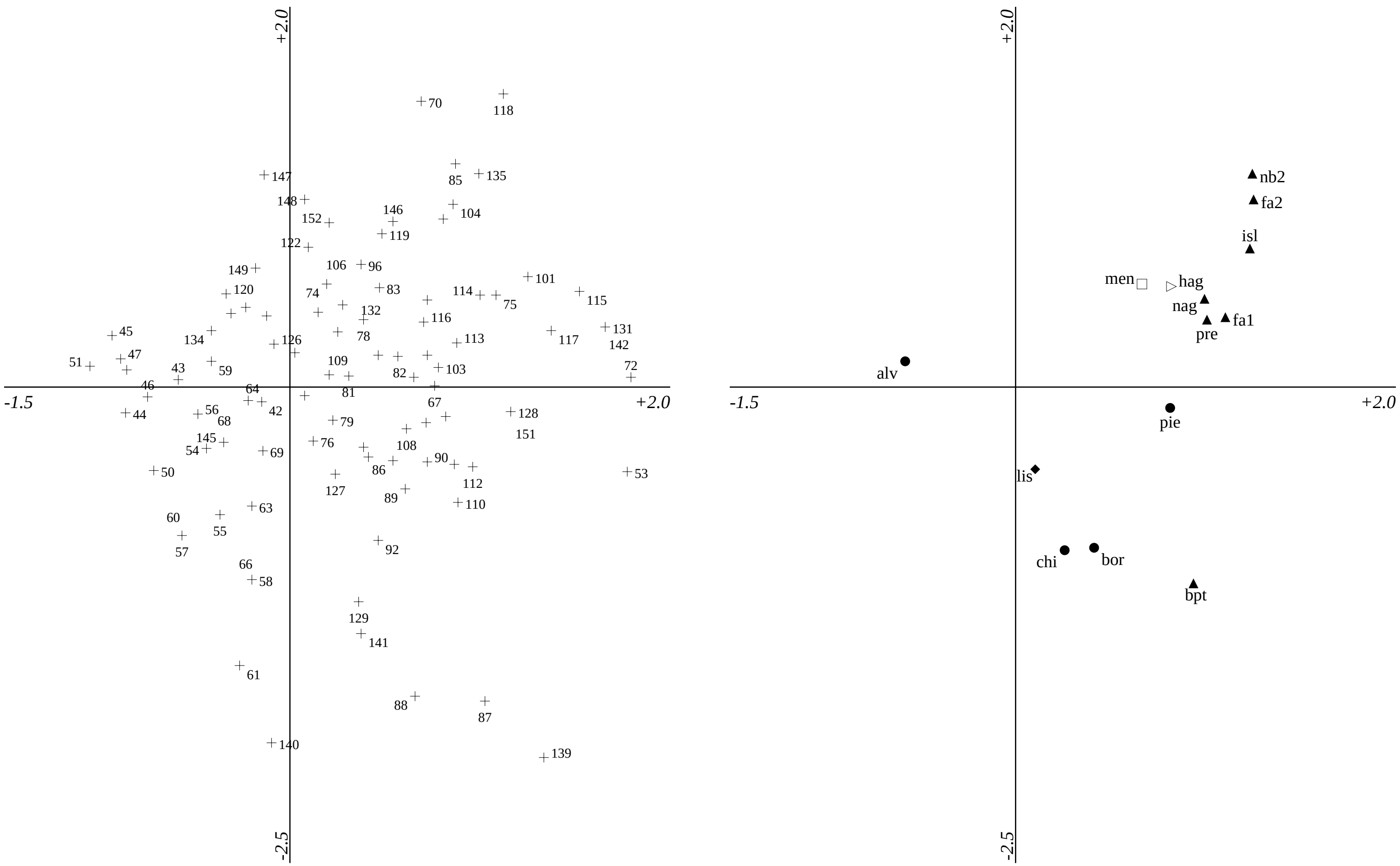


Figure 8.50: Cumulative percentage graphs of hoards in data set `fin42.dat`. Solid lines: Italy; dashed lines: Romania; dotted lines: France, Portugal and Switzerland.



(a) Species map: data points are years. Species 144 not plotted, unique species, co-ordinates 0.9, -3.45.

(b) Sample map: data points are hoards. ● Italy; ☐ Portugal; ▲ Romania; ⧫ France; ▹ Switzerland.

Figure 8.51: Maps from CA of data set `fin42.dat` discussed in section 8.3.16. First (horizontal) and second principal axes of inertia.

	90–80 BC	49–42 BC
Alvignano (ALV)	12%	46%
Other Italian hoards	22–30%	8–24%
Romanian hoards (except Bran Poartă)	26–47%	1–8%
Bran Poartă (BPT)	36%	17%

Table 8.20: Totals for sub-groups of selected hoards in data set `fin42.dat`.

On the sample map (Fig. 8.51b) the Alvignano hoard (ALV) is the only hoard with a positive score on the first axis. Looking at Fig. 8.50 we can see that the hoard has a modern profile compared to the hoards from this date. Unusally, it does not seem to have very many coins of the 80s BC. Totals extracted from the database shows the pattern clearly (Table 8.20).

The first axis is, therefore, primarily highlighting the Alvignano hoard. All the Romanian hoards are at the positive extreme of the first axis. Looking at Fig. 8.50 we can see the Romanian hoards have the most archaic profiles, with the exception of Bran Poartă (BPT). The first axis is therefore also highlighting the usual modern–archaic gradient.

The second axis is more difficult to interpret. It explains only 9.8% of the variance in the data (Table 8.4). It was therefore decided that diagnostic statistics[32] were required and the analysis was re-run using IASTATS. From these (Table 8.21) it can be seen that the two hoards with the highest contribution to this axis, *i.e.,* the most important hoards in defining the axis, are Borzano and Civitella in Val di Chiana (BOR & CHI), with Islaz and Fărcaşele II (ISL & FA2) also contributing. Looking at Fig. 8.50 we can see that the two Italian hoards have a median position in the graph between the Alvignano hoard and the bulk of the Romanian hoards and it is this fact that the second axis is illustrating.

On the second axis of the sample map, all the Romanian hoards are at the positive extreme bar Bran Poartă. Their order on this axis roughly corresponds to how archaic they are. Bran Poartă is at the negative end of the axis and has the most modern structure of the Romanian hoards. Menoita and Haggen (MEN & HAG) are plotted close to the main group of Romanian hoards on both axes, although slightly to the left of the first axis reflecting their slightly more modern profile.

The hoard from Piedmonte d'Alife (PIE) has an unusual profile. It contains years from 60s and 50s BC, unlike most Romanian hoards. Also, it contains few coins of the 40s BC, unlike most Italian hoards, but similar to Romanian hoards. As a result it does not 'fit' the pattern of the second axis and therefore has a score of near zero (-0.11). Its lack of coins of the 40s result in a positive score on the first axis.

The hoard from Lissac (LIS) is also unusual. It has only one coin dating 75–50 BC (RRC 420/1a–b, 60 BC). This may be a reflection of the money supply to Gaul, or it may be the result of the reliability of the record.[33] The variation in the hoard is poorly represented by the first two axes as can be seen by the low value for 'quality' in Table 8.21.

[32]For a description of the diagnostic statistics used in CA see Greenacre (1993) and Baxter (1994, pp. 114–118).

[33]The hoard from Lissac (Gounot 1965) was found *c.* 1836 and is known from records only. The hoard itself was dispersed amongst the general coin collection of the Musée du Puy.

Name	Quality	Mass	Inertia	Axis 1	Cor	Ctr	Axis 2	Cor	Ctr
ALV	997	548	145	−393	967	398	−69	30	43
BOR	728	136	77	287	243	53	406	485	372
BPT	177	14	74	629	122	26	424	55	41
CHI	440	58	62	184	52	9	501	387	240
FA1	290	19	64	744	271	49	−199	19	12
FA2	432	27	91	855	350	91	−413	82	75
HAG	168	14	52	553	140	21	−248	28	15
ISL	469	29	87	828	377	94	−409	92	81
LIS	16	12	48	70	2	0	185	14	7
MEN	235	23	43	447	175	21	−262	60	26
NAG	430	30	60	683	390	66	−216	39	23
NB2	324	10	51	839	228	33	−542	95	49
PIE	300	44	70	535	300	60	−11	0	0
PRE	386	35	76	690	364	78	−167	21	16

Table 8.21: Diagnostic statistics from CA of data set `fin42.dat` discussed in section 8.3.16. All values are × 1000.

Despite the unencouraging nature of the species map, the analysis does show the structure of this data set. The lack of a horseshoe curve is a reflection of the fact that the hoards do not have a simple gradient from modern to archaic profiles. Alvignano can be seen to be exceptionally modern with large numbers of coins of 49–46 BC (38.8% of the hoard). Civitella in Val di Chiana, Borzano and Bran Poartă (CHI, BOR & BPT) have fewer coins of the 40s BC, but have coins of the 60s and 50s BC and thus have an ‘average’ profile. Two hoards (LIS & PIE) are odd as discussed above. The remainder are archaic in structure with a slight possibility that they can be divided into two groups (NB2, FA2 & ISL *v.* the rest).

8.3.17 Hoards closing 41–40 BC

Data set `fin41.dat` contained 10 hoards closing 41–40 BC (Table 8.22). They contained 1339 *denarii*. Years 211–158 formed 0.45% of the data set and were omitted from the CA. Fig. 8.52 is the cumulative percentage graph of this data; Figs. 8.53–8.54 are the maps from CA.

The two Turkish hoards in this data set are the only ones currently uploaded to the database and neither were listed in RRCH. RRCH only lists one Turkish hoard (RRCH 292) which is from Nisibis and only contains one ‘Roman’ coin, a plated *denarius* of L. Rvsti.

The species map (Fig. 8.53a) shows a strong horseshoe curve. The latest years (58–40) occur almost entirely within the top right quadrant, the ‘middling’ years (80s, 70s *etc.*) in the bottom left and the early years in the top left. Year 60 occupies a rather odd position. It is a rare species with only 3 examples. Two are in the Işalniţa hoard, one in the San Pietro Vernitico hoard (ISA & VAL). The first axis, therefore, represents hoards with a large proportion of the newest coins as opposed to hoards with a large proportion of the oldest coins. The second axis represents the opposition between hoards with relatively more ‘middling’ coins as opposed to the oldest and newest issues.

The sample map (Fig. 8.53b) shows the Işalniţa hoard to be quite distinct. The global analysis on page 150 also noted this hoard to be unusual. Fig. 8.52 shows the hoard having an archaic profile

code	hoard	country	'end date'	'good total'
AGN	Agnona	Italy	41	272
BOD	Bodrum	Turkey	41	62
FRN	Francin	France	41	43
ISA	Işalniţa	Romania	41	134
S03	'West Sicily'	Sicily	40	162
SD2	Sadova II	Romania	41	30
STP	Stupini	Romania	41	226
TU3	'Turkey'	Turkey	41	70
VAL	San Pietro Vernotico (Valesio)	Italy	41	201
VIS	Vişina	Romania	41	139

Table 8.22: Hoards in data set `fin41.dat` used in CA discussed in section 8.3.17.

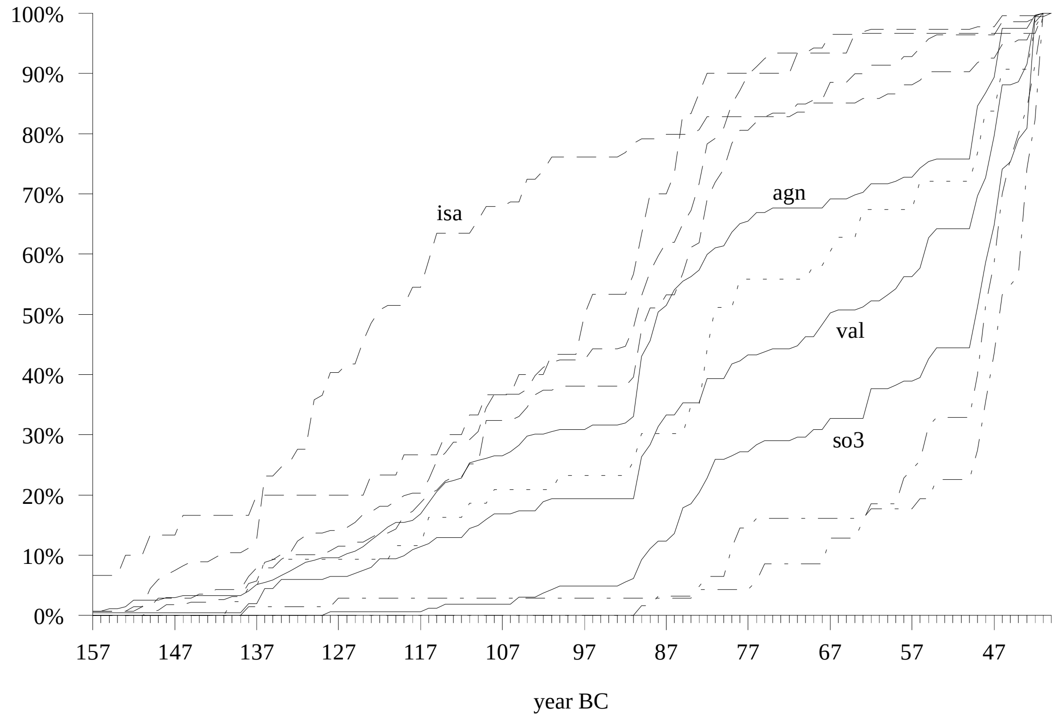
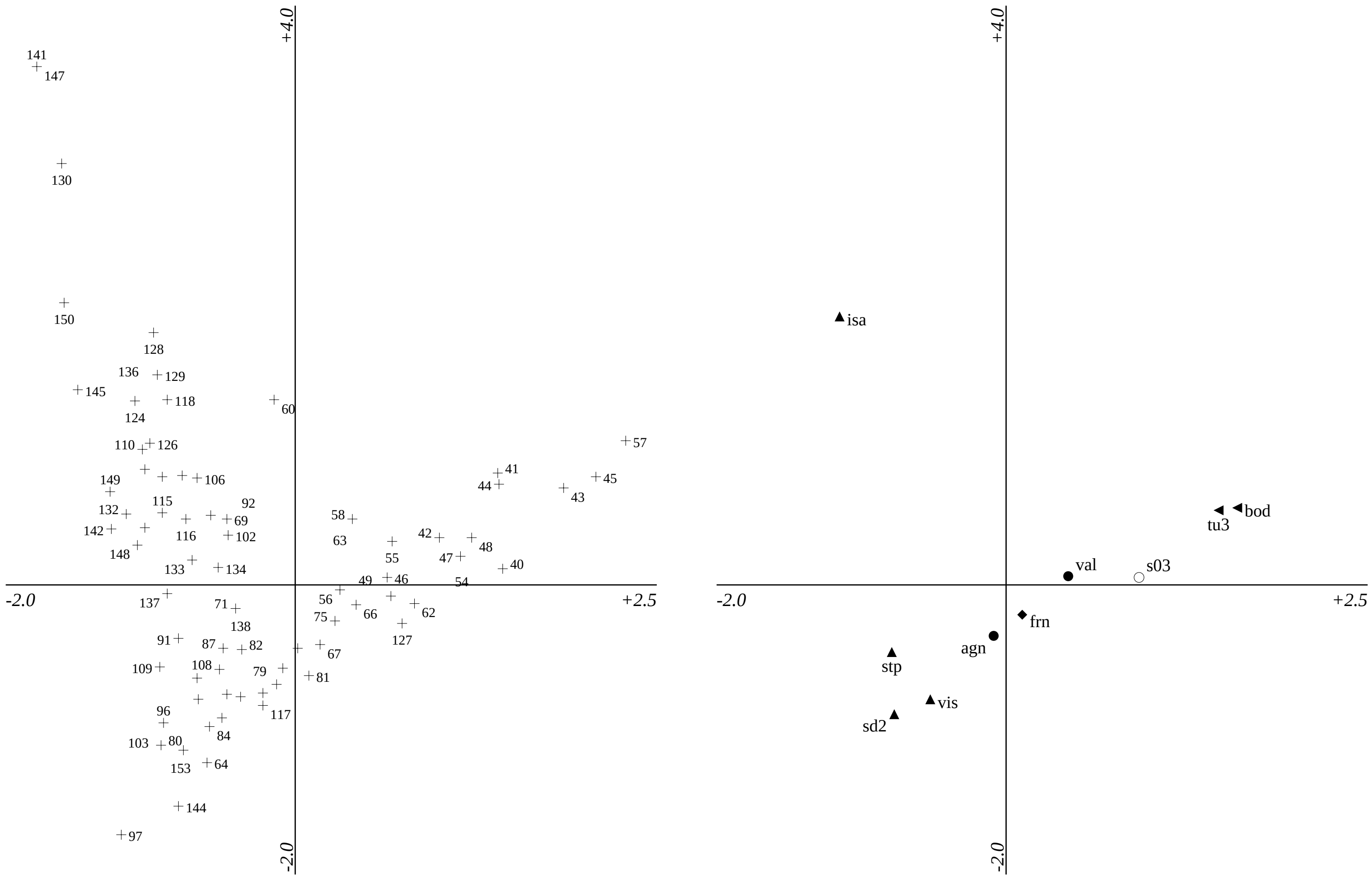


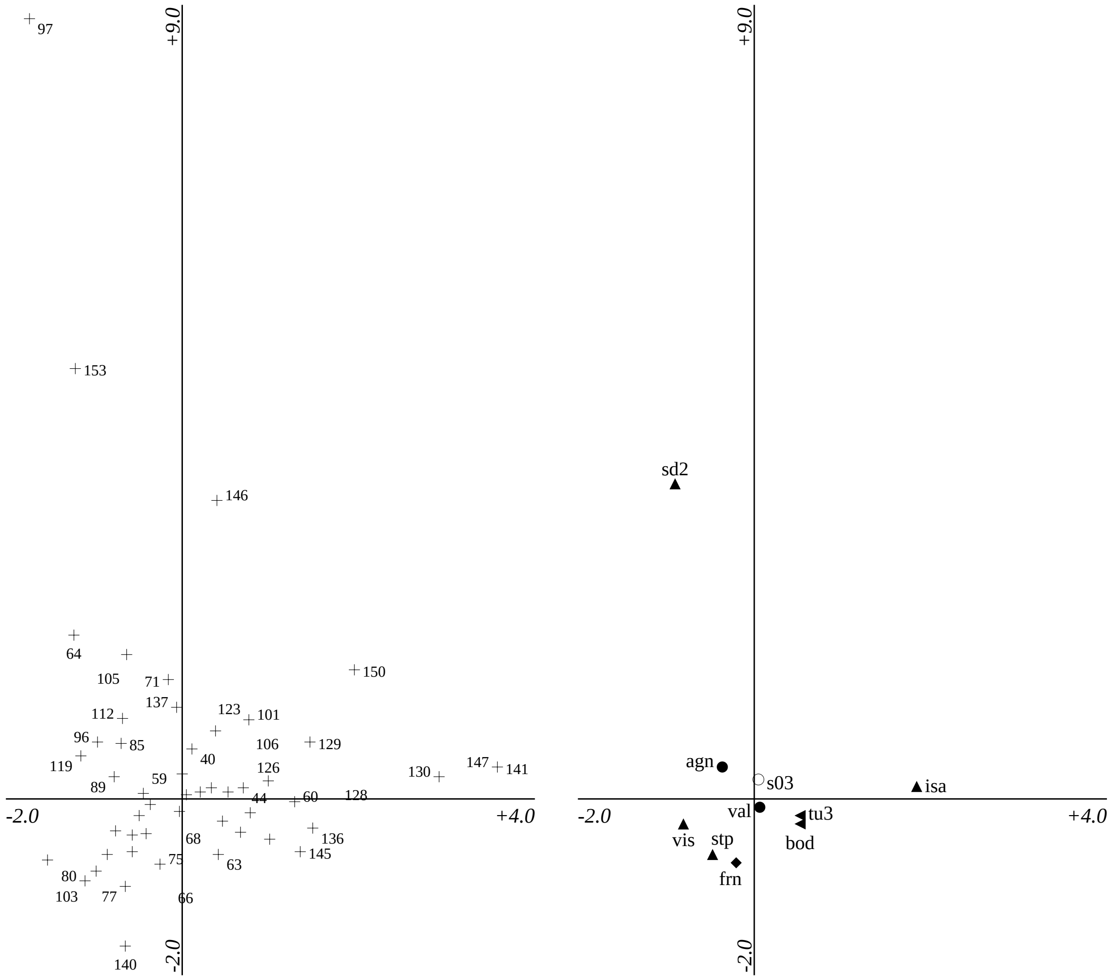
Figure 8.52: Cumulative percentage graphs of hoards in data set `fin41.dat`. Solid lines: Italy; dashed lines: Romania; dotted line: France; dash-dot lines: Turkey.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ○ Sicily; ▲ Romania; ⧫ France; ◀ Turkey.

Figure 8.53: Maps from CA of data set `fin41.dat` discussed in section 8.3.17. First (horizontal) and second principal axes of inertia.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ○ Sicily; ▲ Romania; ⧫ France; ◀ Turkey.

Figure 8.54: Maps from CA of data set `fin41.dat` discussed in section 8.3.17. Second (horizontal) and third principal axes of inertia.

with an unusually high number of coins prior to 100 BC (76%), and unusually few coins of the 80s BC. Nothing in the literature suggests that this hoard has been subjected to modern biases.

The remaining hoards form a straight line along the right arm of the horseshoe. The remaining three Romanian hoards are at the left extreme and are thus associated with coins from the 80s and 70s BC. Only between 2.6% and 3.6% of their coins post-date 50 BC. This is similar to what has been observed in other analyses. The Turkish hoards are at the right extreme of the line. These hoards are therefore associated with the newest coins and Fig. 8.52 shows these hoards having a very modern profile; 67% and 77% of 'Turkey 3' and Bodrum (TU3 & BOD) respectively post-date 50 BC. The Italian and French hoards fall mid-way between these two extremes. Between 24% and 55% of these hoards post-date 50 BC. The most modern of the non-Turkish hoards, 'West Sicily' (S03), is also the only hoard which closes in 40 BC.

The third axis of inertia was examined to see if the Işalniţa hoard was masking other useful information (Fig. 8.53). The sample map (Fig. 8.54b) shows that on the third axis the Sadova hoard (SD2) is separated from the rest of the hoards. This appears to be primarily due to a small number of species such as 97, 153 and 146 (Fig. 8.54a); all of which are quite rare.[34] The influence of these rare species occuring in Sadova in this analysis is large due to the small size of the Sadova hoard. It seems unlikely, therefore, that other significant variation has been missed.

8.3.18 Hoards closing 39–36 BC

Data set `fin39.dat` contained 8 hoards closing in 39–36 BC (Table 8.23). They contained 8279 *denarii*. Years 211–158 formed 0.72% of the data set and were omitted from the CA. Fig. 8.55 is the cumulative percentage graph of this data; Fig. 8.56 presents the maps from CA.

The species map (Fig. 8.56a) is dominated by year 53. There is only one coin of 53 in the data set from Arbanats (ARB). A second analysis (not presented) was run without this species and although the first axis was completely reversed, the relative positions of the hoards and years was otherwise unaltered.

The first axis is, again, representing the new coin *v.* old coin pattern characteristic of many of the data sets examined so far. Most of the 60s, 50s and 40s BC have a positive score on the first axis, the rest mainly have a negative score (Fig. 8.56a). Paradoxically, hoards from the 30s BC have negative scores on this axis. The second axis is less clear. A large proportion of years prior to 79 BC have a postive score on this axis. A mixture of years including most of 78–36 have a negative score. However, there are some exceptions, but many, such as 53, 52 and 97 BC are rare species. Of more significance are years 80, 68, 67 and 49 with 107, 36, 67 and 422 coins each respectively. With exceptions, the second axis represents the middle period coins *v.* old and new coins.

The sample map (Fig. 8.56b) shows the hoards clearly separated by country of origin. The Arbanats hoard has positive scores on both axes, the Italian hoards are just below the origin of the plot, the Romanian hoards in the upper right quadrant. Using the maps and Fig. 8.55 together, we can see that the French hoard (ARB) has the most modern profile, the five Italian hoards have similar ‘average’ profiles, and the Romanian hoards have archaic profiles.

As noted above, some years on the second axis of inertia have an unexpected positive score. For example, coins of 80 BC form between 0.5%–1.3% of Italian hoards, 2.0% of Arbanats but 5.0%–7.5% of Romanian hoards. Coins of 67 form 3.1% of Poroschia (PRS) but $<$1.6% of Italian hoards. Year 135 has been shown to associated with Romanian hoards previously (see sections 8.3.7–8.3.8). This year has a high score on the second axis. All hoards have $<$0.3% from this year apart from Poroschia which has 0.9%. Such detailed observations do have an important significance which will be discussed in detail in Part III, section 14.4.8.

[34] 97: 2 coins in SD2; 153: 2 coins in SD2 & AGN; 146: 3 coins in SD2, ISA & AGN.

code	hoard	country	'end date'	'good total'
ARB	Arbanats	France	39	929
AVE	Avetrana	Italy	38	1652
CR2	Carbonara	Italy	36	2371
CTG	Contigliano	Italy	39	634
LOS	Mornico Losana	Italy	38	1088
ME2	Meolo	Italy	39	1011
PRS	Poroschia	Romania	39	541
RAC	Răcătău de Jos II	Romania	39	53

Table 8.23: Hoards in data set `fin39.dat` used in CA discussed in section 8.3.18.

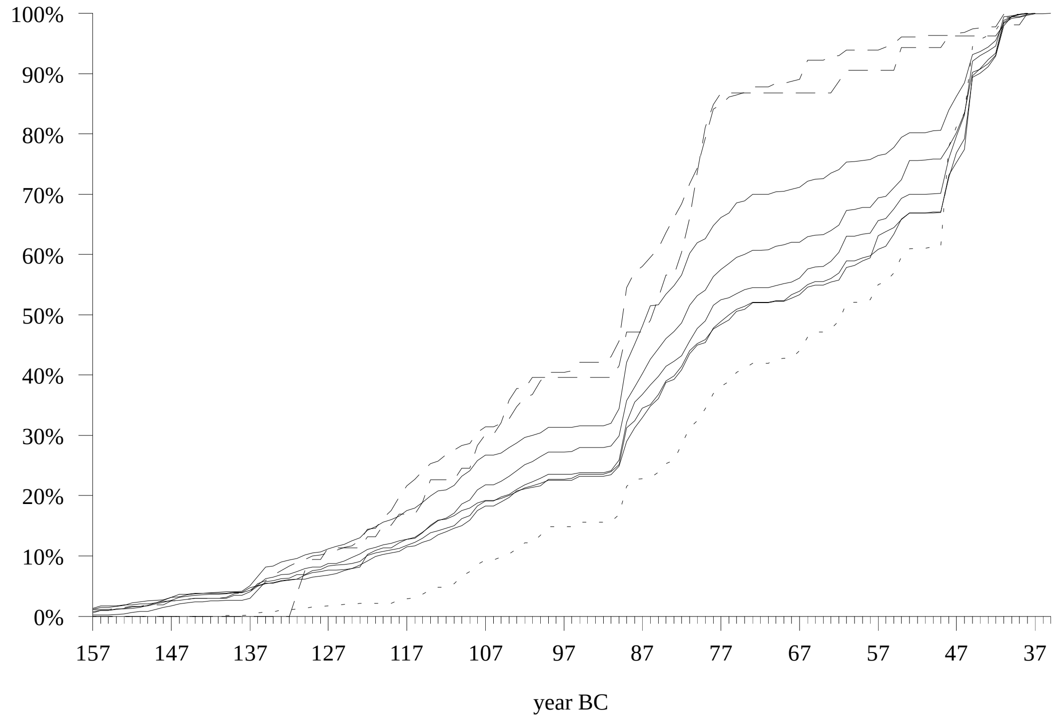
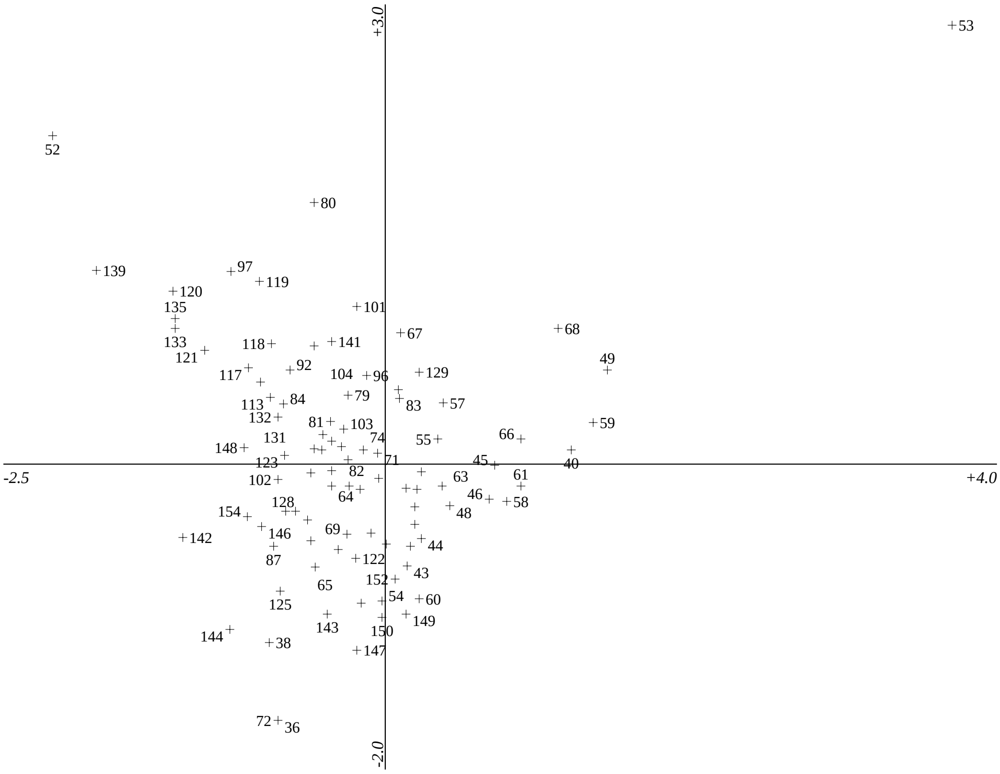
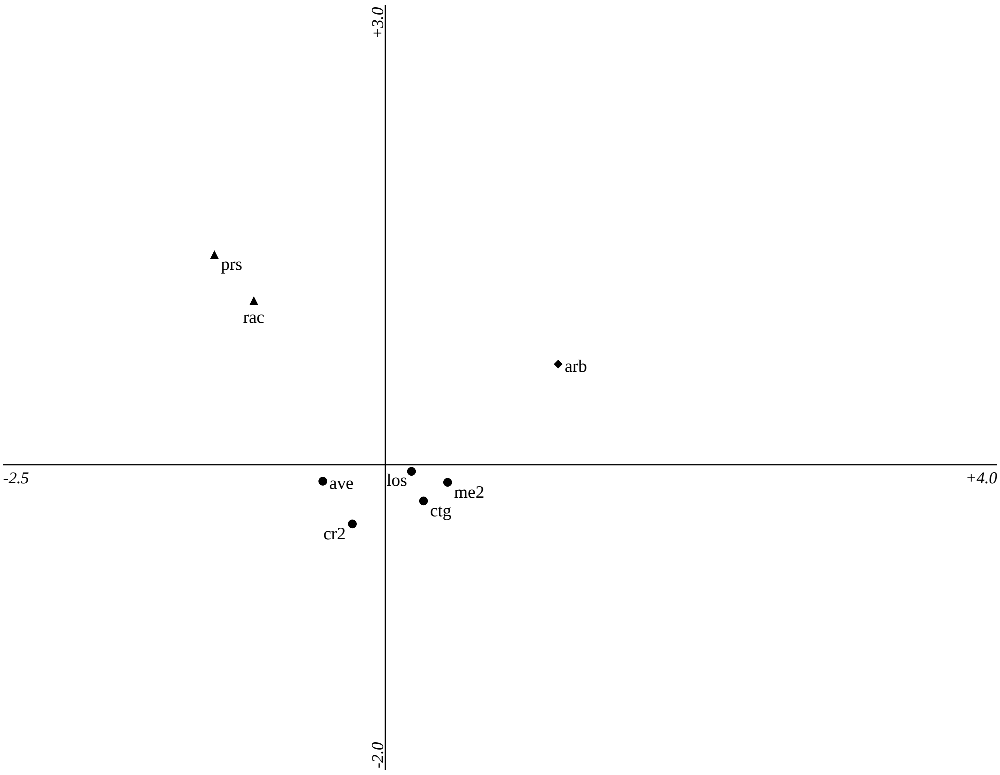


Figure 8.55: Cumulative percentage graphs of hoards in data set `fin39.dat`. Solid lines: Italy; dashed lines: Romania; dotted line: France.



(a) Species map: data points are years.



(b) Sample map: data points are hoards. ● Italy; ▲ Romania; ⧫ France.

Figure 8.56: Maps from CA of data set `fin39.dat` discussed in section 8.3.18. First (horizontal) and second principal axes of inertia.

8.3.19 Hoards closing 32 BC

Data set `fin32.dat` contained 7 hoards closing 32 BC (Table 8.24). They contained 1124 *denarii*. Years 211–158 formed 0.27% of the data set and were omitted from the CA. Fig. 8.57 is the cumulative percentage graph of this data; Fig. 8.58 presents the maps from CA.

All the hoards from this analysis end with the legionary issue of Mark Antony (RRC 544). This issue was minted in 32–1 BC prior to the battle of Actium where the combined forces of Cleopatra and Mark Antony were defeated by Octavian (Scullard 1982, pp. 168–171). Each legion had a coin type minted in its honour. It was an extremly large issue estimated by Crawford at 864 dies (Crawford 1974, Table L, pp. 699–71). It was also debased, with only *c*. 85% silver (Crawford 1974, Table XLV, pp. 570-1) and became very common throughout the Empire and in large areas of *barbaricum*.

The hoards in this data set are generally small. Of the total number of coins, 713 (63%) are legionary *denarii*. However, 606 of those come from the largest hoard, Delos (DEL). As a result few issues have a significant contribution to the CA. Fig. 8.58a shows the species map with all species plotted, Fig. 8.58b shows only years with a weight of over 1%.[35] The first axis of inertia represents the relationship between year 32 and a selection of years from 82 BC and before. The second axis is representing the presence of coins of 46 BC, and to a lesser extent 49, 42 and 89 BC.

The sample map (Fig. 8.58c) shows three hoards (ACT, DEL & BDS) plotted close together at the negative end of the first axis, near to the position of 32 BC on the species maps. All these hoards have over 80% legionary *denarii* as can be seen in Fig. 8.57.[36] They also have scores around zero on the second axis indicating that that they have relatively little coinage of the 40s BC.[37]

Two hoards (MOG & BEU) have high scores on the second axis and thus are associated with coins of 46 BC *etc.*[38] The position on the first axis shows that they have less legionary *denarii* than the first three hoards, but more than the remaining hoards (GUR & OBI).[39] They have a middle position on the cumulative percentage graph (Fig. 8.57). The remaining two hoards are characterised by having older coin especially from the 90s–80s BC. They have little of either coins of the 40s BC, or of legionary *denarii*. They have very archaic age profiles (Fig. 8.57).[40]

The dominance of the legionary issue in the two Greek hoards is no suprise. The Belmonte del Sannio (BDS) hoard has a structure so similar to the Greek hoards it is likely that it was a collection hidden without being added to, or circulating in, the Italian coinage pool. The other Italian hoard has a smaller proportion of legionary *denarii*, the French hoard far fewer. This is much as one would expect. The Romanian hoards have a very archaic profile as has been seen in other data sets.

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[35] CANODRAW provides an option to omit species that have 'less than 1% weight.' The weight for a species is calculated as a percentage of the most abundant species. In this case the most adundant species is 32 BC with 713 coins. Only 16 species have more than 7 coins and these are shown in Fig. 8.58b.

[36] ACT: 33 coins, 82.5%; DEL: 606 coins, 93.5%; BDS: 50 coins, 94.3%.

[37] For example, 46 BC: ACT: 1 coin, 2.5%; DEL: 8 coins, 1.2%; BDS: 0 coins.

[38] For example, 46 BC: BEU: 5 coins, 15.6%; MOG: 15 coins, 21.7%; *cf.* GUR and OBI: 0 coins.

[39] BEU: 2 coins, 6.2%; MOG: 20 coins, 28.9%; *cf.* GUR: 1 coin, 0.4%; OBI: 1 coin; 2%.

[40] For example, 90–80 BC: OBI 15 coins, 30%; GUR 80 coins, 30.5%; *cf.* MOG 17 coins, 24.6%; DEL 1 coin, 0.15%.

code	hoard	country	‘end date’	‘good total’
ACT	Actium	Greece	32	40
BDS	Belmonte del Sannio	Italy	32	53
BEU	Mont Beuvray	France	32	32
DEL	Delos	Greece	32	648
GUR	Gura Padinii	Romania	32	232
MOG	Moggio	Italy	32	69
OBI	Obislav (Dîmbroviţa)	Romania	32	50

Table 8.24: Hoards in data set `fin32.dat` used in CA discussed in section 8.3.19.

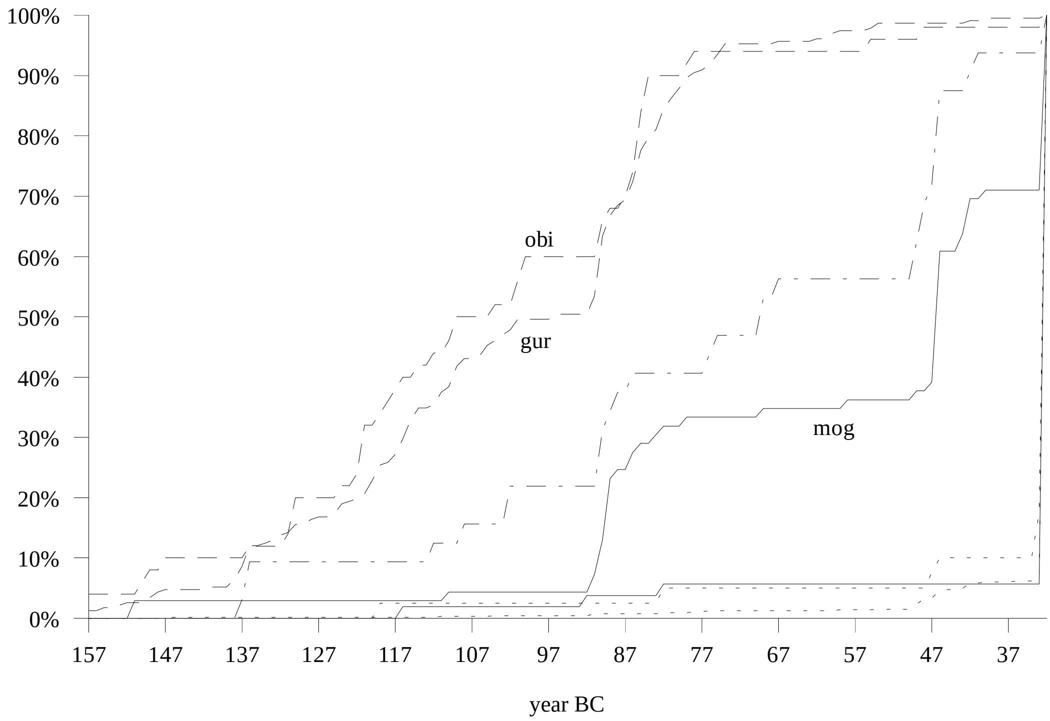
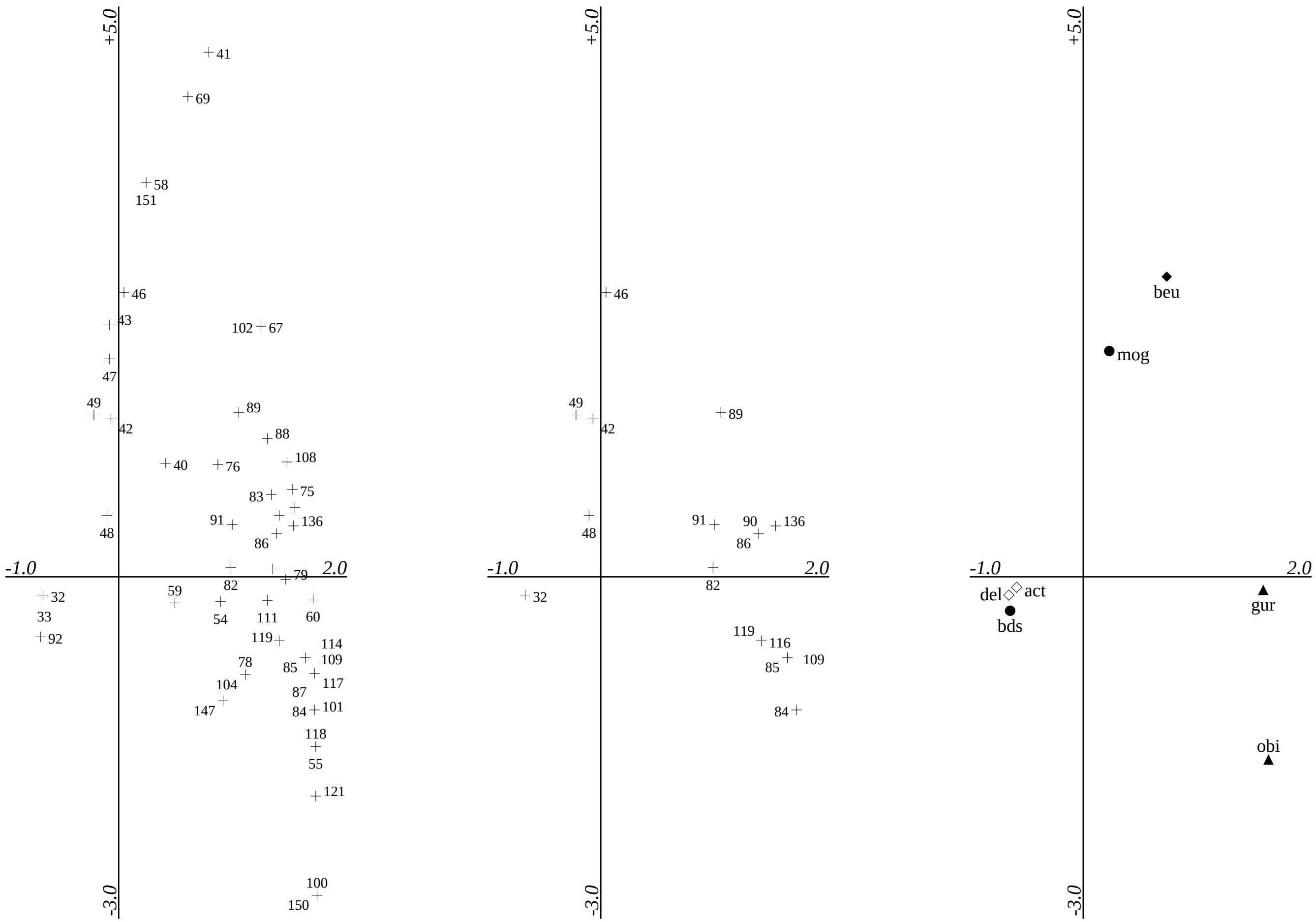


Figure 8.57: Cumulative percentage graph of hoards in data set `fin32.dat`. Solid lines: Italy; dashed lines: Romania; dotted lines: Greece; dash-dot line: France.



(a) Species map: data points are years.

(b) Species map: data points are years — years with over 1% weight only (see text).

(c) Sample map: data points are hoards. ● Italy; ▲ Romania; ⧫ France; ◊ Greece.

Figure 8.58: Maps from CA of data set `fin32.dat` discussed in section 8.3.19. First (horizontal) and second principal axes of inertia.

8.3.20 Hoards closing 29 BC

Data set `fin29.dat` contained 13 hoards closing in 29 BC (Table 8.25). They contained 6075 *denarii*. Years 211–158 formed 0.95% of the data set and were omitted from the CA. Fig. 8.59 are cumulative percentage graphs of this data; Fig. 8.60 presents the maps from CA.

In 30 BC Mark Antony and Cleopatra were finally defeated and committed suicide. This is normally taken as the end of the Republic and the beginning of the Imperial period. This data set is the first in which some coins are identified according to *Roman Imperial Coinage*, volume 1 (Sutherland 1984). This catalogue does not give close dates to coin issues, unlike RRC, but assigns much wider date brackets. As a result many hoards have the same `end_date`, and there are gaps in the sequence.

The hoards in this analysis come from all over western and central Europe. One hoard, Cerriolo (CRR), has an `end_date` of 29 BC because it contains a *quinarius* of that date whereas its last *denarii* are from the legionary issue of 32 BC. There is only one hoard from Romania in this analysis, Şeica Mică (SEI). This hoard is of particular importance as it is one of the hoards used by Crawford in his estimates of the size of coin issues (Crawford 1974, Table L, see section 3.13.4) and was also sampled for metallurgical analysis (see section 14.4.3).

The first species map was dominated by two outliers, years 142 and 53. Both were unique and so the analysis was re-run omitting these years. This resulted in maps at a more usable scale, but did not significantly alter the positions of either samples or species.

The first axis of the species map (Fig. 8.60a) is again representing the relative abundance of the newest issues, coins from the 40s and 30s BC, in contrast to the oldest issues from the 150s, 140s, 130s *etc.* Year 143 is rare with only two examples. The second axis is more difficult to interpret. The extreme species, year 65, is rare. The abundant years at the positive end of the first axis include 88, 87, 132 and 81 BC.[41] All the years from 49–40 are at the negative end of the second axis and include some of the most abundant years.[42] We can interpret this axis as representing the relative abundance of issues from the 40s BC contrasted to issues from the late 90s and 80s BC. There are exceptions but these are usually rare species.

The sample map (Fig. 8.60b) shows a number of groups and outliers. These groups do not reflect the country of origin of the hoards. The four Italian hoards are quite spread out. The Bulgarian hoard (TOP) is closely similar to an Italian hoard (ES1). A Romanian, Yugoslav and Italian hoard (SEI, GAJ & ME1) are closely grouped.

The cumulative percentage graphs show that there is a less extreme difference between hoards than has been the case with some previous data sets. Cerriolo (CRR) has the most modern profile, and Niederlangen (NIE) has the most archaic profile. Cerriolo's position is primarily determined by the legionary issue of 32 BC which accounts for 24% of this small hoard. The Niederlangen hoard has only one coin post-64 BC. This profile is rather unusual. Crawford (RRCH 452) does not categorise this coin as 'extraneous' and given that the hoard comes from 'free' Germany, we cannot disregard it as extraneous without other cause.

[41] 88: 72 coins; 87: 52 coins; 132: 21 coins; 81: 95 coins.
[42] For example 46: 527 coins; 49: 363 coins; 47: 208 coins.

code	hoard	country	'end date'	'good total'
ALA	Cortijo del Álamo	Spain	29	130
BEA	Beauvoisin	France	29	195
CDA	Castro de Alvarelhos	Portugal	29	3447
CDS	Citânia de Sanfins	Portugal	29	281
CRR	Cerriolo	Italy	29	37
ES1	Este	Italy	29	67
GAJ	Gajine	Yugoslavia	29	88
LMP	Lampersberg	Austria	29	52
ME1	Meolo	Italy	29	506
NIE	Niederlangen	Germany	29	62
SEI	Şeica Mică	Romania	29	348
TOP	Topolovo	Bulgaria	29	125
VIG	Vigatto	Italy	29	737

Table 8.25: Hoards in data set `fin29.dat` used in CA discussed in section 8.3.20.

	Şeica Mică (SEI)	Castro de Alvarelhos (CDA)	Cortijo del Álamo (ALA)
92–80 BC	40.8%	17.4%	16.1%
49–40 BC	17.8%	27.7%	30.0%
39–29 BC	1.1%	3.2%	14.6%

Table 8.26: Details of three hoards in data set `fin29.dat` to illustrate the results of the analyses—see main text.

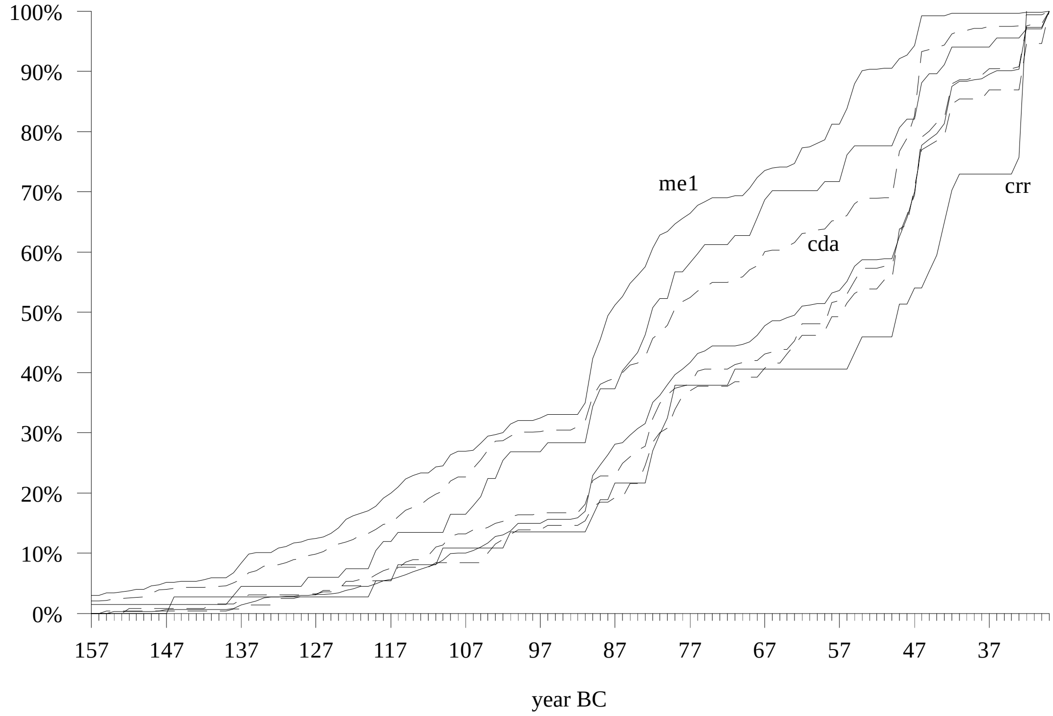
The Meolo I hoard (ME1) is more of a problem. Only four coins (0.8%) post-date 46 BC which makes it rather archaic. On the basis of previous analyses, we would expect the Romanian hoard, Şeica Mică (SEI), to have an archaic profile but it is less expected for an Italian hoard to have such a profile. The Meolo hoard has a reliable coin list and therefore this profile is real, not an artefact of post-recovery factors.[43]

The Castro de Alvarelhos hoard (CDA) is the second largest hoard with detailed information currently in the database. It was found with a number of silver ingots weighing 3.25kg in total (Torres 1979). This hoard is the only one in the bottom left quadrant of the species map (Fig. 8.60b). It is the only hoard with relatively few coins of the 80s BC, relatively few coins of the 30s BC but many coins of the 40s. Table 8.26 is provided to help illustrates the pattern revealed by the analysis.

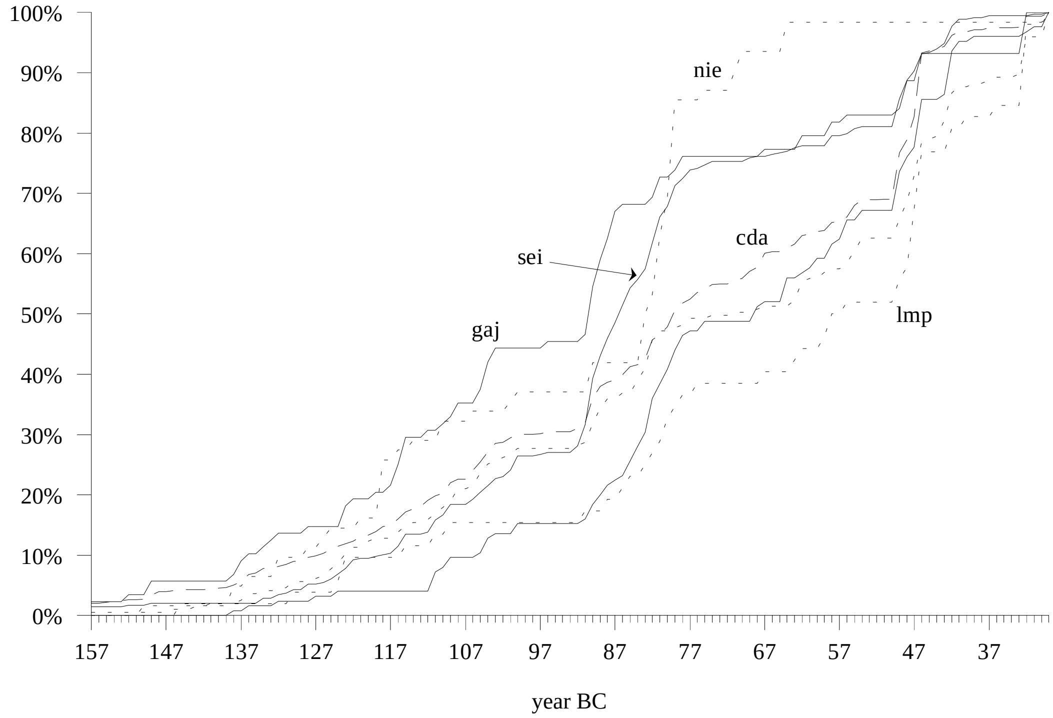
Summary

The thirteen hoards in this analysis are all quite similar. The Niederlangen hoard is exceptionally archaic. Şeica Mică is archaic in keeping with Romanian hoards generally athough it is not extremely

[43]Gorini (1974–1975) states that this hoard contained 515 coins. It is possible that some ten coins were lost but this is a insignificant proportion of the total. Of these, 213 are preserved at the Museum in Venice, the remainder were given to the landowner but are known from manuscript notes made by B. Forlatti. Gorini also notes that there appears to be only 2–4 coins of each magistrate apart from coins of 89–88 BC

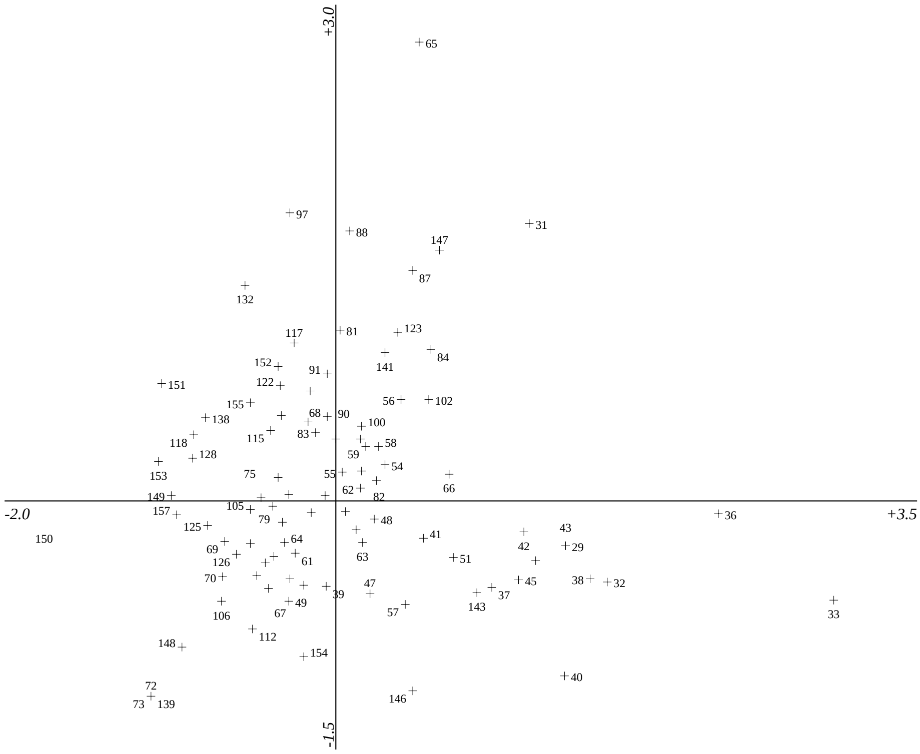


(a) Solid lines: Italy; dashed lines: Spain and Portugal.

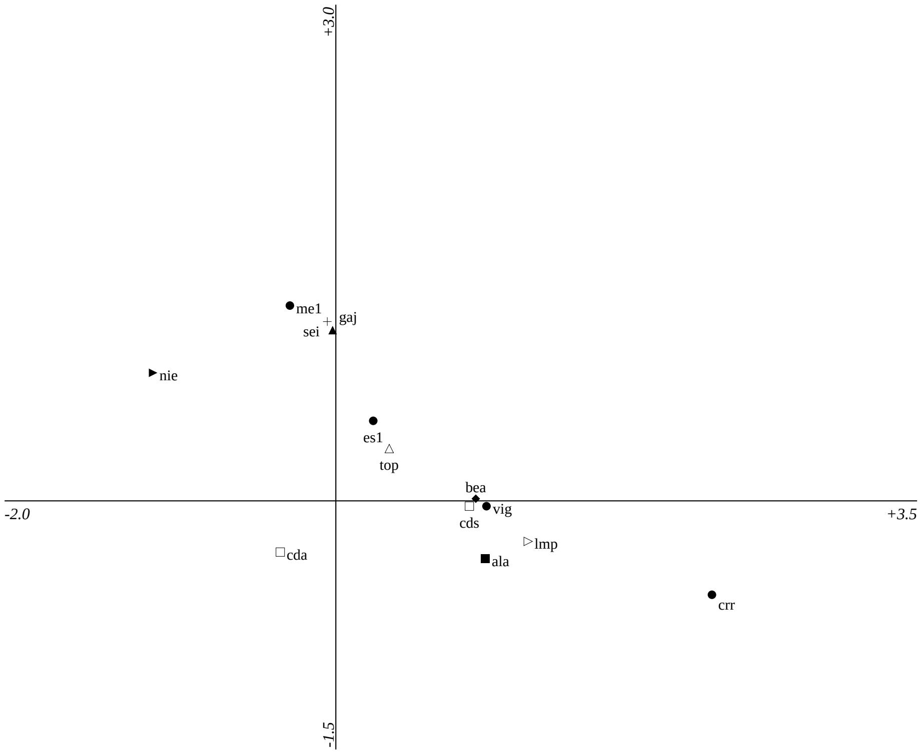


(b) Solid lines: Romania, Bulgaria and the former Yugoslavia; dotted lines: France, Germany and Austria; dashed line CDA (for comparison with Fig. 8.59a).

Figure 8.59: Cumulative percentage graphs of hoards in data set `fin29.dat`.



(a) Species map: data points are years.



(b) Sample map: data points are hoards. ● Italy; ■ Spain; □ Portugal; ▲ Romania; △ Bulgaria; ⧫ France; ▶ Germany; ▷ Austria; + Yugoslavia.

Figure 8.60: Map from CA of data set `fin29.dat` discussed in section 8.3.20. First (horizontal) and second principal axes of inertia.

archaic. The Italian hoards do not cluster in the CA but the maximum difference is not great, and is mainly due to the large numbers of legionary *denarii* in the Cerriolo hoard. Castro de Alvarelhos is moderately unusual in its age profile. This is perhaps due to its size which might suggest that normal processes of hoard formation, *i.e.*, random selection from the coinage pool, are not applicable here. The French, Austrian, Spanish and the other Portuguese hoards are unremarkable.

8.3.21 Hoards closing 19–15 BC

Data set `fin19.dat` contained 13 hoards closing in 19–15 BC (Table 8.27). They contained 2282 *denarii*. Years 211–158 formed 0.26% of the data set and were omitted from the CA. Fig. 8.61 is the cumulative percentage graph of this data; Fig. 8.62 presents the maps from CA.

The first analysis on this data set represented Bordeşti (BRD) as an outlier due to two unique years, 97 and 16 BC. The analysis was re-run omitting those coins.

The species map (Fig. 8.62a) does not present a clear picture. The latest years such as 15, 18, 19 and 21 BC are scattered around the map. The first axis accounts for only 16.1% of the variation in the data, second axis accounts for 14% (Table 8.4). Both axes are, however, significant.[44]

The sample map (Fig. 8.62b) shows a more regular patterning. Both Italian hoards are plotted in the top right quadrant, both Iberian peninsula hoards in the top left, all bar one Romanian hoard in the bottom right. The two French hoards have the same score on the second axis, but quite different scores on the first. Neither axis orders the hoards according to their closing dates. For example, Penamacor and Poiana (PEN & 1PO) both close in 15 BC but are placed at opposite extremes of the map. Unfortunately, both Iberian peninsula hoards close in 15 BC while the Italian hoards close in 19–18 BC which makes it difficult to be entirely sure whether the time gradient or other factors have created these results.

Examining those species with a reasonable abundance we find that years 66, 25, 19, 18 and 15 are at the negative end of the first axis.[45] Note that there are no coins for years 16, 17 and 20. Year 21, which occurs at the positive end of the first axis, is rare. Many years with a low abundance are found at the positive end of the axis, and many of these are older issues. The most abundant early examples date from 130–114 BC.[46] We also find that all but one year from the 30s BC also has a positive score on the first axis.

On the second axis the group of outliers in the bottom right corner all have low abundance (155, 27, 140 *etc.*). Most years from 92–80 have a negative score and are reasonably abundant. The most abundant years with a positive score are 74, 56, 33, 32, 25 and 15.[47] Of the rarer years many of those from the 60s and 50s have positive scores as well.

We can conclude that the first axis is generally representing hoards with many of the newest coins compared to the oldest coins and coins from the 30s BC. The second axis is representing hoards with coins from 92–80 BC compared to hoards with newer coins, especially those from 32, 25 and 15 BC.

[44] First axis $\chi^2 = 2274 \times 0.165 = 375.21$; second axis $\chi^2 = 2274 \times 0.144 = 327.46$. Critical figure for 12×118 degrees of freedom: 215. Critical figure estimated graphically from Pearson & Hartley 1976.

[45] 66 BC: 6 coins; 25 BC: 7 coins; 19 BC: 127 coins; 18 BC 46 coins; 15 BC: 16 coins.

[46] For example: 130 BC: 7 coins; 125 BC: 6 coins; 124 BC: 18 coins; 116 BC: 17 coins; 144 BC: 11 coins.

[47] 74 BC: 9 coins; 56 BC: 33 coins; 33 BC: 9 coins; 32 BC: 111 coins; 25 BC: 7 coins and 15 BC: 16 coins.

code	hoard	country	‘end date’	‘good total’
1PO	Poiana†	Romania	15	141
ABE	Abertura†	Spain	15	38
BOU	Bourgueil	France	18	689
BRD	Bordeşti	Romania	16	43
CNT	Conţeşti†	Romania	15	141
CRN	Cornii de Sus	Romania	18	110
MAI	Maillé	France	19	421
MED	Medovo	Bulgaria	19	150
PEN	Penamacor†	Portugal	15	81
PLP	Plopşor	Romania	19	51
SPG	Şpring†	Romania	15	49
SSR	Santo Stefano Roero	Italy	19	97
ZAR	Zara	Italy	18	271

Table 8.27: Hoards in data set `fin19.dat` used in CA discussed in section 8.3.21. † Also occurs in data set `fin15.dat`.

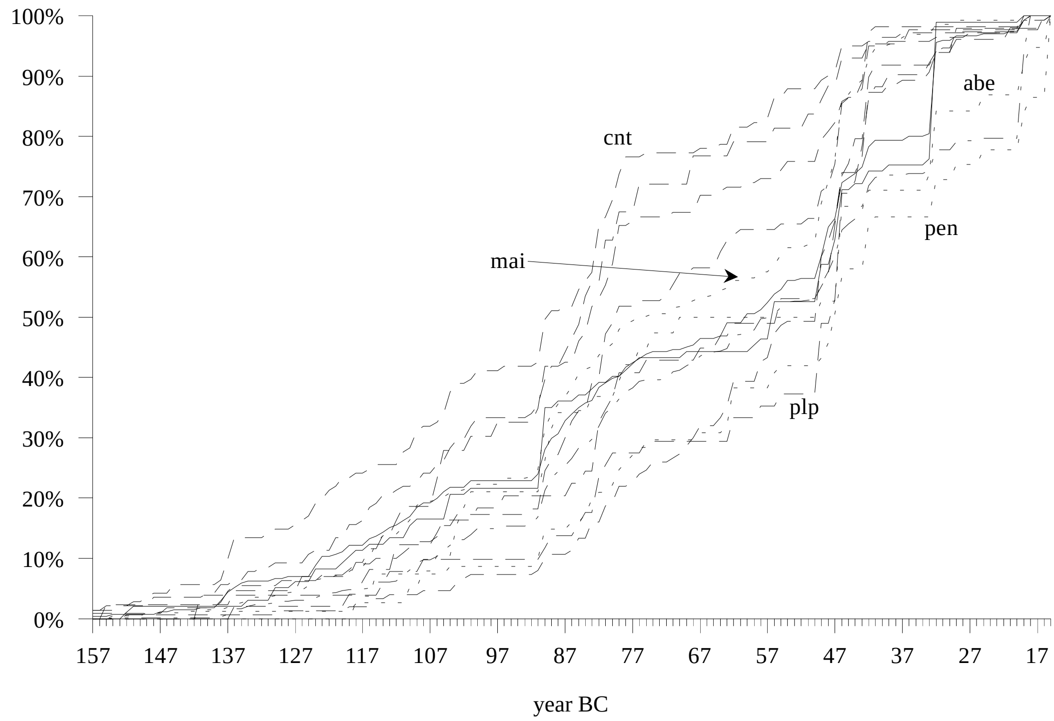
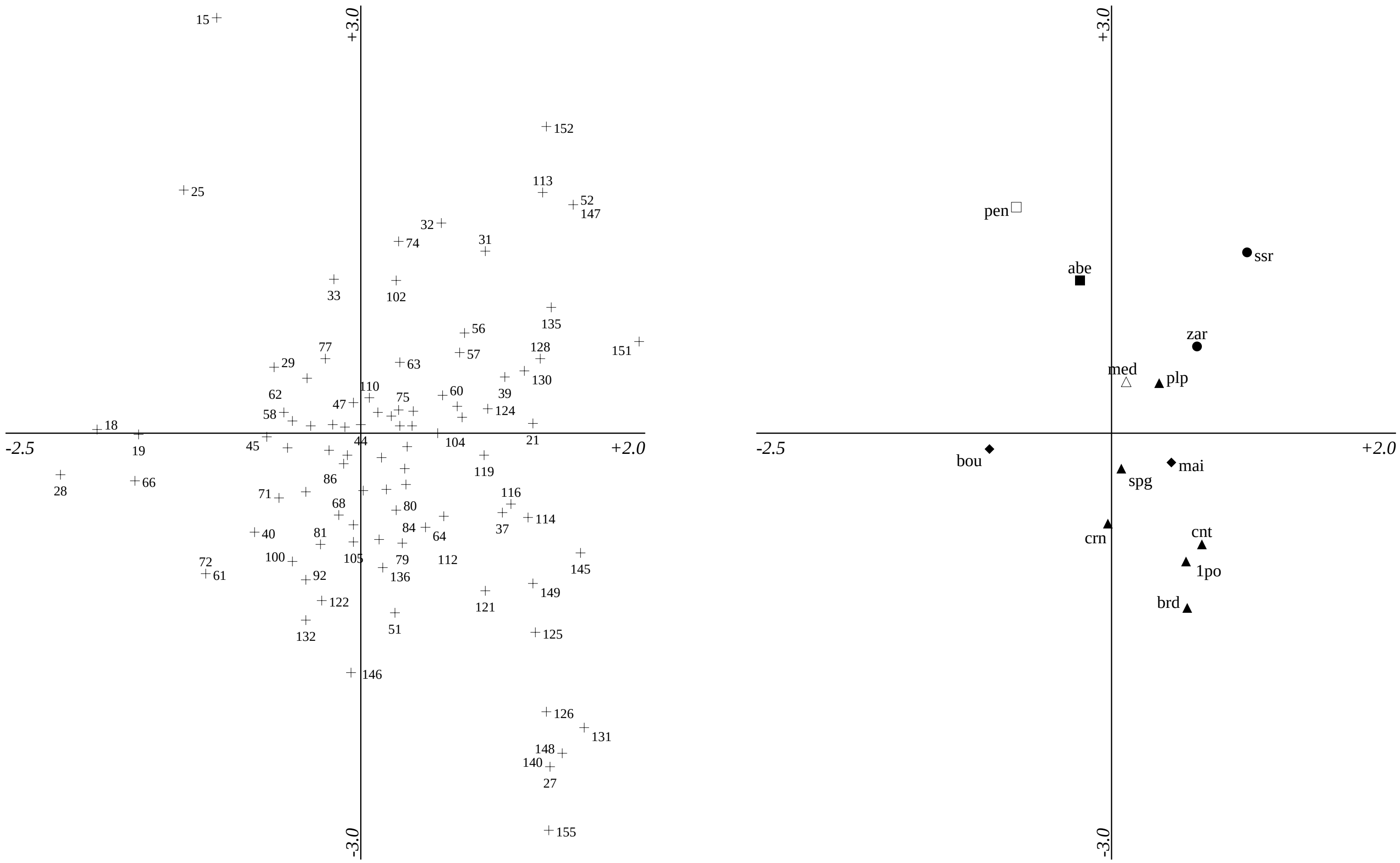


Figure 8.61: Cumulative percentage graphs of hoards in data set `fin19.dat`. Solid lines: Italy; dashed lines: Romania and Bulgaria; dotted lines: Maillé, Spain and Portugal; dash-dot line: Bourgueil.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ■ Spain; □ Portugal; ▲ Romania; △ Bulgaria; ⧫ France.

Figure 8.62: Maps from CA of data set `fin19.dat` discussed in section 8.3.21. First (horizontal) and second principal axes of inertia.

The cumulative percentage graph (Fig 8.61) shows both Italian hoards with large quantities of coins of 32 BC. The four hoards at the positive end of the second axis have the highest quantities of these coins.[48] The Bourgueil hoard has exceptional numbers of coins of 19–18 BC but few coins of 32 BC, hence its location near the origin of the second axis.

The Iberian peninsula hoards are characterised by having relatively more coins post 32 BC than other hoards but are separated from Bourgueil on the sample map by virtue of having a higher percentage of coins of 25 BC, and their later closing date.

The cumulative percentage graph shows some Romanian hoards with a very archaic profiles. For example, coins from before 74 BC account for 52–77% of CRN, BRD, 1PO & CNT.[49]

Four hoards (MED, PLP, CRN & SPG), all from Romania and Bulgaria, are poorly represented on the first two axes of inertia.[50] For MED, PLO & SPG years from 49–40 account for 38–51% of these hoards. These years are also poorly represented on the first two axes. In Fig. 8.61 the line for Plopşor, for example, can be clearly seen cutting across those for Italian hoards.

Summary

Of the Romanian hoards, Bordeşti, Poiana, Conţeşti and Cornii de Sus (BRD, 1PO, CNT & CRN) have archaic profiles similar to other Romanian hoards in previous analyses. The remaining Romanian and Bulgarian hoards do not fit the two-dimensional maps well, having relatively few older and newer coins but relatively more coins of the 40s BC. The Italian hoards have relatively more coins of 32 BC compared to newer coins and the older coins. The Iberian peninsula coins have relatively more coins of 19–15 BC compared to older coins and coins of 32 BC. Bourgueil (BOU) has a large proportion of coins of 19–8 BC but few of 32 BC or, because of its closing date, 15 BC.

In previous analyses the simple archaic to modern age profile gradient often seen could be adequately represented in the two dimensions of a CA map. This data set with its more complicated pattern, shown clearly by the number of crossing lines in Fig. 8.61, cannot. The first axis accounted for 16.1% of the variation, the fourth axis for 11.9%! However, four groups seem possible. Those mainly associated with post 32 BC coins: PEN, ABE, & BOU; those with 32 BC: SSR & ZAR; those with coins of the 40s BC: MAI, PLP, MED & SPG; and finally those with mainly older coin: BRD, 1PO, CNT AND CRN.

8.3.22 Hoards closing 15–11 BC

Data set `fin15.dat` contained 10 hoards closing in 15–11 BC (Table 8.28). They contained 1437 *denarii*. Years 211–158 formed 0.63% of the data set and were omitted from the CA. Fig. 8.63 is the cumulative percentage graph of this data; Fig. 8.64 presents the maps from CA.

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[48] SSR: 22.7%; ZAR: 15.1%; ABE: 10.5%; PEN: 6.2%; *cf.* BOU: 3.5%; BRD, CNT & CRN: 0%.

[49] Coins before 74 BC: CNT: 77.3%; BRD: 72.1%; 1PO: 66.7%; CRN: 52.7%.

[50] Due to the complicated nature of this data set the analysis was re-run using IASTATS. The output with its excellent diagnostic statistics was merged with a list of years from dBASE to overcome the lack of labels. The output gives the 'quality' of the representation of units and variables and ranges from 0 to 1000. For CRN, MED, PLP & SPG the quality is 84, 69, 47 and 1 respectively.

code	hoard	country	'end date'	'good total'
1PO	Poiana†	Romania	15	141
ABE	Abertura†	Spain	15	38
CET	Cetăţeni	Romania	13	124
CIU	Ciuperceni	Romania	12	161
CNT	Conţeşti†	Romania	15	141
GAL	Gallignano	Italy	13	432
PEN	Penamacor†	Portugal	15	81
SG1	Sfîntu Gheorghe	Romania	13	61
SPG	Şpring†	Romania	15	49
STB	Strîmba	Romania	11	209

Table 8.28: Hoards in data set `fin15.dat` used in CA discussed in section 8.3.22. † Also occurs in data set `fin19.dat`

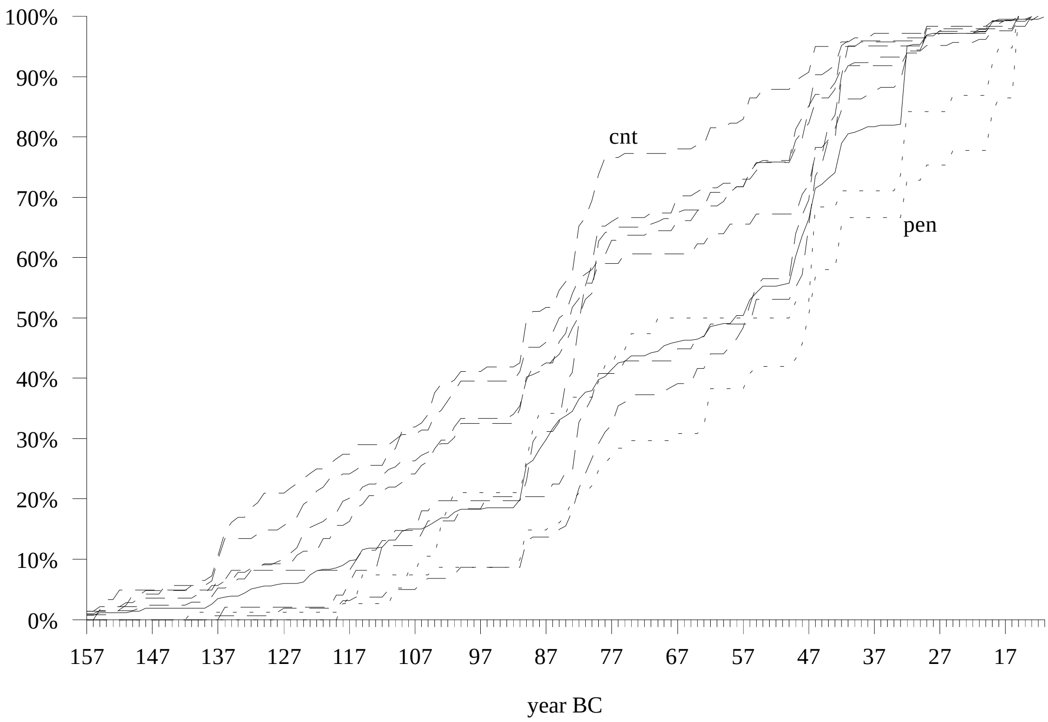
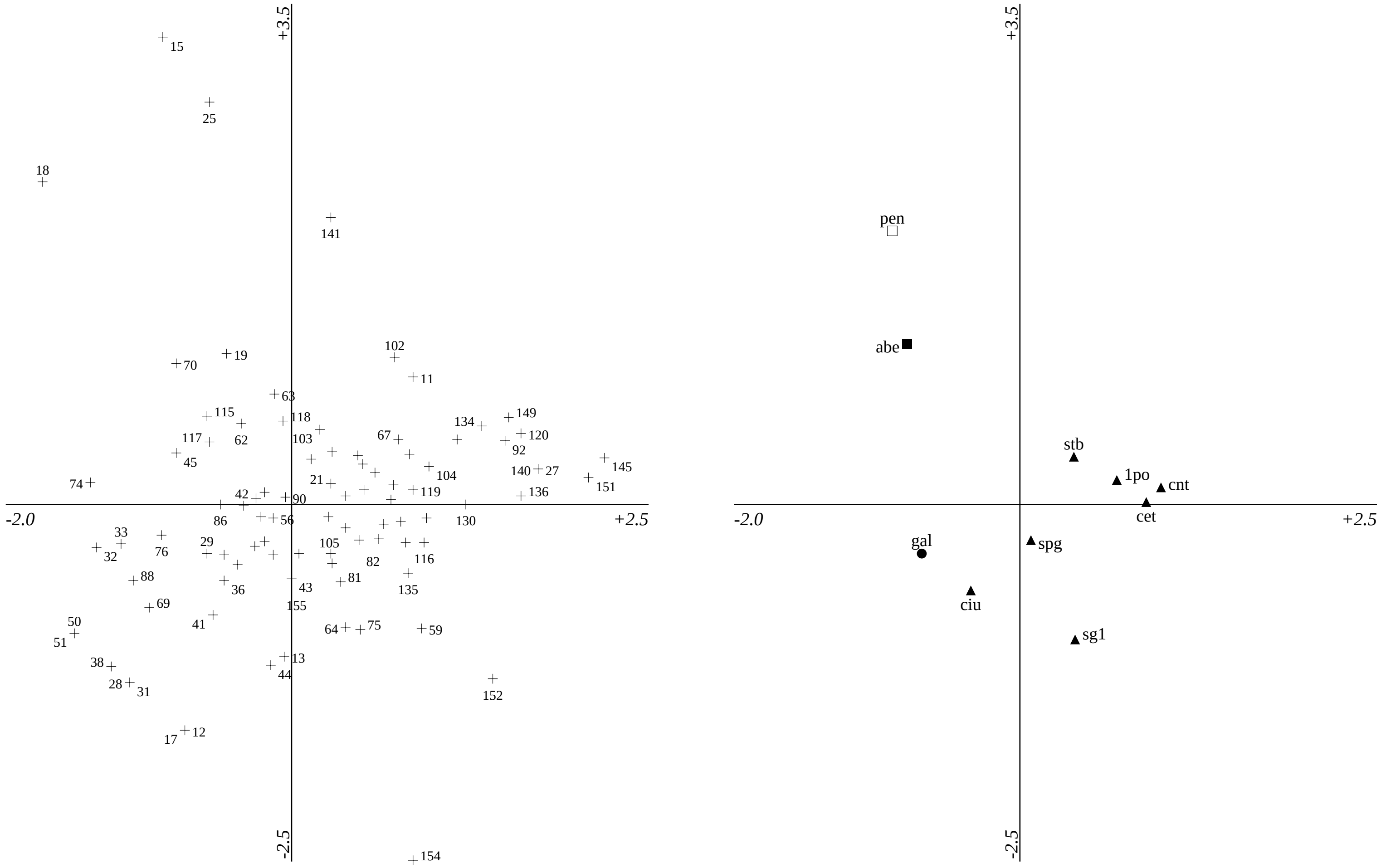


Figure 8.63: Cumulative percentage graph of hoards in data set `fin15.dat`. Solid lines: Italy; dashed lines: Romania; dotted lines: Spain and Portugal.



(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ■ Spain; □ Portugal; ▲ Romania.

Figure 8.64: Maps from CA of data set `fin15.dat` discussed in section 8.3.22. First (horizontal) and second principal axes of inertia.

The first axis (Fig. 8.64a) is representing the contrast between the abundant newest coins, especially those from 32, 19 and 15 BC against the older coins, especially those abundant issues from 136–119 BC. There is a scatter of rare species of all years along the axis. The second axis is representing the newest years from 25, 19, 18 and 15 BC contrasted to years 32–89. The newest coins, years 13–11 BC, are rare.

Some previously important years are poorly represented on this map. For example, 90 BC, an abundant year with 72 coins, is at the origin of the map. Its distribution across the hoards is even, and the observed variation is not associated, for example, with geographical location. The following five figure summary demonstrates this:

Coins of 90 BC

#10			
M5h		4.6	
H3	4.1		5.2
1	0.0		7.1

The sample map (Fig. 8.64b) is comparable to the sample map from CA of the previous data set. The Spanish and Portuguese hoards, which were carried over from data set `fin19.dat`, remain the most modern in age profile (Fig. 8.63) and are placed together in the top left quadrant of the map. The Italian hoard, Gallignano (GAL), has few coins post-32 BC. It has, however, more coins of 32 BC than the Romanian hoards. The Romanian hoards are in a separate, if slightly dispersed group, on the sample map. They are either very archaic and mainly associated with years prior to the mid-70s BC, or are associated with issues from the 40s BC, *e.g.*, Şpring (SPR). The pattern is simpler than previously, allowing the first two axes to represent 36.5% of the variation in the data.

The hoards can be divided in four groups again. Group one has relatively few coins after the mid 70s BC (STB, 1PO, CNT & CET); group two has few coins after the 40s (SPG, CIU & SG1); group three has few coins after the 30s (GAL); and group four has the newest coins (PEN & ABE). These groups can be clearly seen in Figs. 8.63 and 8.64b.

8.3.23 Hoards closing 8–2 BC

Data set `fin8.dat` contained 10 hoards closing in 8–2 BC (Table 8.29). They contained 1709 *denarii*. Years 211–158 formed 0.18% of the data set and were omitted from the CA. Fig. 8.65 is the cumulative percentage graph of this data; Figs. 8.66–8.68 are the maps from CA.

The first sample map (Fig. 8.66b) is dominated by Viile (VII) on the first axis. Fig. 8.65 shows this hoard to have an exceptionally archaic profile. It is also unusual in that it does not show the usual sharp rises in the 80s or 40s BC as might be expected from previous analyses.[51] The species map (Fig. 8.66a) shows the scatter of early years particularly associated with this hoard. The list

[51]The Viile hoard (Ocheşeanu & Papuc 1983–1985) was found in a handled Dacian vase by an inhabitant of the village. The authors state (p. 128) that the capacity of the vase is larger than the 51 coins recovered and therefore some of the hoard may be dispersed.

code	hoard	country	'end date'	'good total'
AQU	Aquileia	Italy	2	559
BAG	Bagheria	Sicily	2	311
BRZ	Breaza	Romania	8	131
BYL	Bylandse Waard	Netherlands	2	60
ES2	Este	Italy	7	281
KL1	Köln (I)	Germany	2	33
PIS	Vico Pisano	Italy	2	159
PRA	Pravoslav	Bulgaria	8	58
RDJ	Răcătău de Jos I	Romania	8	67
VII	Viile	Romania	2	50

Table 8.29: Hoards in data set `fin8.dat` used in CA discussed in section 8.3.23.

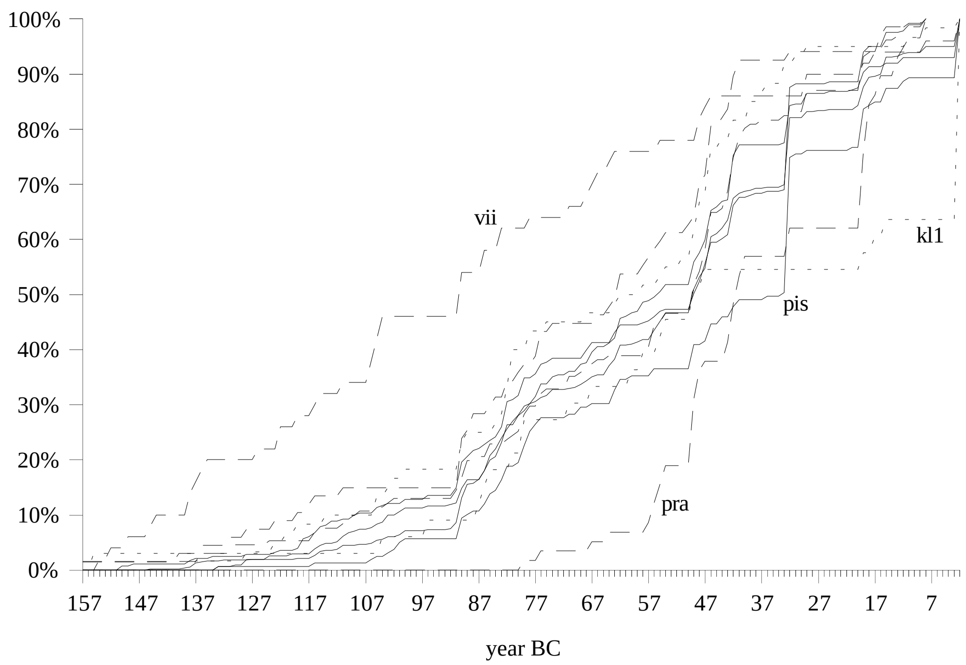
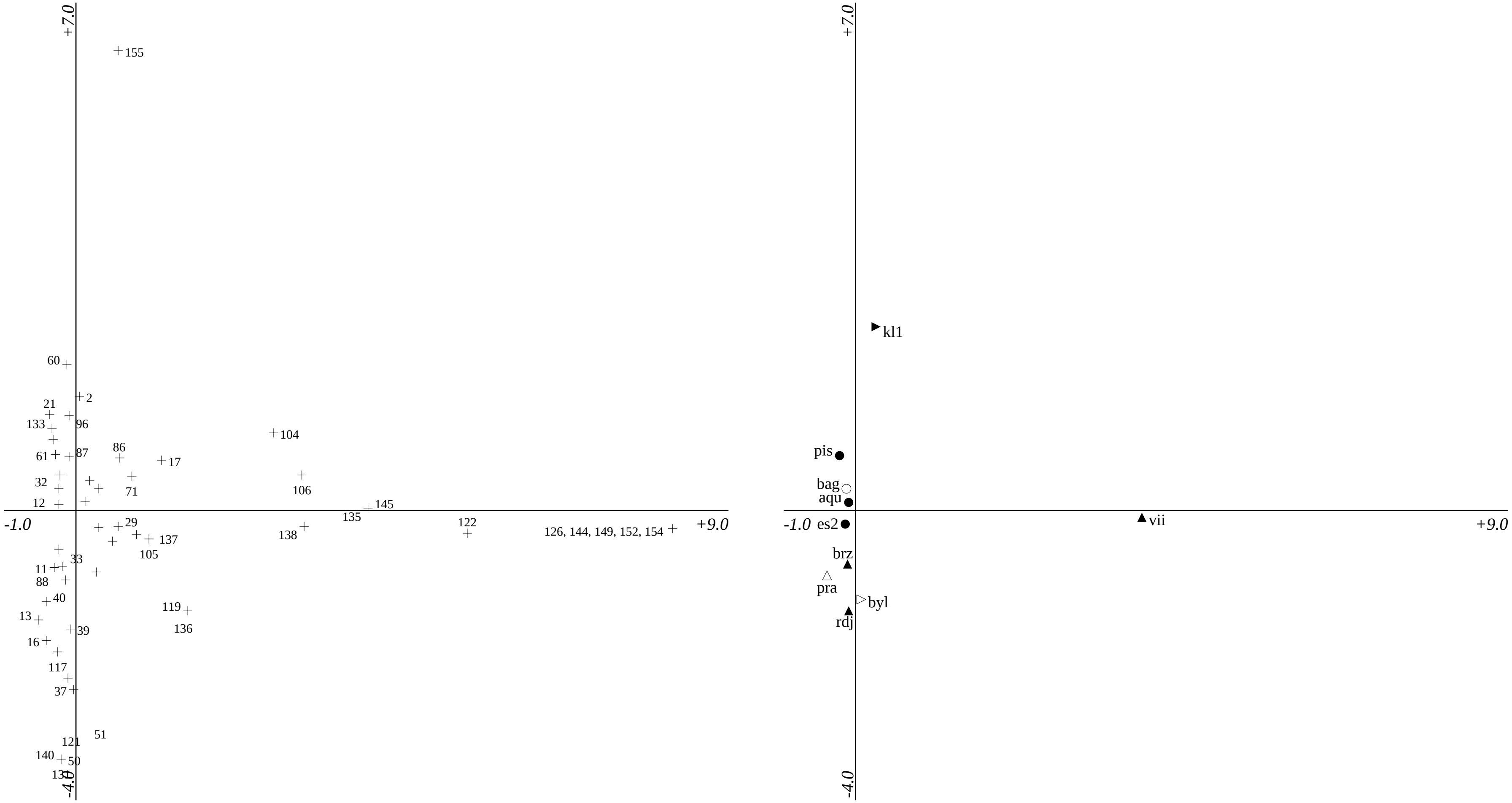


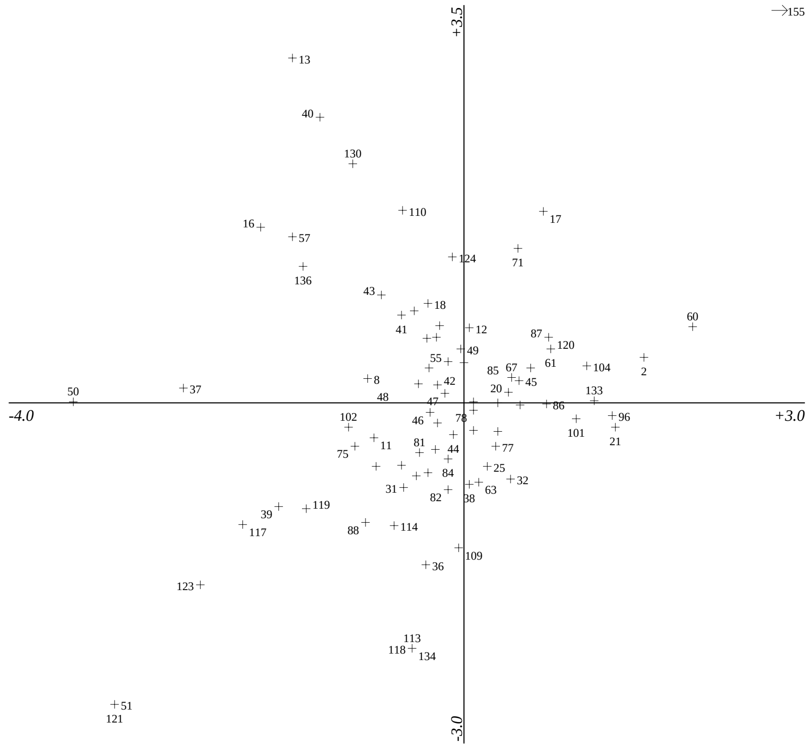
Figure 8.65: Cumulative percentage graph of hoards in data set `fin8.dat`. Solid lines: Italy and Sicily; dashed lines: Romania and Bulgaria; dotted lines: Germany and the Netherlands.



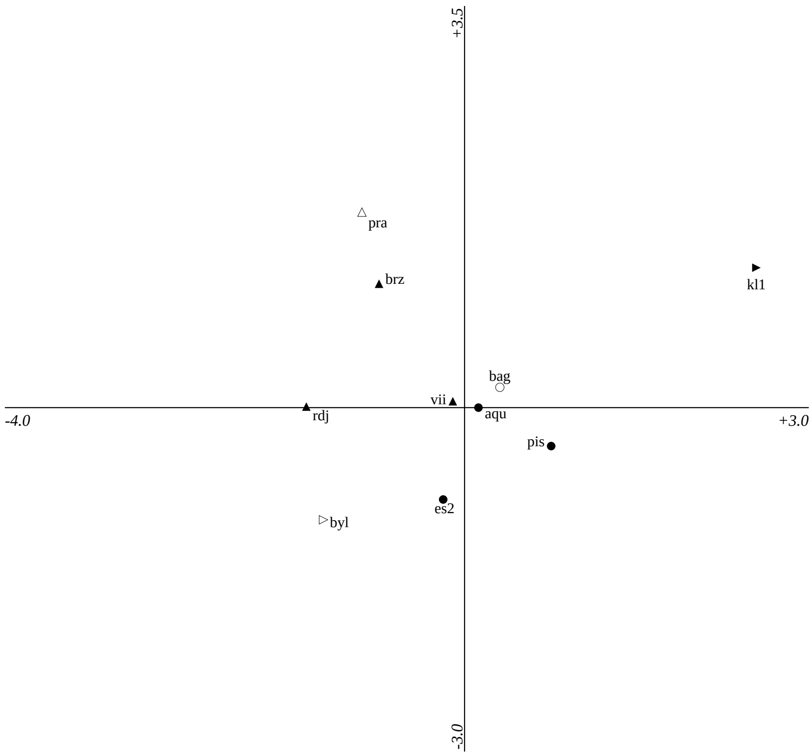
(a) Species map: data points are years.

(b) Sample map: data points are hoards. ● Italy; ○ Sicily; ▲ Romania; △ Bulgaria; ▶ Germany; ▷ the Netherlands.

Figure 8.66: Maps from first CA of data set `fin8.dat` discussed in section 8.3.23. First (horizontal) and second principal axes of inertia.



(a) Species map: data points are years. Year 155 at co-ordinates 6.35, 3.29.



(b) Sample map: data points are hoards. ● Italy; ○ Sicily; ▲ Romania; △ Bulgaria; ▶ Germany; ▷ the Netherlands.

Figure 8.67: Maps from first CA of data set `fin8.dat` discussed in section 8.3.23. Second (horizontal) and third principal axes of inertia.

of species at the extreme of the first axis are all unique and only found in the Viile hoard. Those species in the middle of the map are slightly more common but still to be mainly found in Viile.[52]

The second sample map (Fig. 8.67b) shows the second and third axes of inertia. Viile is now at the origin of the map and is poorly represented. Köln I (KL1) is at the positive end of the second axis. On the species map (Fig. 8.67a) Year 2 is the first on the second axis with a reasonable abundance (87 coins). The Köln hoard contains 12 coins (36%) from that year. These coins are the abundant C. L. Caesares issue which were probably minted in Gaul at Lugdunum (RIC 1, 207–212, 2 BC–(?)AD 4). The four hoards at the negative end of the second axis have none of these coins. These four hoards (PRA, BRZ, RDJ & BYL) are associated with a mixture of rarer species. Of significance is year 8 which has 15 coins in the data set. Hoards Pravoslav, Breaza and Răcătău de Jos (PRA, BRZ & RDJ) close at that date and it is thus unsurprising that they are associated with it. Bylandse Waard (BYL), however, does not close until 2 BC, but has a coin (1.7%) of that date, the third highest percentage. Köln, which closes at the same date as Bylandse Waard, has no coins of that year. The negative end of the second axis is also associated with hoards with many coins of the 40s BC.[53]

The third axis is even more difficult to interpret. Of the 11 years with a score of over 1.0, none have more than 9 coins. Of the 53 coins from these years, 23 come from Pravoslav and Breaza. These years are an odd mixture — in order they are 155, 13, 40, 130, 110, 17, 16, 57, 71, 124 and 136. Years 13, 17 and 16 account for 16 of the 53 coins. Of these, 5 come from Pravoslav, 2 from Breaza. Fig. 8.65 shows that Pravoslav has a large proportion of coins from 19–16 BC.[54] In contrast, the negative end of the third axis has most years from 91–81 including the abundant years 90, 85, 83 and 82. The Pravoslav hoard has no coins before 79 BC; the Breaza hoard has only 11.4% from these years compared to 21.7% for Bylandse Waard and 17.4% for Este.

The most obvious feature of the Vico Pisano hoard (Fig. 8.65) is the quantity of coins from 32 BC. It is plotted in a similar position on the sample map as 32 BC on the species map, although 32 is not in a extreme position. However, the three hoards with the most coins of this year, Aquileia, Vico Pisano and Este, are the three closest to the species point (AQU, PIS & ES2).[55]

The picture from this analysis is again not clear cut. The sample maps appear to show regional groupings but it is difficult to see patterning in the years associated with these groupings. There is a complicated interaction between the rarer years and their more extreme co-ordinates on the maps, and the more common and, perhaps, more important years, with less extreme values. Despite this, it would appear that the hoards do still form regional groupings with the Italian hoards having an 'average' profile.

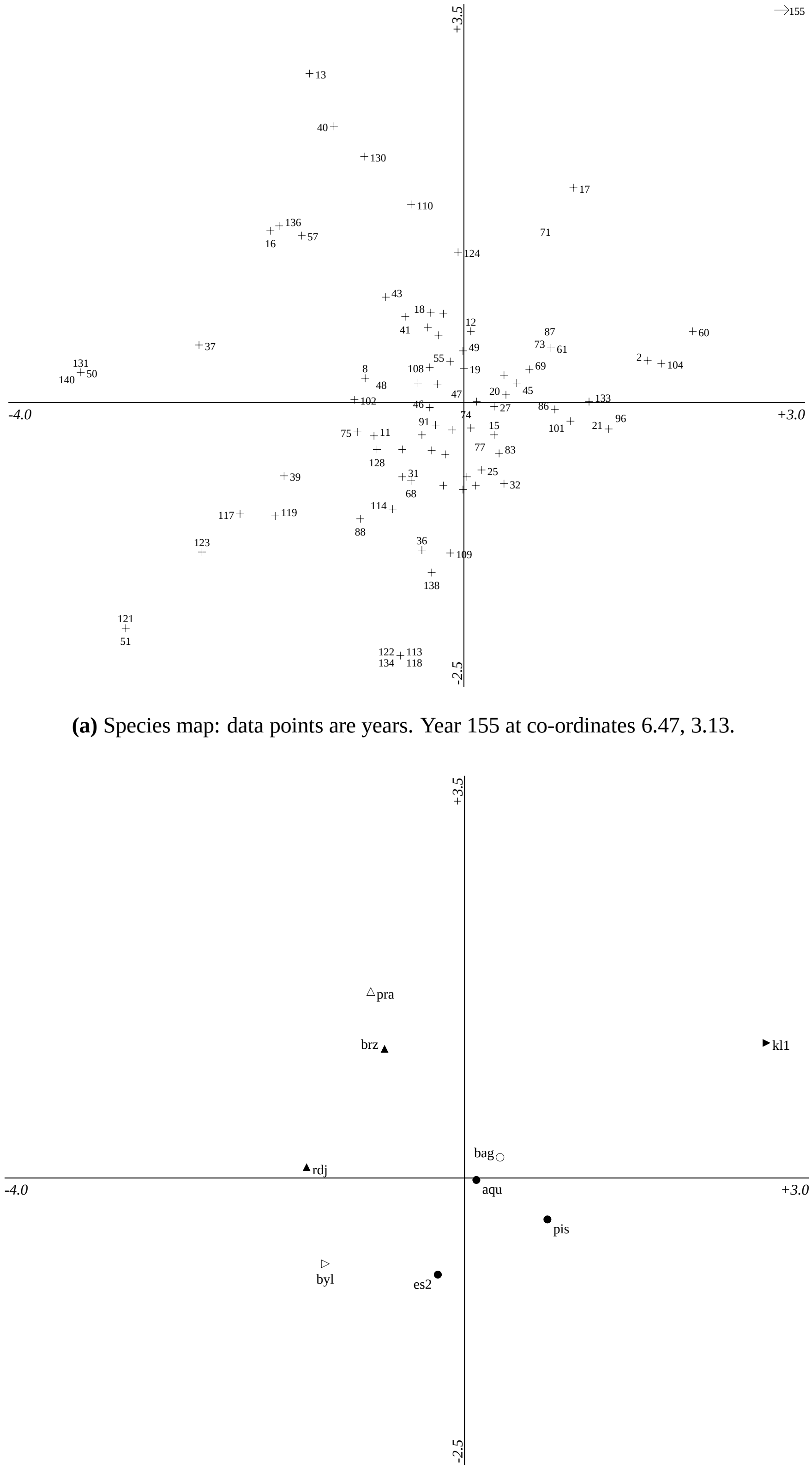
In this analysis we have concentrated on the second and third axes due to the easily explicable dominance of Viile on the first axis. An alternative procedure would be to remove Viile from the

[52] For example, 106 BC, 5 coins of which 2 are in Viile, 2% of the hoard; 104 BC, 6 coins of which 2 are in Viile, 2% of the hoard.

[53] Coins from 49–40 account for 37.9% of PRA; 33.6% of BRZ; 29.8% of RDJ; 25% of BYL. Conversely, KL1 only has 9.1%.

[54] Years 19–16 BC account for 27.6% of PRA. They account for only 0–8.2% of other hoards. They account for only 6.1% of KL1.

[55] Coins of 32 BC: PIS 24.5%; ES2 18.5%; AQU 12.1%; *cf.* other hoards 0–6.7%.



(a) Species map: data points are years. Year 155 at co-ordinates 6.47, 3.13.

(b) Sample map: data points are hoards. ● Italy; ○ Sicily; ▲ Romania; △ Bulgaria; ▶ Germany; ▷ the Netherlands.

Figure 8.68: Maps from second CA of data set `fin8.dat` discussed in section 8.3.23. First (horizontal) and second principal axes of inertia.

data set and re-run the analysis. Fig. 8.68 shows the first and second axes from an analysis omitting Viile. The result is almost identical to the second and third axes of the first analysis (*cf.* Fig. 8.67). This will be discussed further in section 8.4.3.

8.4 Summary, conclusions and problems

This section will attempt to stand back from the mass of detail presented in the previous section and to summarise the results. Firstly, a series of regional summaries are presented, followed by a discussion of some numismatic aspects of the data. Finally, some obervations on the use of CA in the analysis of hoard data will be made.

8.4.1 Regional patterns

Italy

The majority of the hoards analysed come from Italy, including Sicily, Sardinia, Corsica, Elba and San Marino. For much of the period under examination the majority of the coins were minted here, mainly in Rome itself.

For the early period, insufficient hoards were available for analysis to permit very detailed conclusions. However, the remarkable homogeneity of hoards of similar closing dates was noted. It is also *possible* that the earliest *denarii* remain better represented in Sicilian hoards than mainland Italian hoards despite having 60–90 years for their distribution to homogenise.

The pattern for the period 118–97 BC is difficult to interpret (sections 8.3.3–8.3.4). With the current chronology for these issues, it appears that Italian hoards occur in 118–112 BC, and then from 103 BC. This contrasts with the Spanish material which occurs from 115 BC onwards including seven hoards in the period 110–104 BC. All issues in this period, except for the Narbo issue of 118 BC, were minted in Rome. The Italian hoards from 118–112 are homogeneous, as are the majority of the hoards from 103–97 BC.[56] The most interesting aspect of this period is the comparison of these hoards with the Spanish material and will be discussed below (page 253).

All the hoards from 92–87 BC analysed come from Italy or Sicily (section 8.3.5). Most of these hoards are very homogeneous except for the latest two which have very modern profiles. This is the result of the massive issues minted during and after the Social War (91–89 BC; Scullard 1982, pp. 63–8). The effect of these coins can be seen clearly in the next period (87–81 BC) where there are large differences in the coinage pool (section 8.3.6). The newest coins had not been in circulation for long enough for their distribution to become even and this, coupled with the large size of the issues in this period, results in large differences between hoards. A beneficial aspect of this is that these large differences allow us to examine the flow of coinage within the coinage pool. As might be expected, Sardinia and Isola Pantelleria have archaic local coinage pools, *i.e.*, the newest coins had yet to reach there in quantity. More unexpected are the archaic hoards from northern Italy in *Gallia Cisalpina*. This area had been under Roman control for some time and although initially

[56] The two exceptions are Manfria (MNF) which appears archaic, but is also the oldest hoard in data set `fin105.dat`, and Ricina (RCN) which has a rather odd profile.

it had a different monetary history (Crawford 1985, chapter 5), one would have expected it to be integrated into the mainstream Italian economy by this period. Within peninsula Italy and Sicily the hoards are still variable but are relatively homogeneous. There is a large difference between them and the archaic hoards. Unfortunately, we have as yet only two northern Italian hoards from this period and caution is called for. It is, however, an interesting discovery and one which would repay further research.

The 70s BC are a period of increasing homogeneity between hoards (sections 8.3.7–8.3.10). This is a result of the distribution of the large issues of the Social War and the 80s BC slowly becoming even as the *denarii* circulate around Italy and Sicily, and the issues of the 70s being relatively small. By the end of the 70s the similarity between Italian hoards is so marked that some hoards, such as Villa Potenza and Ossero (VPT & OSS) are almost identical. The CAs cease to be able to identify meaningful variation between hoards.

Perhaps the most notable aspect of this decade is the large numbers of hoards dated to 74 BC. Whereas only four hoards of 30+ *denarii* date to the Social War (91–89 BC), 22 hoards date to 74 BC. It has been argued that some years may be over-represented due to the size of the issues (page 137). Apart from the odd hoard of Érd, coins of 74 BC only form at most 4.7% of the coinage pool, and rarely more than 3% (see Fig. 9.7b in the next chapter). Spartacus' revolt did not take place until the following year and was crushed in 71 BC by Crassus and M. Lucullus (Scullard 1982, pp. 92–3). This pattern is easily explained. Although the issues of 74 BC were relatively small, they were much larger than those that followed. There are only 4 coins of 73 BC in all the hoards in the CHRR database with 30+ *denarii* and they form <0.5% of any hoard; there are only 19 coins of 72 BC forming at most 1.5% but usually <1%. It is likely that many of the hoards with closing dates of 74 BC actually closed later, and some of these are likely to be as a result of the revolt. It is an interesting observation that the revolt appears to have resulted in the non-recovery of a larger number of hoards than the Social War.

Very few Italian hoards closed during the 60s and 50s BC. This is due to a combination of factors. Firstly, as Crawford notes, this was a period of relative peace within Italy (Crawford 1969a). Secondly, very few coins were minted in this period compared to the 80s or the 40s BC. Such hoards as there are, for example Mesagne and Sustinenza (MES & SUS) continue to be remarkably similar. Only in the 40s BC do Italian hoards show a degree of differentiation.

The analysis of hoards from 46 BC (sections 8.2.4 & 8.3.14) show the reliable Italian hoards either with an average, and often very similar profile, or with a modern profile. Again, this can be easily explained. A large issue of coins was minted in 46 BC in Spain prior to the battle of Munda where Caesar defeated the Pompeians (Scullard 1982, p. 142). Variations in the coinage pool in Italy in this data set are largely due to this large issue, although the issues from 49–47 BC also contribute significantly. The average hoards are those where the hoarders have only received small quantities of these coins in secondary exchanges. Those with large quantities of these coins were hoarded by those who had either received them as part of a primary exchange or payment, *i.e.*, they obtained the coins direct as part of a state payment, or they had been involved in secondary exchanges with the initial payee, or perhaps slightly further down the line. We can speculate, although this can never be more than speculation, that the most modern hoards were concealed by Caesar's victorious returning troops.

Hoards from the rest of the 40s show a similar pattern (section 8.3.15–8.3.17). Hoards from 39–36 are again remarkably similar and must reflect the relative homogeneity of the Italian coinage pool (section 8.3.18). The large issues of the 40s BC now have a reasonably even distribution. Coin issues of this period seem to be small with only two hoards having more than 2% of their total from any one of these years.[57] This seems to repeat the pattern observed from the 80s and 70s BC.

The huge, debased legionary issue of Mark Antony (RRC 544), minted immediately prior to the battle of Actium in 31 BC, dominates the pattern for 32 BC. The Belmonte del Sannio (BDS) hoard must have been concealed soon after the battle, possibly by a returning defeated soldier, or by a victorius soldier for whom the coins were booty.

For the final period examined (29–2 BC) the patterns are more complex. This is partly because Augustus opened new mints outside Italy, in Gaul and Spain. Also, the date brackets given by RIC 1 are larger resulting in greater clumping of hoards when the closing date is defined as the `date_from`, *i.e.*, the start date of a date bracket of the newest coin. The CA analyses are less able to depict the variation in the hoards successfully in two dimensions.

In this final period there are relatively few hoards from Italy. This trend becomes even more noticable in the first century AD (Guest 1994). Within this material, however, there is a reasonable amount of homogeneity, with only the issues of 32 BC creating variations between the Italian hoards, as might be expected. There are a couple of oddities such as the Meolo hoard (ME1; section 8.3.20) and the Vico Pisano hoard (PIS; section 8.3.23), which despite its late closing date (2 BC) has a comparatively large number of coins of 32 BC.

Perhaps the most remarkable aspect of the Italian material is how *unremarkable* it is. With some exceptions, mainly explainable by data quality, the hoards fit a regular and predictable pattern. The material seems to fit the model proposed in Chapter 6. New coin, in varying amounts, enters the system. Over time the distribution of each type becomes even. Only the massive issues of the 80s allow us to see regional differences and these quickly even out over time. The issues of the 40s BC do not form a recognisable pattern within Italy — the two modern hoards are both from the south of Italy but the four average hoards are from south and central Italy. No hoards analysed from 46 BC are from the north. As issues become older, they also become rarer, as coins are lost, exported or reminted. The incidence of hoards is generally explicable by a combination of periods of 'violence', to use Crawford's (1969a) phrase, and the size of issues. Only towards the end of the period, and in the first century AD, does the pattern change with a decrease, in *silver* hoards which may be due to a period of increased security under Augustus resulting in a decrease or change in the 'hoarding habit' (Guest 1994).

Given this, we can use the Italian pattern as benchmark against which patterns in other regions can be compared, and this is in itself a valuable asset — to use Reece's (1981) phrase, we now know what a 'normal' hoard looks like for this period.

Finally, the archaic nature of the Sardinian material seems to be in contrast with the pattern presented by Rowland (1977). Rowland's paper is, in fact, a classic example of the dangers of interpreting the pattern of coinage in an area with no reference to the wider pattern. The periods

[57] Bylandse Waard (BYL) 2 coins of 39 BC, 3.3% of total hoard, Bordeşti (BRD) 1 coin of 36 BC, 2.3% of the hoard.

he identifies as having high levels of coinage in Sardinia, which he interprets as being the result of military contacts, are in fact periods when large numbers of coins were struck. Analysis of the hoards suggest that Sardinia was, in monetary terms at least, a backwater.

Spain and Portugal

The monetary history of Spain is complicated and a matter of some debate. Before attempting to interpret the patterns identified in section 8.3 the background to the material is presented. In monetary terms, there are three regions of Spain which are of importance. These are the north-east coast and Cataluña including the lower Ebro valley; the upper Ebro and Duero valleys (often known as Celtiberia); and southern Spain mainly along the Guadalquívir valley and its tributaries, an area which includes ancient Turdetania.

Prior to Carthaginian involvement in the area during the Punic wars (Caven 1980), the only coinage were the issues of the Greek colonies on the coast at Emporiae, Rhodes or Gades (Crawford 1985, p. 86). There were local copies of the Emporian coinage struck in its immediate hinterland (Crawford 1985, pp. 86–7; Knapp 1987, pp. 21–2). After Hamlicar's arrival in 237 the Carthaginians minted a large series of gold, silver and bronze issues but these seem to have had little or no effect on the monetary development of the area (Crawford 1985, pp. 87–8). The Punic war also resulted in some new coinages, such as that of Arse (Saguntum; Crawford 1985, p. 88).

Up until the issues of C. Annius in 82–81 BC (RRC 366), the Romans only minted two small issues of *victoriati* in Spain (Crawford 1985, p. 89; RRC 96/1). Between the Punic wars and the last two decades of the second century, very little Roman silver coinage entered the region. Crawford argues that the only two hoards of Roman silver coinage of this period, which are of worn *victoriati*, do not represent the coinage in circulation (Crawford 1985, p. 91).[58] Crawford (1985, p. 90) states:

> Other evidence supports the view that at times in the second century, and even in the first century, Republican coins were slow in arriving in Spain and were not being bought in on a regular basis in the context of the administration of the two provinces.

Crawford then argues (p. 91) that if there was no regular flow of Roman coinage into Spain between 137 BC and the wars with Sertorius (82–72 BC), it is unlikely that the troops were paid in Roman coin.

During this period a number of issues of coinage were struck by the native communities. Knapp (1987) divides the issues into approximately the same three zones used by Crawford noted above. In the coastal region of Cataluña, *drachmae* were issued by Emporiae and issues of silver were struck by centres such as Tarraco (the KESE issues) and AUSEKESKEN (Knapp 1987, p. 21–22). The details of the Catalan chronology remain obscure. The coins of Emporiae were minted in the late third century; the other issues such as the KESE coins start at some point during the second century and continue into the first. The appearance of these native coinages may be related to the payment of newly instituted Roman taxes (Crawford 1985, pp. 94–96; Keay 1990, p. 128). A number of

[58] Numantia (NUM) & Santa Catalina del Monte (SCM). Crawford (1985, p. 91) argues, on the basis of the worn condition of the coins, that these hoards are buried much later than their 179 BC closing date.

hoards of Republican *denarii* come from this region including the Sarrià and Baix Llobregat hoards (SAR & LLO). Casual and site finds suggest a dominance of native bronze in circulation until the end of the Republic but hoard evidence shows a mixture of Iberian *denarii*, Emporian *drachmae* and Roman *denarii*, *e.g.*, La Barroca and Segaró (LAB & SEG) — see Table 8.30. On the basis of the site and hoard evidence Knapp (1987, p. 21) argues that the area "enjoyed as close to a market economy as most areas of the Roman world ever approached."[59]

The Ebro Valley (Knapp 1987, 22–28) minted a mixture of silver and bronze. The silver issues were on the *denarii* standard with legends in an Iberian script. Some of these issues appear to be large, *e.g.*, those of BOLSKAN. The date of these issues is disputed: Crawford (1985, p. 91–95) prefers a mid-second century date, Knapp (1987, p. 23) prefers an earlier date in the first half of the second century; Villaronga (cited in Crawford 1985, p. 91 and Knapp 1987, p. 23) argues for a date in the latter second century but Crawford views this with 'incredulity', and such a late date does appear on the whole unlikely. These mints continue to produce coinage up until the wars with Sertorius (82–72 BC) although there is some evidence that they did not all strike simultaneously but in a rough sequence (Crawford 1985, p. 94 and Appendix 29). Some native issues continued to be struck until *c.* 50 BC.

Knapp (1987, pp. 23–4) also notes that the mints in this region either strike mainly bronze issues (*e.g.*, SETEISKEN) or mainly silver issues (*e.g.*, ARSAOS and BOLSKAN). These two categories of mint have discrete distributions with the bronze-only mints lying close to the Ebro and the silver-only mints lying in outlying areas. Only two mints seem to strike a more even mix, those of BELIGIO and SEKAISA in the lower Ebro valley, but even these strike only 12% silver and Knapp states they they belong, in location and output, with the bronze-only mints. Knapp also notes (p. 24) that Roman coinage does not greatly penetrate this area.

It is the function of the Iberian *denarius* coinage which is most disputed. Crawford (1985, p. 94) states:

> It is most plausible to suppose that it was initially struck at the behest of the Romans in order to convert some of the revenue of the two provinces into a coinage which could be used without more ado for the payment of Roman troops. If they then used the coinage to purchase supplies in the areas where it had been struck and issued, the strong tendency of the Iberian denarius coinage to circulate locally finds a ready explanation.

His main arguments in support of this suggestion are the fact that the Iberian issues appear to be struck in sequence, and the typological and demoninational uniformity of the issues. He goes on to state:

> It is very odd that those for whom it was designed almost never exported it, if the coinage was a response to local needs, whether economic or social, despite the fact it was perfectly compatible with mainstream Roman coinage (Crawford 1985, pp. 94–5).

I would argue, however, that it is less remarkable that this coinage was not exported if it was struck to fulfil local needs, than if it was struck to pay Roman troops who, even if receiving only a small

[59] Keay (1990) presents a detailed overview of the development of this area in the 2nd–1st centuries BC. Also see Knapp (1977, pp. 70–82).

code	hoard	country	date	Iber. *den.*	'good *den.*'	others	total
LAB	La Barroca	Spain	112	2	69	42 *drachmae* of Emporiae	118
SEG	Segaró	Spain	112	2	43	963 *drachmae* of Emporiae; 3 misc. bronze	1015
CO2	Córdoba	Spain	109	80	214	1 *victoriatus*; 1 *drachm* of Arse	306
SMR	Sierra Morena	Spain	102	9	3		12
SEL	Santa Elena	Spain	101	6	537		574
CDL	Chao de Lamas	Portugal	101	1	5		7
CRE	Crevillente	Spain	100	1	4		5
IAV	Idanha-a-Velha	Portugal	100	12	1340	5 *drachmae* of Arse	1367
SAL	Salvacañete	Spain	100	62	9		74
NOV	Torres Novas	Portugal	80	1	5		6
MAL	Maluenda	Spain	78	113	32		145
CAB	Cabeça de Corte	Portugal	74	1	158		175
PLZ	Palenzuela	Spain	74	2628	14		2642
ORI	Oristà	Spain	74	10	58	35 *drachmae* of Emporiae	103
CDR	Castro de Romariz	Portugal	74	1	70		72
EMP	Alt Empordà	Spain	71	21	1122	8 *quinarii*; 10 *drachmae* of Emporiae	1161
HEN	Alcalá de Henares	Spain	59	24	27		51
EL2	El Centenillo	Spain	46	2	57		59
JAE	Jaén	Spain	46	1	65	1 misc. *Quadrigatus*	86
TIE	Tiermes	Spain	19	3	9		12

Table 8.30: Hoards with Roman Republican and Iberian *denarii* in the CHRR database. 'Total' is the absolute total number of coins in the hoard. The Iberian *denarius* in the Cabeça de Corte hoard is thought by Crawford to be extraneous. Not included is the Fuente Álamo hoard (FAL) with one Iberian *denarius* and 1268 Roman *denarii*, details of which have been lost.

part of their wages in Iberian *denarii*, were likely to take some back to Italy or elsewhere. Other non-Roman coinages struck on the *denarius* standard, such as the coins of Juba I and Juba II, are often found in hoards of Roman *denarii* such as Maillé, Vigatto, Zara and even Răcătău de Jos I (MAI, VIG, ZAR & RDJ).

To this criticism Knapp (1987, pp. 25–6) adds that if the Iberian *denarii* were struck to pay Roman troops, why do hoards of Iberian *denarii* cluster away from the most 'monetized' areas where those troops could spend the coins, *i.e.*, the Cataluña coast and the Sierra Morena mining area? These two regions have concentrations of hoards of *Roman* coins, not Iberian *denarii*. The uniformity of the coinage is explained with reference to other 'Celtic' areas of Europe where there is frequently a trend for new coin issues to copy existing designs. Knapp differentiates between the 'financial' uses to which the coins were put — social display, storage of wealth and perhaps commerce, and the 'fiscal' reasons for which they were minted — the need for the issuing authority to meet its obligations. Knapp suggests that these obligations were the payment of native auxiliaries which would explain the concentration of both the mint and hoards of Iberian *denarii* in the interior. He also suggests that the source of this silver was the Sierra Morena mines where slaves for the mines were exchanged for silver.

The Guadalquívir valley produced only bronze coinage apart from the small, early issue of Gades (Knapp 1987, p. 28–30). This seems surprising given the presence of large silver mines in the Sierra Morena in the upper Guadalquívir valley, although these may not have been exploited until the end of the second century BC (Keay 1992). A large number of hoards of Roman Republican *denarii* have been found in the region including the Aznalcóllar and Puebla de los Infantes hoards near Sevilla (AZN & PUE), the Pozoblanco and Villanueva de Córdoba hoards north of Córdoba (PZ1 & CO1) and many hoards in the Sierra Morena region including the two El Centenillo hoards and one from Santa Elena (EL1, EL2 & SEL). The bronze issues from this area are poorly dated; some appear to be issued in the late second century BC, although many are probably not issued until the wars with Sertorius (Knapp 1987, pp. 29–30).

The function of the bronze coinage of Hispania Ulterior is also in some dispute. Knapp (1987, p. 29) interprets this coinage as reflecting the need for 'small change' in an area which had become increasingly monetized due to the army of occupation and an influx of settlers in the late second century BC. Keay (1992, pp. 288–292), however, disputes this and presents another model, which was developed in the light of other archaeological evidence. As well as noting the lack of silver dominations, and the generally later date of the issues, he also shows that the coin legends suggest the existence and persistence of different cultural regions in Hispania Ulterior in the later second century BC (Keay 1992, p. 289 and Fig. 6, p. 290). He suggests the coinage may be "understood in terms of the tributary relationship between settlements" (p. 289) and may "reflect social or economic ties between greater and dependent communities in the later 2nd or earlier 1st centuries BC" (p. 290). He goes on to say that "In this scenario the payment of taxes to Rome would have been managed at a local level by elites in the coin-issuing settlements" (p. 291). Under this model Rome received the taxes due to her whilst the local elites maintained a position of power with ample oppotunities for profit. Keay (1992, p. 291) suggests that this system came to an end either during the wars with Sertorius (82–72 BC) or the civil wars (49–44 BC).

The last large issues of Iberian *denarii* in Hispania Citerior appears to be struck during the wars with Sertorius (Scullard 1982, pp. 86–89) during which time Spain was effectively politically seperate from Italy (Crawford 1985, pp. 209–10). Also at this time the first large issue of Roman *denarii* was struck in Spain, that of C. Annius (RRC 366, 82–1 BC). Crawford (1985, pp. 210–211) believes the Iberian *denarii* were struck to pay Sertorius' troops. In contrast, the Roman generals sent to defeat Sertorius appear to have been chronically short of cash which eventually resulted in Pompey's threat to return to Rome which may be the cause of the last large issue of coinage (RRC 394) struck in 74 BC (Crawford 1985, pp. 211–213). Crawford's observation that "Several Spanish or Portuguese hoards close with precisely this issue" (p. 213) cannot, however, be used in evidence; we have already seen that a large number of hoards close in this year (page 247) and that this may be largely explained by the very small size of issues in the following years. What is more convincing is the contrast with what went before: only one hoard occurs in the data sets in the period 97–75 BC whereas seven hoards from the Iberian peninsula close in 74 BC. Crawford (1985, p. 214) believes that the bronze coinage of the north also ends with Sertorius. In the south it is unclear if the bronze coinages continued until the civil wars (Crawford 1985, p. 214; Keay 1992, p. 291).

Under Augustus, local coinage took on a new lease of life with over twenty mints active but these died out once more by Gaius (Crawford 1985, p. 271). Some official coinages were also minted in Spain, *e.g.*, issues of Augustus from Emerita (Sutherland 1984, pp. 41–42).

Having provided an outline of the situation, we can now proceed to examine the results of the analyses. The first Spanish and Portuguese *denarius* hoards occur in data sets covering the period 118–97 BC (sections 8.3.3–8.3.4).[60] As noted above, the time distribution of hoards is not even when compared to Italy. There are several Italian hoards up to 112 BC, and then more after 103, but none[61] for the period 111–104. In contrast, Spanish *denarii* hoards start in 115 BC with Pozoblanco (PZ1) and continue on to 100 BC— seven of these hoards occur in the period 111–104 BC . The pattern is illustrated in Fig 8.69. Despite the visible difference, application of the two-sample Kolmogorov-Smirnov test,[62] reveals no statistically significant difference, at the 0.1 level, between the distributions.

As one might expect, Iberian peninsula hoards from 115–108 BC are modern in profile compared to later Italian hoards, whereas most Iberian peninsula hoards from 105–100 BC are archaic compared to contemporary Italian hoards. The paradox occurs when one compares Iberian peninsula hoards from 115–108 BC with the Iberian peninsula hoards from 105–100 BC. Some of the former group are much more modern in profile than those in the latter, despite closing earlier. The former group have large quantities of coin from 115–108, whereas the latter do not, even if one does not include the newest issues in the calculations (see sections 8.3.3–8.3.4). Fig. 8.70 shows the complicated nature of the pattern with some hoards from 115–108 cutting upwards and across later hoards in a unusual fashion. Subsequent to the original analysis three more Spanish hoards were added to the CHRR database: Puebla de los Infantes (PUE), Córboba (CO2) and Cachapets (CAC). A further exploratory investigation of the data has yet to shed much light on the problem.

There are several possible interpretations and these are, in decreasing order of likelihood:

- Crawford's sequence and dating scheme for this period is wrong. This could be tested by analyses at the level of types but this is beyond the scope of this thesis.
- The data quality for an abnormally high proportion of hoards of this date is suspect.
- Within Spain, coins of *c.* 117–105 BC were either preferentially hoarded, or preferentially exported, so that after initially forming a substantial proportion of the coinage pool they decrease in abundance rapidly.
- Coins of *c.* 117–105 BC were preferentially removed from circulation for reminting.

[60] Four hoards in the CHRR database pre-date those contained in the data sets. Two are hoards of *victoriati* mentioned above and in footnote 58, and two are very small hoards (Fuente Librilla, LIB & Moratalla la Vieja, MLV). These two have a poor data quality as they are very small remnants of larger hoards (Lechuga Galindo 1986).

[61] There are two very small hoards from Italy which occur in this period, Strongoli (STR) with 4 well indentfied *denarii* and Avvocata (AVV) with 21 well identified *denarii*.

[62] The version of this test presented by Shennan (1988) is not applicable here as the sample sizes are below 40. We therefore apply the test for small samples (Lindley & Scott 1984). $\text{Dmax}_{\text{obs}} = 0.297$; $\text{Dmax}_{\text{obs}} nm = 0.297 \times 17 \times 18 = 90.9$. Critical figure at the 0.1 level for $(n = 17; m = 18) = 118$ (Lindley & Scott 1984, Table 19). We therefore accept H_0: there is no statistically significant difference.

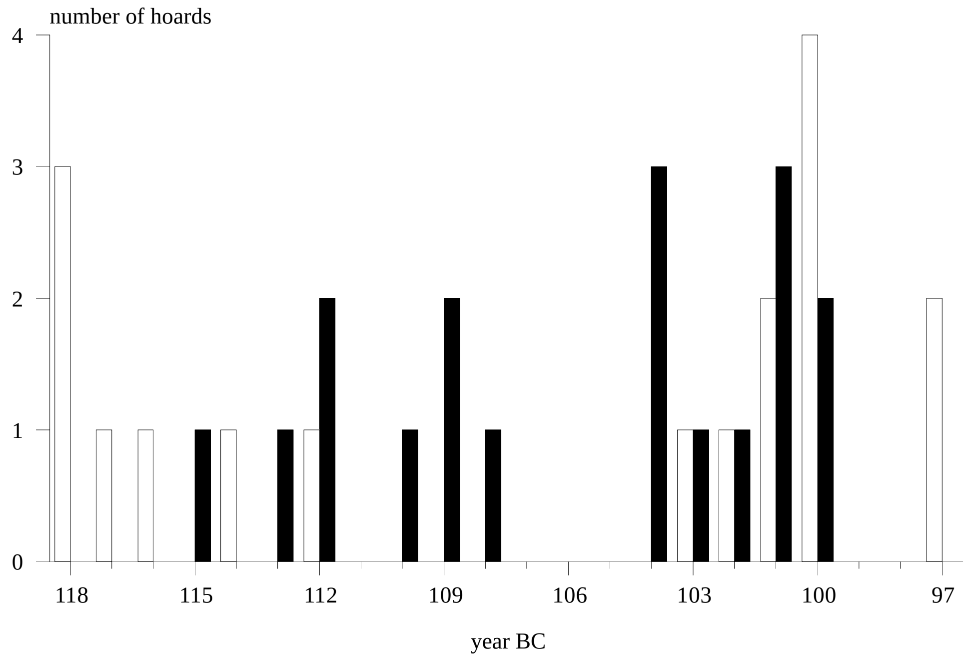


Figure 8.69: Incidence of hoards in Italy and Sicily (open bars) compared to hoards from Spain and Portugal (filled bars). Only hoards with 30 well identified *denarii* used. Figure includes the Cachapets and Puebla de los Infantes hoards (CAC & PUE) not included in previous data sets.

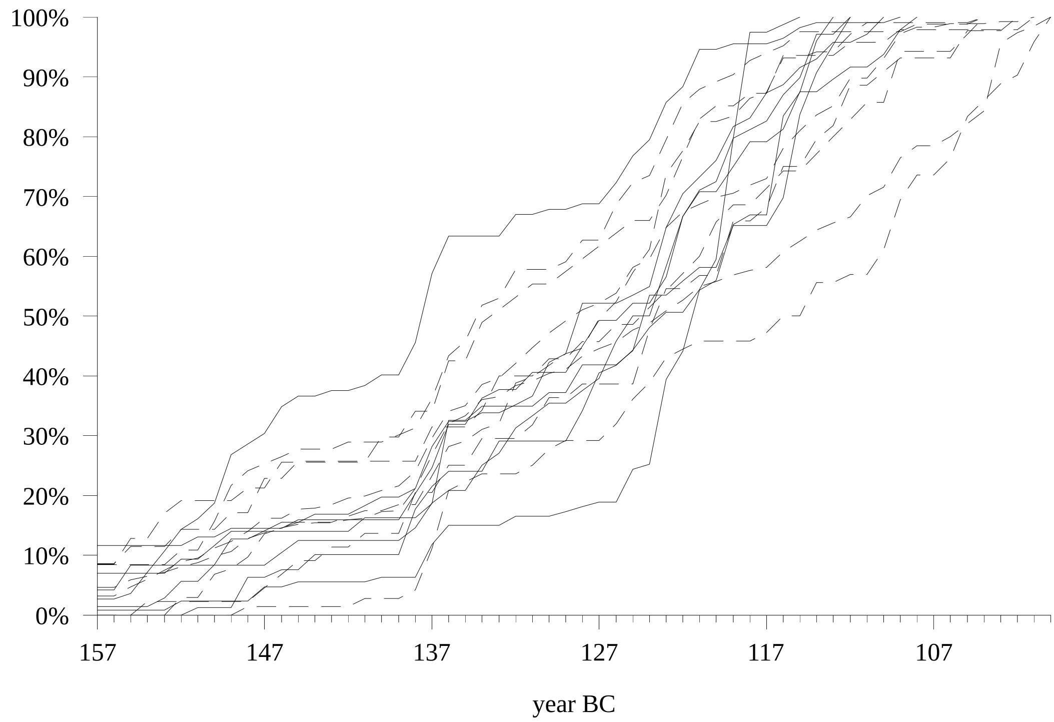


Figure 8.70: Spanish and Portuguese hoards from 118–100 BC.

Until the first two options have been eliminated we cannot accept either of the two more exciting possibilites and this topic must remain a problem for future research.

After the concentration of Spanish and Portuguese hoards in the period 115–100 BC, there are no further hoards in the data sets until the Maluenda hoard (MAL) which closes in 78 BC (section 8.3.8). In the CHRR database, only two Iberian peninsula hoards close in the period 99–79 BC which are both quite small and late, and a further two hoards from 78–75 BC.[63] This is in contrast to the Italian pattern where 26 hoards occur in the data sets for 99–79 BC, and there are a further 7 in the CHRR database. This pattern appears to be real and not an artefact of modern factors. Thus Crawford's assertion that supply of Republican *denarii* to this area was erratic can be supported, although it seems that it was not so much erratic as non-existant for about 20 years. There are, as was noted above, seven Iberian peninsula hoards closing in 74 BC. Hoards from 74 BC are generally very similar although there is a slight tendency for Iberian peninsula hoards to be more archaic than their Italian counterparts (section 8.3.9, page 192). It is possible to suggest that there was no official supply of Roman coinage to this area until *c.* 80 BC, and no substantial supply of coinage until 74 BC.

Crawford believes that the issue of C. Annius (RRC 366, 82–1 BC) was struck in Spain "just before the effective arrival of Sertorius" (Crawford 1985, p. 210). We can see if there is a significantly larger proportion of this issue in Iberian peninsula hoards. Taking six Iberian peninsula hoards and nine Italian hoards from data set `fin74.dat`[64] we obtain the following contingency table:

		RRC 366	others	total
Iberian	observed	10	636	646
	expected	3.2	642.8	
Italian	observed	20	5349	5369
	expected	26.8	5342.2	
total		30	5985	6015

From this table we can see that Iberian hoards do have slightly more coins of 82 BC than expected, and the Italian hoards slightly less. As could be predicted from the large sample size, the value for χ^2 is significant even at the 0.001 level.[65] However, calculation of the Φ^2 statistic (Shennan 1988, pp. 77–79) shows no association between the variables ($\Phi^2 = 0.003$)[66]; conversely Yule's Q (Shennan 1988, pp. 79–81) shows a moderate positive assocation between the variables ($Q = 0.66$).

[63] Torres Novas (NOV), 6 *denarii* including one Iberian *denarius*, closes 80 BC; Monroy (MNR), 24 *denarii*, closes 79 BC; Puerto Serrano (PSE), 27 *denarii*, closes 77 BC; Baños de Fortuna (BDF), 11 *denarii*, closes 77 BC.

[64] Iberian hoards: BDR, CAB, CDR, ORI, POO, SMB; Italian hoards COS, CTR, LIC, MAC, PIC, PL2, PON, RIG, TUF.

[65] $\chi^2 = 16.256$; percentage point for $(\nu = 1; \alpha = 0.001) = 10.828$; therefore reject H_0. χ^2 with Yates correction for a 2×2 table (Fisher & Yates 1963) $= 13.77$; we still reject H_0.

[66] Shennan (1988, p. 79) gives the formula for Crámer's V^2 as:

$$V^2 = \frac{\Phi^2}{\min(r-1, c-1)}$$

where $\min(r-1, c-1)$ refers to either the number of rows minus one, or the number of columns minus 1, whichever is the smaller. In the case of a 2×2 table $V^2 = \Phi^2$. Other standard textbooks, such as Bishop *et al.* (1975, p. 386), however, define Crámer's V, not V^2. In this case, for a 2×2 table, $V = \sqrt{\Phi^2}$. Creighton (1992a, 1992b), following the *very* non-standard notation of Iman & Conover (1983), calls V^2 Crámer's Φ; Iman & Conover (1983) also call χ^2, T. In any case, "the major difficulty in their [contingency coefficients] use is their clear lack of interpretation" (Bishop *et al.* 1975, p. 393) and they (χ^2 based contingency coefficients) are "only useful for comparing several tables" (Bishop *et al.* 1975, p. 386). See also section 3.12.5, page 86.

As Yule's Q is better a detecting weak associations (Shennan 1988, p. 81), we can suggest that there is such an association between coins of C. Annius and Iberian coin hoards.

We can repeat this procedure for the issue of C. Postumius (RRC 394), thought by Crawford to represent the issue minted to pay Pompey's troops in Spain (Crawford 1985, pp. 211–213). Taking the same set of hoards we get the following table:

		RRC 394	others	total
Iberian	observed	8	638	646
	expected	8.8	637.2	
Italian	observed	74	5295	5369
	expected	73.2	5295.8	
total		82	5933	6015

In this case, χ^2 is only 0.083[67], which is not significant even at the 0.1 level. Correspondingly, Φ^2 is only 0.00001 (*i.e.*, there is no association between the variables) and Yule's Q is -0.054 which also indicates no association between the variables. We can therefore conclude that there is slight evidence from the hoards that the issues of C. Annius are associated with the Iberian peninsula but no evidence from the hoards that the C. Postumius issues are associated with the Iberian peninsula. It seems highly unlikely that substantial numbers of this issue were transported to the peninsula specifically to pay Pompey's troops. Crawford's observation that "Several Spanish or Portuguese hoards close with precisely this issue" (Crawford 1985, p. 213) is not helpful because many hoards outside the Iberian peninsula also close with this issue.

After the hoards of 74 BC, there is one hoard closing in 71 BC (Alt Empordá, EMP) and then there are no more Iberian peninsula hoards in the data sets until La Grajuela (GRJ) which closes in 51 BC, and then four hoards which close in 46 BC. This is less of a contrast to the Italian pattern than the previous hiatus — only sixteen Italian hoards close 73–47 BC. This period is dominated by Romanian hoards. The reasons for this low level of hoard recovery are two-fold. Firstly, the period between the end of the Sertorian war and the civil wars was one of relative peace (Crawford 1969a). Secondly, as noted above, in the period 73–50 BC few coins were struck. This leads to small hoards having a closing date of, perhaps, 74 BC whilst probably closing later. It is therefore currently impossible to assess the scale of the supply of coinage to Spain at this period.

In 46 BC several issues were struck in Spain (RRC 468–471). These coins were struck as part of the military campaigns fought in the peninsula culminating with the battle of Munda (Scullard 1982, pp. 142–3). Four coin hoards close in 46 BC. These have, however, quite different profiles with two modern hoards (Sendinho da Senhora, SEN, & El Centenillo, EL2), one average hoard (Fuente de Cantos, FDC), and one archaic (Jaén, JAE). The Italian material, as could be predicted, consists of average or modern profile hoards. Only one more Iberian peninsula occurs in the data sets between 45–30 BC— Cataluña (CAT) closing in 44 BC. The Cataluña hoard has a slightly modern profile. Although it is difficult and dangerous to interpret such a sparse pattern, there is a suggestion that *denarii* circulation in Spain was at a slower rate than in contemporary Italy at this period.

[67] $\chi^2 = 0.083$; percentage point for $(\nu = 1; \alpha = 0.1) = 2.705$; therefore accept H_0. χ^2 with Yates correction for a 2×2 table (Fisher & Yates 1963) $= 0.012$ — we still accept H_0.

With the advent of the Imperial issues we again have Iberian peninsula hoards. As noted above, it is at this period that many autonomous city issues were struck, as well as official Imperial issues from new Spanish mints such as Emerita. Of the three hoards which close in 29 BC, two, Cortijo del Álamo and Citânia de Sanfins (ALA & CDS) are unremarkable and are very similar to Vigatto (VIG). The remaining hoard, Castro de Alvarelhos (CDA), is remarkable in size (3447 *denarii*) and has a modern structure due to an abnormally large quantity of coins of the 40s BC (page 231). It is not, however, unusual for very large hoards to have unusual structures (page 260).

The last two hoards in the data sets, Abertura and Penamacor (ABE & PEN) are similar to Bourgueil (BOU) and these three hoards are characterised by having relatively large numbers of new coin, mainly those struck at the Spanish mints. It is thus difficult to assign any interpretation to the early Imperial hoards other than they are associated with coins struck in Spain.

The Iberian peninsula material presents us with a number of problems which are deserving of a case study in their own right. The analyses in this chapter have revealed several detailed issues worthy of further investigation in addition to problems already well-known from the literature. At present, the CHRR database requires further enhancement as regards the Iberian peninsula material — most effort was directed towards Italian and Romanian material in order to provide a sufficiently large data set for Part III of this thesis. This enhancement should include the input and uploading of futher Republican coin hoards and the addition of more detailed information regarding Iberian issues currently input as general categories. As yet, no definitive answers to the problems outlined can be offered, although some tentative suggestions have been made.

Romania and Bulgaria

As has been noted, the most astounding fact about these hoards is the sheer number of them. The Bulgarian hoards generally seem to follow the same pattern as the Romanian although the small number of Bulgarian hoards available for analysis makes definite conclusions difficult. Roman coinage seems to enter the region in significant quantities for the first time in the early 70s BC. Some early hoards, for example Bobaia (BOB, section 8.3.7) have an archaic profile but most at this time appear to be very similar to Italian hoards, *e.g.*, hoards from 78–74 BC (section 8.3.8). However, over time, Romanian hoards appear to have increasingly archaic profiles. In the late 60s–early 50s BC there are a suprising number of Romanian hoards all of which are archaic compared to the only two Italian hoards (section 8.3.11). This pattern continues through to the mid-40s BC. Thereafter the pattern becomes more variable. Many hoards are still extremely archaic, *e.g.*, Gura Padinii (GUR, section 8.3.19). A few hoards have moderate quantities of the abundant issues of the 40s BC but rarely enough to prevent them still being relatively archaic, for example the Şeica Mică hoard (SEI, section 8.3.20). Rarely, they have significant quantities of these issues and have a mixed profile due to large quantities of these coins, but few coins dating from the 30s onwards, *e.g.*, Plopşor (PLP, section 8.3.21). The complicated nature of the pattern from the 30s BC on results in many Romanian hoards having a poor ‘quality’ on the correspondence maps, *i.e.*, they do not fit into a straightforward pattern.

This pattern suggests that the coinage supply to this area was erratic. It seems that after an initial influx of material in the 70s, there was a fall in the volume of coinage supplied to the area by whatever means. The more variable pattern of the mid-40s onwards suggests renewed contacts. The subject of coinage supply to this area will be discussed in more detail in Chapter 10 and Part III.

From the analyses it seemed that certain years were particularly associated with Romanian hoards. For example, coins of 135 BC seem to be often found in these hoards. It is difficult to assess how strong this association is. As we are often comparing very archaic Romanian hoards to modern Italian hoards, this association with 135 BC could be a simple function of that pattern. With the hindsight of research to be presented in Part III, some of the relationships observed are known to be significant — see section 14.4.8.

The former Yugoslavia

There are only six Yugoslavian hoards in the data sets analysed. They are generally unremarkable, with four being very similar to contemporary material (Stobi, Zasiok, Neresine and Sučarac), one slightly modern in profile (Dračevica) and one somewhat archaic (Gajine).

The monetary pattern in this region, however, is more complicated than this suggests (Crawford 1978). In the north of the former Yugoslavia there are an unusual set of highly mixed hoards such as the Mazin find (RRCH 142) which contained various bronze bars and coins of a wide range of dates (Crawford 1978, pp. 3–5, especially map 3; Crawford 1985, pp. 222–3). Crawford is 'baffled' as to why this area 'sucked in' this mixed set of coinages and kept them for so long. If, however, we adopt the anthropological viewpoint proposed in Chapter 2 it seems explicable in terms of 'primitive valuables'; the objects gaining their high value by virtue of their 'otherness', and subsequently by their antiquity.

Further south, the Greek cities situated on the Dalmatian coast had long minted their own large silver coinages, and some of the native polities also seem to have minted more limited coinages. The largest coinages were those of Apolonia and Dyrrachium, cities now in modern Albania (Crawford 1985, pp. 219–221). Crawford interprets their large issues as the direct result of the trade in slaves (Crawford 1985, pp. 224–225). One very large hoard of *denarii* was found in Apolonia (Gjongecaj 1981) but has not been uploaded due to large discrepancies in the report.

Crawford shows that the majority of the Republican *denarius* hoards from Yugoslavia are found in coastal locations near Split (Crawford 1985, map 31 and Appendix 52[68]) and suggests that these are the result of settlement of the area by Roman or Italian *latifondisti* (Crawford 1985, p. 225). Although the Stobi hoard is further inland than the *denarius* hoards discussed by Crawford, the structure of all the hoards certainly suggests that they are mainly withdrawals from the contemporary coinage pool in Italy; there does not seem to be any evidence that these were 'official' payments.

[68]Of the seven hoards listed by Crawford (1985), five have reasonable detail and have been input to the database. Only three were analysed as the Čitluk (CIT) and Ljubuški (LJU) hoards have less than 30 *denarii*. The Gajine hoard (GAJ; RRCH 479) is not mentioned in Crawford's discussion or appendix.

Greece and Turkey

Nine hoards from Greece and Turkey, closing in 86–32 BC, were analysed. The earliest of these, the Peiraeus hoard, is unremarkable and appears similar to contemporary material (section 8.3.6). Likewise, the Kerassia and Kavalla hoards (KER & KAV) are also similar, remarkably so in the case of the latter hoard (section 8.3.8 & 8.3.11). The remaining six hoards, from 54–32 BC are, however, extremely modern in their structure. This is not perhaps suprising with the two hoards closing with the legionary issues of 31–32 BC, which were minted to pay the troops that were to fight at the battle of Actium, and as one was found at Actium! It would seem that the *denarius* coinage in this area was introduced as official payments, perhaps to troops. This is in line with Crawford's (1985, p. 197) interpretations.

France

Eleven French hoards were analysed. Two of these date from the 70s, the rest from the 40s and after. The hoards from the 70s BC, Noyer and Peyriac-sur-Mer (NOY & PEY), are very similar to contemporary Italian hoards (sections 8.3.8–8.3.9). Of the hoards from the 40s BC, Lissac (LIS) has a strange profile as discussed and probably has a low data quality (section 8.3.16). The rest of the hoards fit generally with the wider pattern but do not seem to have a definite regional trend. For example, the Arbanats hoard (ARB) is the most modern in its group (section 8.3.18), whereas the Villette hoard (VLL) is similar to the most archaic Italian hoards (section 8.3.15). The Maillé and Bourgueil hoards (MAI & BOU), which close in 19 and 18 BC respectively, do have differences with the former having little of the latest coinage, and the latter having a great deal. Given, however, that these issues were in, or just before, the closing date, it is unsurprising that differences exist between local coinage pools.

Southern Gaul ('The Province') had come under Roman control during the latter part of the second century BC although the date it became a formally constituted province is disputed (Drinkwater 1983). The colony of Narbo Martius (Narbonne) was founded in 118 BC and minted a single issue, probably in that year. The remainder of Gaul was not conquered until Caesar's Gallic wars of 58–51 BC. Crawford (1985, pp. 165–172) shows that despite excellent evidence for trade from both archaeological and literary sources, Roman coinage did not gain a dominant rôle in this trade. The increase in finds in the 40s BC must surely reflect increased Roman interest as a result of the conquest by Caesar. It has been argued that Rome took little interest in its new possessions until Augustus finally consolidated his rule (Drinkwater 1983). Under Augustus, Gaul gained its own mints at Lugdunum (Lyons) and Nemausus (Nîmes; Sutherland 1984).

Germany and the Netherlands

Of the ten hoards uploaded to the database from this region, only three had more than 30 well identified *denarii*. All these hoards, as would be expected, have a late date. The Niederlangen hoard (NIE) has an exceptionally archaic profile compared to contemporary hoards of 29 BC (section 8.3.20). The two hoards closing in 2 BC, Bylandse Waard and Köln I (BYL & KL1) have varied profiles, with Köln having a modern profile and Bylandse Waard having a more archaic profile.[69] Obviously, with so little material, little more can be added. This material forms the beginning of the widespread occurrence of Roman coins in this region and would be seen more profitably in context of first century AD, which is beyond the scope of this thesis.

8.4.2 Numismatic aspects

Data quality, random samples and the problem of 'odd' hoards

Coin hoards, by their very nature, rarely turn up in controlled conditions and often have a complicated and poorly known history. This leads to problems with the quality of our data. In an ideal world we would have enough well known hoards to be able to exclude all those without secure information and a reliable list. Unfortunately, to exclude all those hoards would result in so few hoards being admissible in evidence that we would not be able to proceed. In the above analyses I have not excluded hoards on the basis of 'data quality' although I have noted this factor when an individual hoard appears different, odd or important. This procedure was justified by the argument that post-recovery factors will conspire to destroy patterns in the overall data set, rather than create them. I cannot imagine, for example, how the homogeneity of a data set such as `fin72.dat` (section 8.3.10) could have been created by post-recovery factors. The analyses presented do show a consistent pattern over time and region, although exceptions were noted and discussed, and thus justify the procedure followed.

Another important observation, which seems so obvious as to not require stating had it not been for the propensity for some studies to draw conclusions from a couple of hoards, is the need for every hoard to be seen *in context*. Simply selecting a hoard to represent a region or period, no matter how good the data quality appears to be, could lead to serious errors. Also, deciding that a hoard is odd or unusual by comparison with what is known elsewhere is an equally dangerous procedure; many Romanian hoards look very strange compared to Italian hoards, but part of a regular pattern when compared to other Romanian hoards. The Érd hoard, discussed on page 154 is unusual, but in this case we can make no judgement as there are so few hoards from Hungary.

The next important question is: are we justified in concluding that the majority of hoards are partially random collections of coins from the coinage pool? I here use the phrase 'partially random' because what we are actually asking is 'are the *denarii* in these hoards a random selection of *denarii* in the coinage pool.' Again, the consistency of the patterns found described above strongly suggest that they are mainly random selections. There are possible exceptions: the Meolo hoard (section 8.3.20, and footnote 43, page 231), for instance, is suggested by Gorini (1974–1975) to be a non-random selection of coins. It is can be seen to be unusual in the context of the other hoards of that period.

Numismatists have also tended to regard large hoards as being a more reliable guide to the composition of the coinage pool than small hoards (Reece 1981; Volk 1987). Casey (1986, p. 15) states:

[69] For a further discussion of the Bylandse Waard, also known as Bijlandse Waard, see MacDowall *et al.* (1992).

> We can see something of the relative annual issue volume by looking at the evidence of coin hoards where, in some periods, they reflect the rarity or commonness of coins in circulation. Just such a hoard is that which was found at Reka Devnia... This hoard of over 100,000 coins was buried in the middle of the third century [AD]... We can, with some justification, claim that from the second century onwards the hoard effectively represents in its composition the relative frequency of coin issues from the Rome mint.

I have shown (page 74) that this hoard does not seem to be as reliable a guide as Casey hopes when seen in the context of other hoards. I would go on to argue that large hoards are often not as representative as is often believed. Crawford deliberately chose large hoards for inclusion in Table L (Crawford 1974), from which he derives estimates of the number of coin dies used in all issues from 157 BC–31 BC. Included in that table were:

- Berchidda (BER) — now seen to be rather archaic (section 8.3.6);
- Alvignano (ALV) — now seen to be modern, and somewhat unusual, in structure (section 8.3.16);
- Şeica Mică (SEI) — a ‘normal’ Romanian hoard but rather archaic compared to Italian hoards (section 8.3.20);
- Maillé and Bourgueil (MAI & BOU) — although both from the same area of France at about the same date — are quite different in structure (section 8.3.21).

A detailed examination of Crawford’s die estimates is given in Chapter 11. Here I would like to argue that simply because a hoard is large, does not mean that it is representative. Conversely, it would seem unlikely that very large hoards are random selections from the coinage pool, and they are thus less likely to be good representation of that pool. Burnett (*pers. comm.*) has made a similar observation with early Roman material.

The problem of ‘extraneous’ coins

Many hoards are said to have contained ‘extraneous’ coins, *e.g.*, RRCH 311 (Pontecorvo), RRCH 352 (Brandosa) and so on. Extraneous coins are those which have become associated with a hoard but are, to use Vidal Bardán’s (1982) phrase, ‘logically not part of the hoard.’ Crawford often assesses whether a coin is extraneous on the basis of its patination, *e.g.*, RRCH 172 (Maddaloni). In what ways can extraneous coins become associated with hoards? The following are some possibilities.

- Coins not associated with a hoard are lost in its vicinity and they are added to the hoard upon recovery. This is likely, given most hoards are recovered in an unsystematic manner.
- Coins are muddled with the hoard in Museum or private collections.
- In areas where finders are paid for hoards, additional coins found unassociated with the hoard may be added to it to increase the value of the hoard (Milhăilescu-Bîrliba *pers. comm.*).

How, then, can we identify extraneous coins? Differences in patination is one method, but in many cases we can no longer examine the coins as they have been dispersed. We can suggest that coins are extraneous if they substantially alter the date of a hoard which otherwise looks, as a result of its structure, as as if it should belong to another date. The Castelnovo hoard (CST) is a good example (section 8.3.14): this hoard has a structure quite unlike any other Italian hoard in the sample, and quite unlike the general pattern. If, however, we accept that the three coins post-71 BC are extraneous, the hoard appears as a normal Italian hoard of the late 70s.

The Torre de Juan Abed hoard (JUA) was included in two analyses to illustrate this point. In the first analysis (section 8.3.4) the hoard, omitting the disputed coins, appeared to be quite in keeping with the rest of the pattern. In the second analysis the hoard, including the disputed coins, appeared quite anomalous (section 8.3.7).

It is important to stress, however, that the hoard must be seen in context. A number of Romanian hoards, if only seen against the Italian pattern, would seem to contain extraneous coins. Looking at the wider pattern we can see, however, that this is not the case. In the case of some hoards, such as Niederlangen (NIE; section 8.3.20), a coin appears to be extraneous, but because of a lack of comparative material we have no grounds for classifying it as such.

One final possibility must be admitted.

- A hoard substantially collected at one period, may later have additions, which affect the hoard's date and structure.

This is always a possibility but thankfully hoards where this is possible are rare and would not alter the wider pattern. It does, however, illustrate how difficult, if not impossible, it is to explain the occurence, circumstances and so forth of individual hoards.

Coin hoard variability and the speed of coin circulation

So far, the question of cross-period variability has been avoided. Why are the hoards from, for example 72–69 BC, so remarkably similar, and those from 87–81 BC so remarkably variable? Although tempting to ascribe this to the speed of coin circulation (*e.g.,* Creighton 1992a, p. 73) or to the operation of the money supply equation (see page 267), we should be cautious until we fully understand the mathematics of the situation. A detailed investigation and explanation are presented in the next chapter.

8.4.3 Further comments on the CA of hoard data

Many of the following observations, with hindsight, appear obvious but may be of use to others embarking upon the multivariate analysis of hoards. Many of the observations are particular to the case where species (variables) are many, and occasionally dominated by large occurrences, samples are comparatively few and the data sets are sparse. These conditions, despite sounding rather restrictive, are quite common in archaeology.

Firstly, rare species generally have little effect on the overall configuration of the sample and species maps. Their presence, however, can confuse the pattern and make interpretation difficult although CANODRAW's ability to omit rarer species from the maps can help with their interpretation. Rare species were not omitted here as patterning in rarer, as well as abundant species, was possible. Rare species do create a problem when they form a high proportion of a small hoard, *e.g.*, the Bordeşti hoard (section 8.3.21). The acceptable solution to this problem is the omission of those species. Often this procedure simply results in the rescaling of the map so that the main patterns can be observed, with the occasional relocation of the one hoard that contained a high proportion of that species.

As shown in section 8.2.4, extremely 'odd' samples, such as Érd or Alife, can dominate the first axis of inertia. Omitting them allows the structure of the main mass of the data to be seen. Once the axes which allow this structure to be observed have been accounted for, the lower order axes often represent the structure of a single hoard *v.* all other hoards. For example, the second axis of inertia from the analysis of data set `fin74.dat` represents the Spain hoard (SP2); the third axis the Jdioara hoard (JDI; see section 8.3.9). Removal of a hoard results in the 'promotion' of a lower order axis. For example, in the first analysis of data set `fin8.dat` the first axis was dominated by the Viile hoard (VII; see section 8.3.23, Fig. 8.66b). The second and third axes of inertia revealed the structure in the rest of the data set (Fig. 8.67). If we analyse the same data set omitting Viile, the maps of the first and second axes of inertia are almost identical to the maps of the second and third axes of the first analysis (*cf.* Figs. 8.67 & 8.68).

Table 8.4 on page 166 presents the eigenvalues and cumulative percentage explained figures for the analyses. These figures are interesting but must be interpreted with care as several factors contribute to them. Firstly, the latent structure of the data set—highly structured data sets will have a high total inertia and *vice versa*. For example, data set `fin87.dat` was highly structured (section 8.3.6) and had a total inertia of 1.256, whereas data set `fin72.dat` was poorly structured (section 8.3.10) and has a total inertia of 0.253. Secondly, high inertias can be the result of outliers. For example, in the first analysis of data set `fin92.dat` there were two outliers (section 8.3.5) and the total inertia was 0.918; analysis of a smaller data set without these two outliers resulted in a total inertia of only 0.365. Thirdly, the data sets vary in size having both a variable number of hoards, and an increasing number of years as one moves on through time. The larger the number of samples/species, the less variation the first few axes of inertia are likely to be able to explain. Also, the larger the proportion of the data set which has been in circulation long enough for their distribution in the coinage pool to become even, the larger the proportion of the data set will be basically random noise and this will have an effect of the total inertia. Finally, some data sets have hoards from, for example, only Italy whereas others have hoards from across Europe, and some data sets only have hoards from a single year whereas others have hoards from a number of years. Despite this, the figures can be used as an indication of those data sets with a strong structure, and the correspondence of those data sets with years of high coin production can be seen.

In a number of cases the third or fourth axes of inertia explain almost as much variance as the first or second. Most of these cases occur when the total inertia is low and is a reflection of the poor structure of many of those data sets.

It has been argued that CA's diagnostic statistics simply confuse non-statisticians and that the maps are of greatest importance (Scollar *pers. comm.*). Others have argued that the diagnostic statistics are of the utmost importance in the interpretation of the maps (Orton *pers. comm.*). In the analysis of large, complex data sets, I would argue that the diagnostic statistics are invaluable. For example, as the diagnostics made clear that the Lissac hoard (LIS) had a very low 'quality' for the first two axes of inertia, no attempt was made to interpret its position on the map. As noted above, no software available to the author, at the time the analyses were performed, allowed the easy generation of labelled, standard diagnostics.[70]

One phenomenon noted on several occasions deserves further explanation. In the analysis of data set `fin147.dat`, the three hoards which closed in 125 BC were placed in a very similar position on the sample map (Fig. 8.15, page 169) whereas three hoards closing in 118 BC were not. Application of the Kolmogorov-Smirnov two sample test showed, however, that there was no statistically significant difference between the three hoards from 118, but there were differences within the three hoards from 125 BC. Similarly, in data set `fin63.dat` the Romanian hoards were spread along the second axis (Fig. 8.41b, page 204). Five of these Romanian hoards, all closing in 56 BC, were carried over into data set `fin56.dat` but in the analysis of that data set those hoards were tightly clustered along the origin (Fig. 8.43b). The reason for this phenomenon lies in the longevity of a coin issue in circulation, and the rapidity that new issues come into circulation. This is symbolically represented in Table 8.31. In this table three hoards, δ, ϵ and ζ, all end with coin type G. In a CA these hoards are likely to be placed close together. Hoards θ, ι and κ end togther in year L. They are likely to be more spread out on the resultant CA map. This is because *only* those three hoards have coin types J, K and L, and therefore even minor variations between those three years will be highlighted over and above the variation between years E, F and G in hoards δ, ϵ and ζ. If we were to omit hoards η–κ the variation between years E–G would be highlighted. This phenomenon should be kept in mind when analysing data sets which exhibit a horseshoe gradient, and in some cases splitting the data into several overlapping groups may reveal hitherto unsuspected structure.

In the above analyses, there has been occasion to test the 'significance' of an axis of inertia. This method, outlined by Greenacre (1993, p. 173), has some uses. This test, however, presumes no prior knowledge about the objects in the test. In the case of the hoard data examined, we have some prior knowledge — the findspot of the hoard. In some cases there were definite regional groups on the CA map despite the axes used not being significant in terms of the formal test. The answer would be to somehow incorporate our prior knowledge in a way that it would influence our posterior knowledge, *i.e.,* the results of the test. This is a Bayesian approach which although sounding attractive and simple in theory, is in fact difficult to achieve in practice.[71] Another approach would be to assess the stability of the maps using bootstrapping (Ringrose 1988; Greenacre 1993) but no software was available.

One final question is: do the CAs enable us to see more patterning in the data than would be possible from the cumulative frequency diagrams alone (be they constructed as here, or in the

[70]Subsequent to the analyses described, the Windows version of the *Bonn Archaeological Statistics Package* was released. The author β-tested this package and in the light of the analyses here recommended that it provide standard diagnostic statistics. This suggestion, amongst others, was implemented by the author of the package, Irwin Scollar.

[71]For a recent review of Bayesian statistics in archaeology see Litton & Buck (1995).

	A	B	C	D	E	F	G	H	I	J	K	L
α	•	•	•									
β	•	◦	•									
γ	•	◦	•	•								
δ	◦	◦	•	•	•	•	•					
ϵ	◦	◦	•	•	•	◦	•					
ζ	◦	◦	•	•	◦	•	◦					
η	◦	◦	◦	◦	•	◦	•	•	•			
θ	◦	◦	◦	◦	•	◦	•	•	◦	•	•	◦
ι	◦	◦	◦	◦	•	◦	•	•	◦	•	•	•
κ	◦	◦	◦	◦	•	◦	•	•	◦	◦	◦	◦

Table 8.31: Table showing ten hypothetical hoards (α–κ) with twelve hypothetical coin types (A–L). ◦ represents a low occurance of that coin type in the hoard; • represents a high occurance. See text for details.

manner of Reece 1995)? I would argue that they do significantly add to the detail and ease with which the patterns can be seen and interpreted. The cumulative frequency graphs can be confused, and it is not always immediately apparent which parts of the coin hoards are creating the patterns observed. Conversely, the patterns identified by CA are often more easily explained, especially to persons not familar with the technique, by the use of the cumulative frequency graphs. The *combination* of the two methods is extremely powerful.

Despite the problems, however, the CAs proved extremely useful in the analysis of hoard data. In order to ensure breadth of coverage, some interesting detailed patterning may have been missed, but these analyses do reveal important temporal and spatial patterns. For the first time we have an explicit description of European-wide patterns against which individual hoards, regions or periods can be compared, and thus their interpretation can lie upon firmer foundations.

Chapter 9

Cross-period comparisons and the speed of coin circulation

9.1 Introduction

In the past there have been various attempts to identify differences in the speed of circulation of coinage across time and space (Goulpeau 1981; Duncan-Jones 1987; Creighton 1992a). Various problems with all these analyses have been discussed (sections 3.8, 3.10.1 and 3.12). The work of Creighton inspired an attempt to identify changes in the speed of circulation of coin (Lockyear 1993a) which, although unsuccesful in its primary aim, had two other useful results.[1] This chapter will briefly outline the methodology used by Lockyear (1993a), and then will use data sets and analyses from Chapter 8 to illustrate the results. I have chosen to use these data sets, rather than those used originally for three reasons: it makes comparisons with other analyses in this thesis easier; the larger quantity of data now available allows smaller time periods to be covered in any one data set; and because the original data sets included *quinarii* as well as *denarii* in the totals. *Quinarii* are excluded as their inclusion or exclusion from a hoard is a non-random decision on the part of the hoarder, *i.e.,* a hoard with no *quinarii* does not indicate that the local coinage pool did not contain *quinarii*, simply that the hoarder did not wish to collect these coins. This fact, coupled with the limited number of years in which *quinarii* were struck, has an undesirable effect on the results of the CAs. The ramifications of the results (section 9.5) are of the utmost importance in the interpretation of inter-hoard variability, especially between periods.

The speed of coin circulation (V) is an essential part of the classical quantity theory equation (Crockett 1979, p. 48):

$$MV = PT$$

where M is the quantity of money, V the velocity of circulation, T is the volume of transactions and P the average price of the transaction. Whether this formula is applicable to the ancient world is highly debatable. However, the speed of coin circulation V could still be a useful parameter

[1] The full details of the analyses presented in Lockyear (1993a), including all plots and scores, is given in Lockyear (1992).

to chart as it should partly reflect the uses to which coinage was put, and perhaps the degree of ‘monetization’ of an economy. Monetization is a term which is rarely defined by scholars. Reece (*pers. comm.*) takes a minimal view and uses ‘monetization’ to refer to the number of coins per head of population. Another implicit use of the term seems to be the frequency of use of coin (Creighton 1992a). This definition seems rather weak as the frequency of use of coin need not reflect how coin was used, *i.e.,* its socio-economic function. It would be possible to define monetization as the movement towards the use of money in a manner that would be recognised by neo-classical economists but I would argue that this is inappropriate in the period under consideration. The initial aim of this analysis was to detect spatial or temporal variations which, in conjunction with other evidence, may help to chart variations in the use of coinage.

9.2 The methodology

Reece (1988d) showed that when comparing Imperial coin hoards of a similar date, the representation of coins in periods[2] prior to the last period would be similar, and that the largest variations between hoards would be in that period when the hoards closed. Lockyear (1989) identified the same pattern in Republican hoards and attempted to investigate the causes of this variation using computer simulation (Lockyear 1989; 1991; see section 3.5). Although it was impossible to single out a cause of variation in the ultimate period, the cause of the similarity in the other periods was easy to suggest (section 6.2). The irregularities in the representation of coins in the pool is caused by coins being issued at a limited number of places only. As the coins circulate their distribution will become more even. How long this takes depends on a number of factors, the most important of which is the speed of circulation of coin.

On the basis of this I proposed that the structure of coin hoards could be divided into three “zones” (Lockyear 1993a, p. 368).

1. *The “fall out zone”*: this is the oldest fraction of the hoard. The coins have been in circulation for so long that they have become rare, and comparisons between hoards of the same closing date show an irregular representation of these coins. This fraction of the hoard has been made passive in most of the CAs presented in Chapter 8.

2. *The “homogeneous zone”*: this is the fraction of the coin hoard where coins have been in circulation long enough for their distribution within the coinage pool to be relatively even. Comparisons between hoards of similar origin and closing date will show a high level of similarity.

3. *The “erratic zone”*: this fraction of the hoard contains the newest coins which have not been in circulation long enough for their distribution to be particularly even.

Figure 9.1 illustrates this pattern. If this tripartite structure of coin hoards could be demonstrated, it might be possible to use the time span of the erratic zone (T_{ez}) as a measure of the speed of

[2]For the purposes of reporting and analysis, Reece divides coin lists from the UK into twenty-one periods of varying duration (Reece 1987b, pp. 73–77).

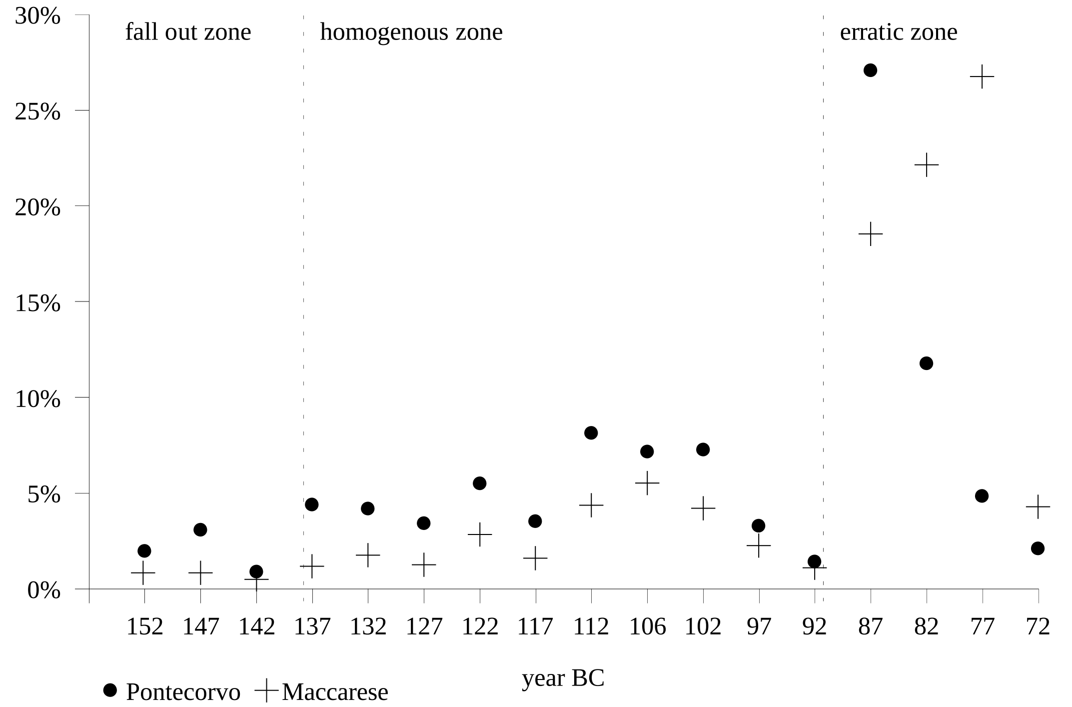


Figure 9.1: Proposed zones within the structure of coin hoards. See text for details. The percentages have been combined into five year groups.

circulation (V). In reality, the dividing line between the homogeneous and erratic zones (T_{bp}) is unlikely to be a sharp division; this need not be a problem if we could devise a method that gave *consistent* results. The time span of the erratic zone (T_{ez}) would represent two possibilities:

- the amount of time taken for the coinage pool to homogenise;
- the amount of time over which the hoard was collected.

There was some concern that having two possible causes for variation in T_{ez} would negate the usefulness of the measure, but it was hoped that if usable figures for T_{ez} could be obtained, they could be plotted or analysed spatially. If consistent patterns were revealed, they would be the result of the introduction delay[3] rather than collection patterns.

The method used to try and measure T_{ez} was correspondence analysis. In CA, as we have seen, a highly structured data set is likely to produce a map exhibiting a horseshoe curve. Conversely, data sets where either all the objects are very similar, or all the objects are highly variable, will produce maps where the objects and variables form unpatterned clouds of points. If we take a data set which exhibits strong structure, such as `fin87.dat` (section 8.3.6), we could predict that an analysis of coins from the fall out and homogeneous zones only would produce unstructured maps, whereas analyses which contained some coins from the erratic zone would produce structured maps. In the case of data set `fin87.dat`, we could firstly analyse coins from 157–107 BC, then 157–102, 157–97, 157–92, 157–87, and finally all years, 157–81 BC. At some stage the maps should change

[3]See section 6.2, page 129 for a discussion of the model of coin circulation and the terms used here.

from a cloud of points, to a map with a cluster of points at the origin and an outlier or outliers, and finally to a map with a horseshoe curve, as shown in Figs. 8.27–8.28. For each hoard, the stage at which it pulls away from the central cluster around the origin would be defined as its T_{bp} and the range from that point to the hoard's closing date would be T_{ez}.[4]

In the original analysis, this procedure was applied to two data sets: the first consisted of hoards from 91–79 BC; the second contained hoards from 80–70 BC (Lockyear 1993a, 369–373). In the case of the first data set the predicted pattern was observed (Lockyear 1992; Lockyear 1993a). Here, data sets `fin87.dat` (section 8.3.6, page 183) and `fin74.dat` (section 8.3.9, page 192) were analysed.

9.3 Results

9.3.1 The first analysis — hoards from 87–81 BC

The first stage of this analysis was to confirm the existence of the proposed tripartite structure of coin hoards. This was achieved in a novel fashion. The variables used in these data sets are of an ordinal data type (Shennan 1988, pp. 10–13). It is this attribute which allows the hoard structure to be displayed as cumulative percentage graphs. It also allows us to plot the variable scores from CA as a line graph as well as maps. This method of display has several advantages. Firstly, more than two principal axes of inertia can be plotted. Secondly, patterning in the degree of variation between coin hoards can be seen clearly in terms of the order of the variables.

A CA was performed on data set `fin87.dat` with all variables active (*cf.* section 8.3.6). No variable or sample weights were applied and the symmetric scaling option was used. The scores from the first four axes of inertia were plotted on a line graph (Fig. 9.2). A tripartite division is suggested although less clearly than previously (*cf.* Lockyear 1993a, Fig. 46.3). The older, and therefore rarer, species in the data set have large scores. This is then followed by a fairly long zone of relative similarity from *c.* 149–114, and a short period of high similarity from *c.* 114–103 BC. The remainder of the graph shows a relatively high degree of variation. Despite being less pronounced than previously, this figure does show the tripartite division of the hoards' structure.

As the data set showed the required hoard structure, the sequence of partial CAs proposed above was performed. As a few rare early years strongly influenced the results, years 211–158 were made passive. Otherwise, the CAs were performed on untransformed data using symmetric scaling. Figs. 9.3a–9.5b are a series of joint maps of the results of these analyses. The eigenvalues of these, and all following analyses, are presented in Table 9.1. As can be seen, the analysis of coins from 157–107 produces a map with an unstructured cloud of points (Fig. 9.3a), as do the maps from analyses of 157–102 (Fig. 9.3b) and 157–97 (Fig. 9.4a). However, the analysis of years 157–92 produces an incipient horseshoe curve (Fig. 9.4b) which becomes more marked over the remaining two analyses (Figs. 9.5a–9.5b). In this case, the intermediate stage of a central cluster and some outliers either does not exist, or possibly lies between the analyses of years 157–97 and 157–92 BC.

[4] I would like to thank Clive Orton for this idea.

	Eigenvalues					Cumulative % variance explained			
Data set	Axis 1	Axis 2	Axis 3	Axis 4	Total In.	Axis 1	Axis 2	Axis 3	Axis 4
`fin87.dat`									
157–107 active	0.172	0.143	0.073	0.056	0.621	27.7	50.6	62.5	71.5
157–102 active	0.180	0.149	0.103	0.059	0.675	26.7	48.8	64.1	72.9
157–97 active	0.181	0.149	0.109	0.065	0.718	25.2	45.9	61.0	70.1
157–92 active	0.184	0.173	0.134	0.067	0.790	23.3	45.2	62.2	70.7
157–87 active	0.469	0.167	0.140	0.116	1.153	43.0	57.5	69.6	79.7
All years active	0.483	0.191	0.148	0.137	1.370	35.2	49.1	59.9	70.0
`fin74.dat`									
All years active	0.095	0.032	0.030	0.026	0.390	24.3	32.6	40.4	47.2

Table 9.1: Eigenvalues *etc.* from partial CAs — see text for details.

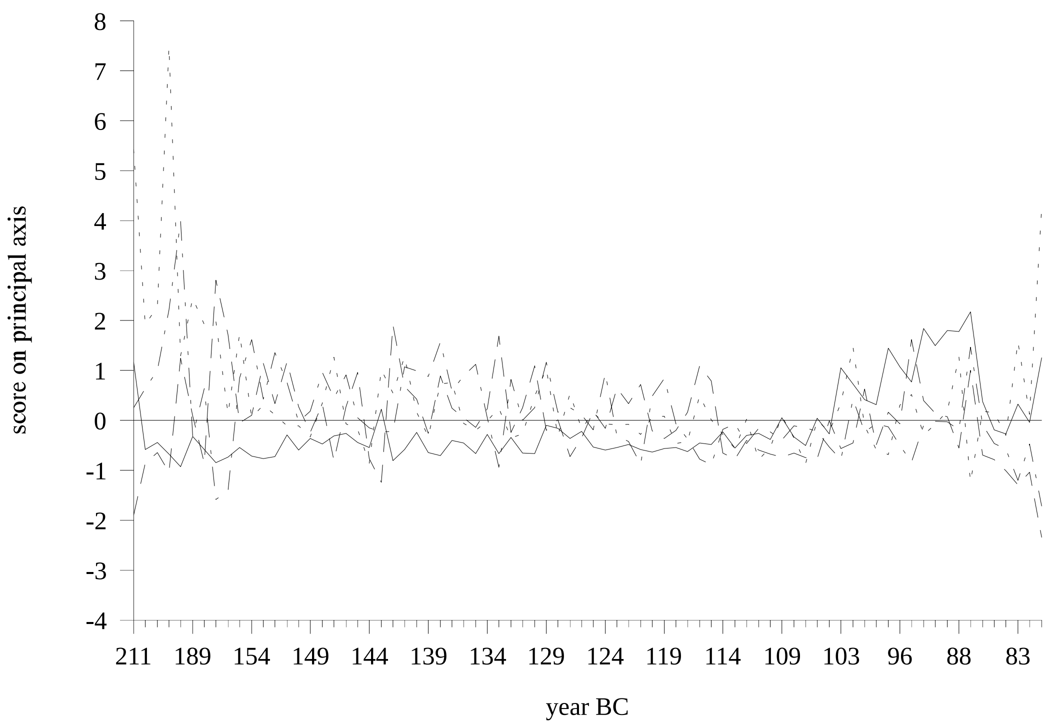
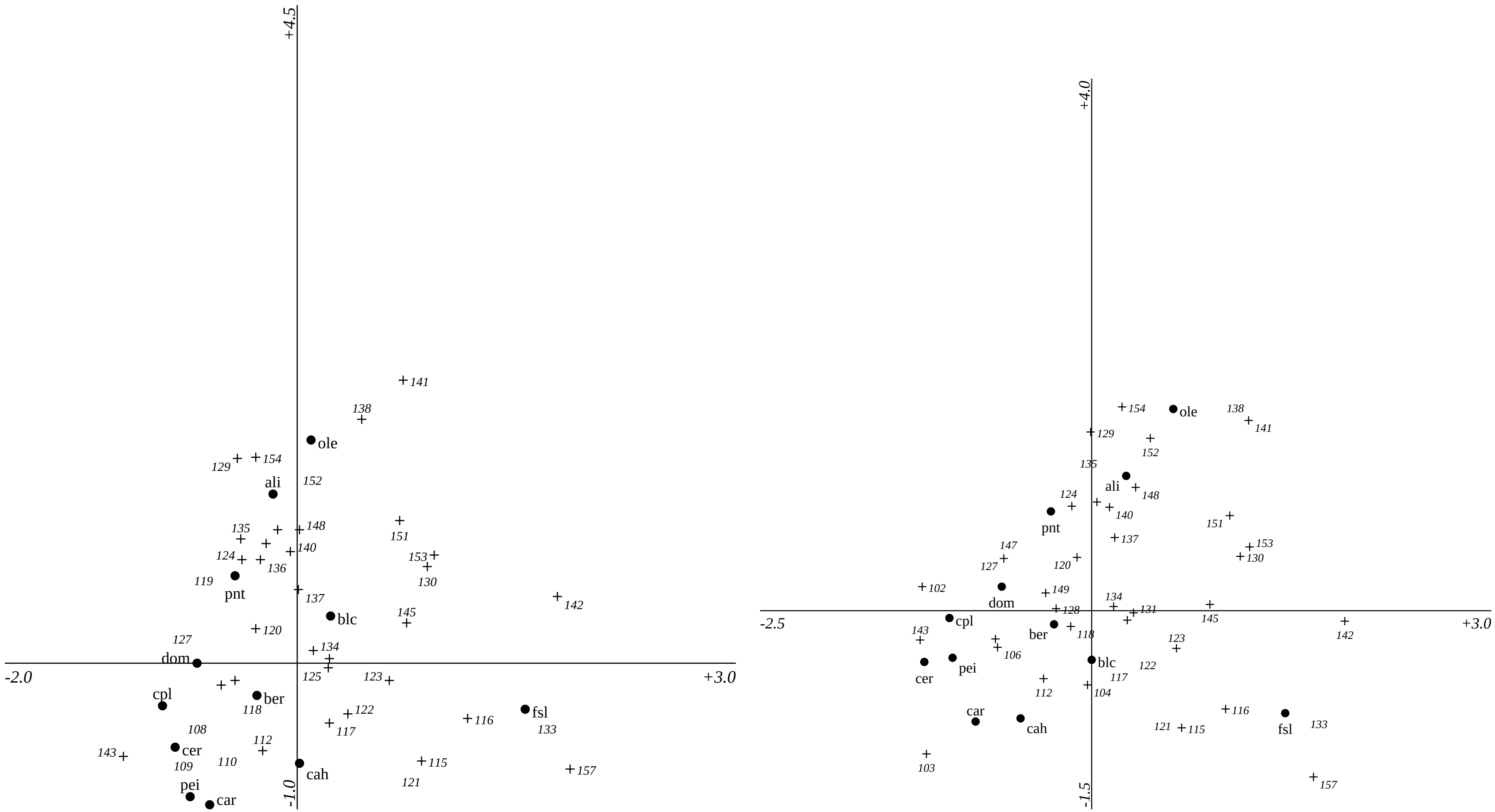


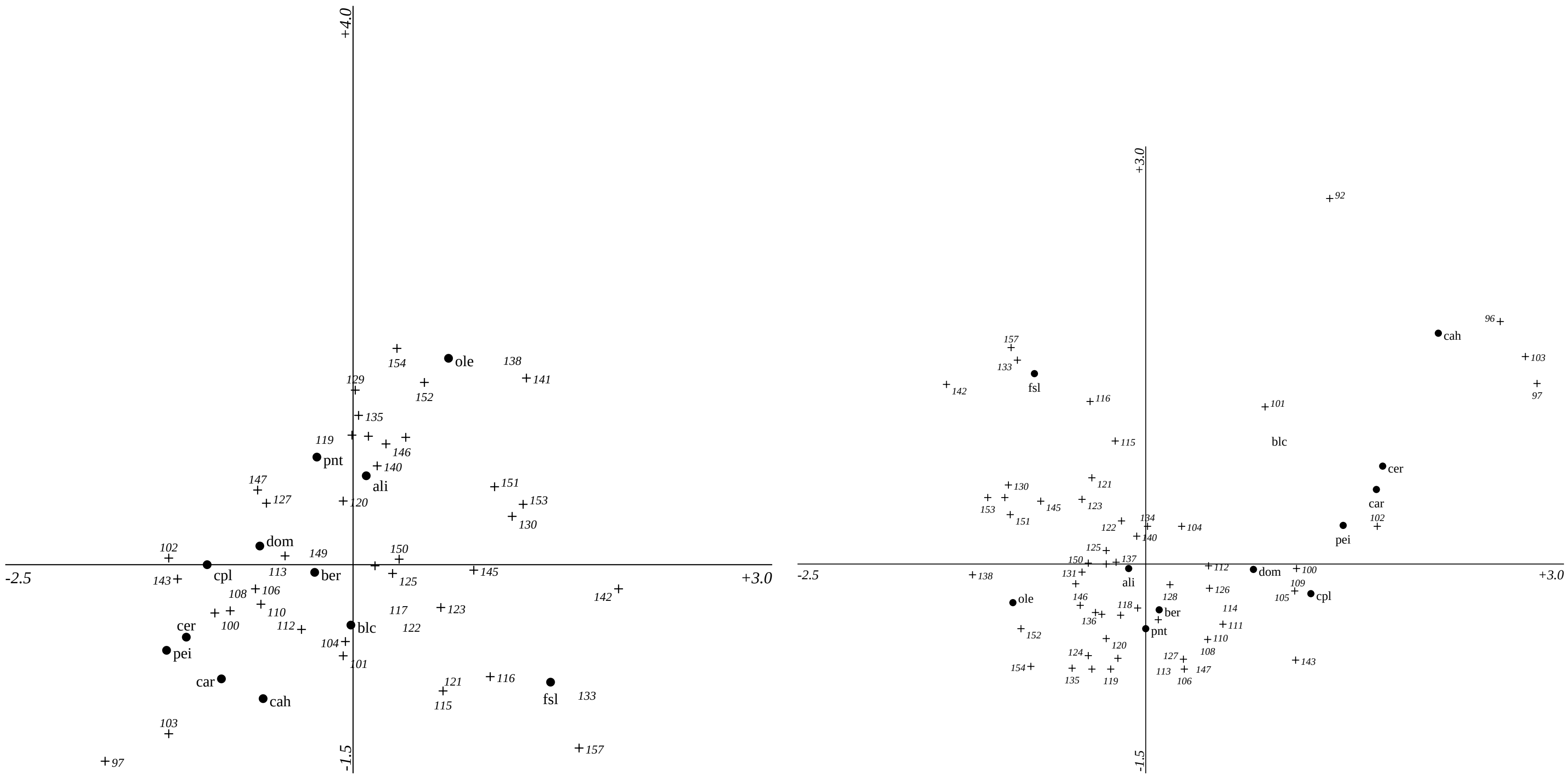
Figure 9.2: Line graph of the species scores from CA of data set `fin87.dat`. Solid line first axis, dashed line second axis, dash dot line third axis, dotted line fourth axis. Years with no coins in the data set cannot have a score and are thus omitted, hence irregular time gaps on the x-axis



(a) Years 157–107 active

(b) Years 157–102 active

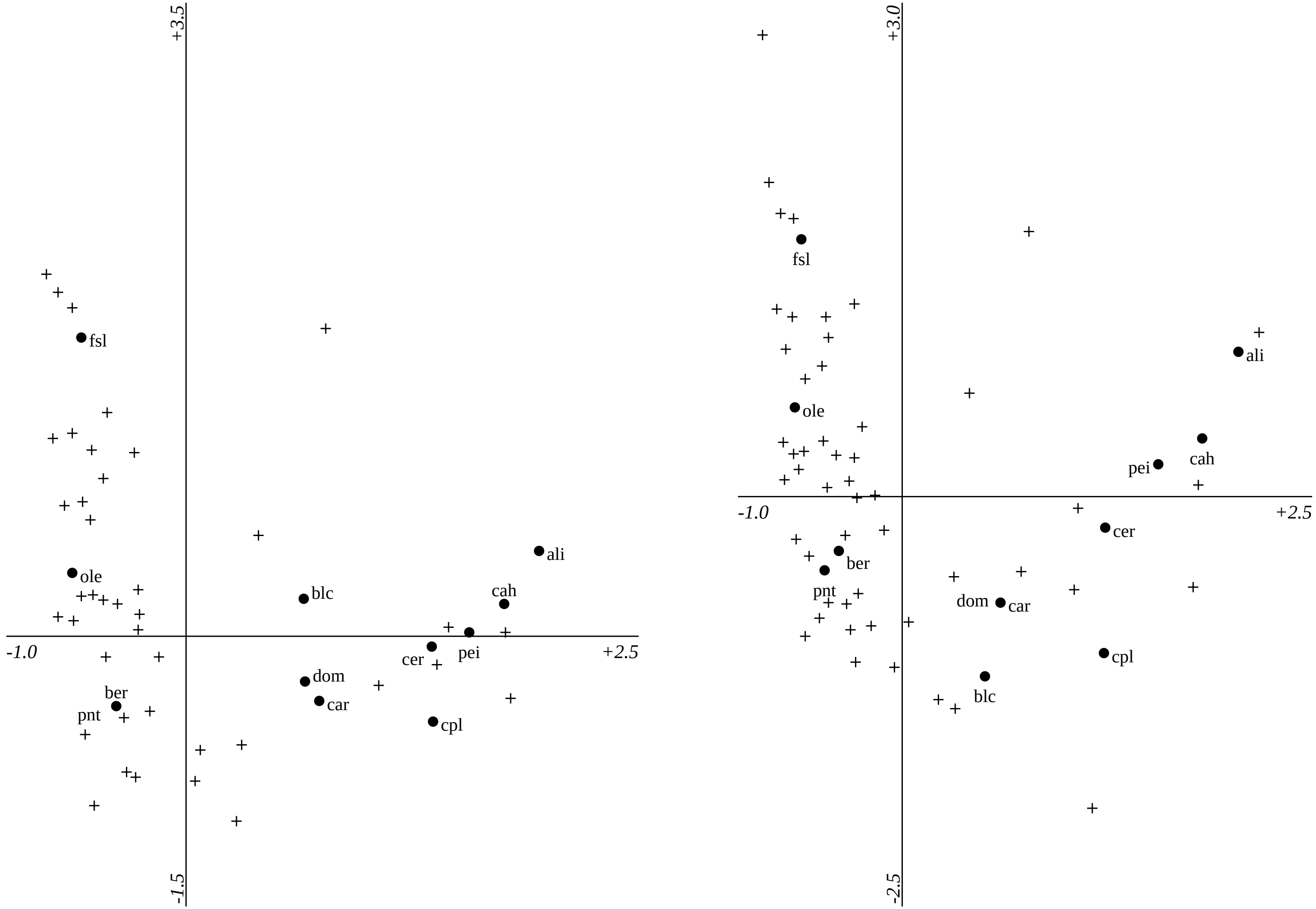
Figure 9.3: Partial CAs of dataset `fin87.dat`. Crosses are years of issue, bullets are hoards. First (horizontal) and second principal axes of inertia.



(a) Years 157–97 active

(b) Years 157–92 active

Figure 9.4: Partial CAs of dataset `fin87.dat`. Crosses are years of issue, bullets are hoards. First (horizontal) and second principal axes of inertia.



(a) Years 157–87 active

(b) All years active

Figure 9.5: Partial CAs of dataset `fin87.dat`. Crosses are years of issue, bullets are hoards. First (horizontal) and second principal axes of inertia.

The results are slightly different from those of Lockyear (1992) but they do not alter the basic conclusions. It would seem that important variation in this data set occurs in years after 97 BC, and more importantly from 92 BC. Within this, we can see the influence of smaller groups of years on subsets of this data. In Fig. 9.5a there is a group of eight hoards on the right side of the map. They become more spread out in Fig. 9.5b suggesting that years from 87–81 BC is important in separating out these hoards. Although these results graphically demonstrate the dynamics of the coinage pool by showing how older issues have an even distribution whereas newer issues do not, it does not help us to assign a specific value for T_{bp} for individual hoards. It does suggest, however, that it took only about 10 years for the distribution of most issues to homogenise within Italy. This is most dramatically illustrated by the inertias presented in Table 9.1. The total inertia figure can be seen as an indication of the strength of the latent structure within a data set. For the first four analyses the total inertia for the partial data sets was 0.6–0.8 compared to the last two data sets which had total inertias of 1.15 and 1.37.

9.3.2 The second analysis — hoards from 74 BC

As with the first analysis, the first task was to demonstrate that the tripartite division existed. To this end, a CA with all variables (years) active and symmetric scaling was performed; eigenvalues *etc.* are presented in Table 9.1. The two hoards with doubtful data quality (IT2 & SP2, see section 8.3.9) were omitted. The variable scores from the first four axes of inertia were plotted as a line graph (Fig. 9.6).[5] As can be seen, the tripartite division is much less clear in this analysis than in the previous analysis.

If we compare the percentage variance explained figures and the total inertias for the analysis of all of data set `fin87.dat` and this data set (Table 9.1), we can see that CA is much less able to summarise the data in the latter set than the former (see also section 8.3.9). These figures are not entirely comparable as this data set contains 22 hoards compared to 12 in the previous analyses *but* these lower figures do reflect the fact that the hoards in this data set are much more similar to each other than hoards in the former data set (also *cf.* Fig. 8.26, page 184 with Fig. 8.35, page 196). As the variation in the former set is primarily due to the last 10–15 years, we must conclude that conversely, the lack of variation in these hoards must be due to a higher level of similarity in the last 10–15 years. The partial CA procedure is pointless with this data set and the analyses were not performed.

This raises the obvious question, *why* are the last few years in data set `fin74.dat` more similar than the last few years in data set `fin87.dat`? The answer to this question was not immediately obvious. It is, however, fundamental for understanding coin hoard formation processes.

[5]The equivalent graph in Lockyear (1993a, Fig. 41.6) has been altered by the editors. They have placed the correct data lines for Fig. 41.6 onto the axes of Fig. 41.3!

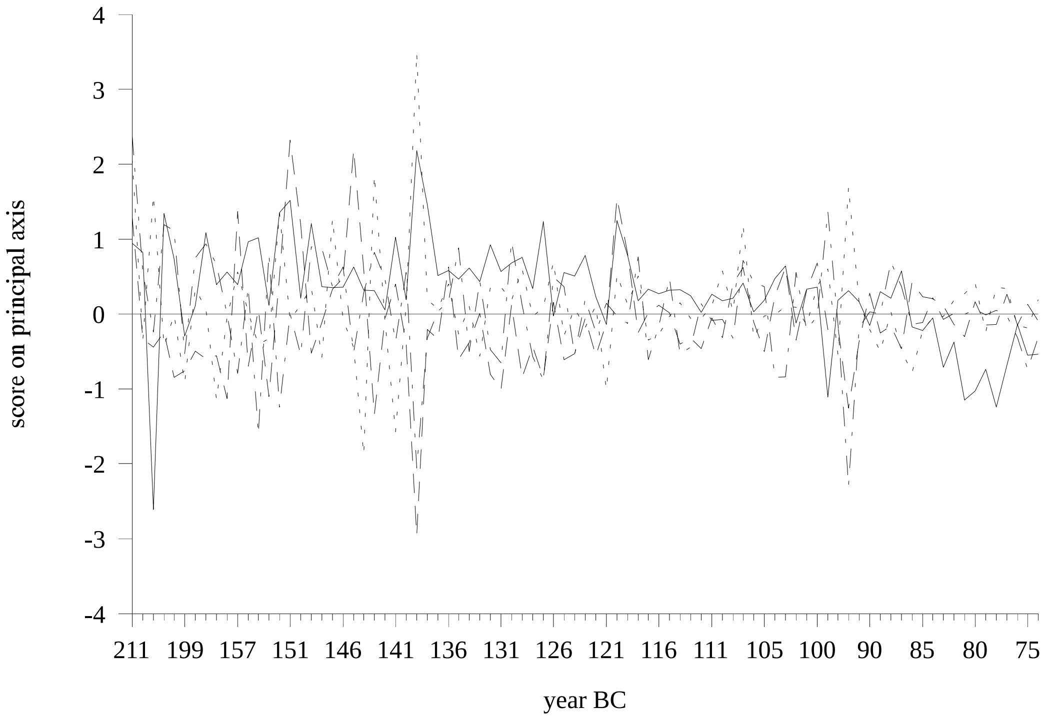


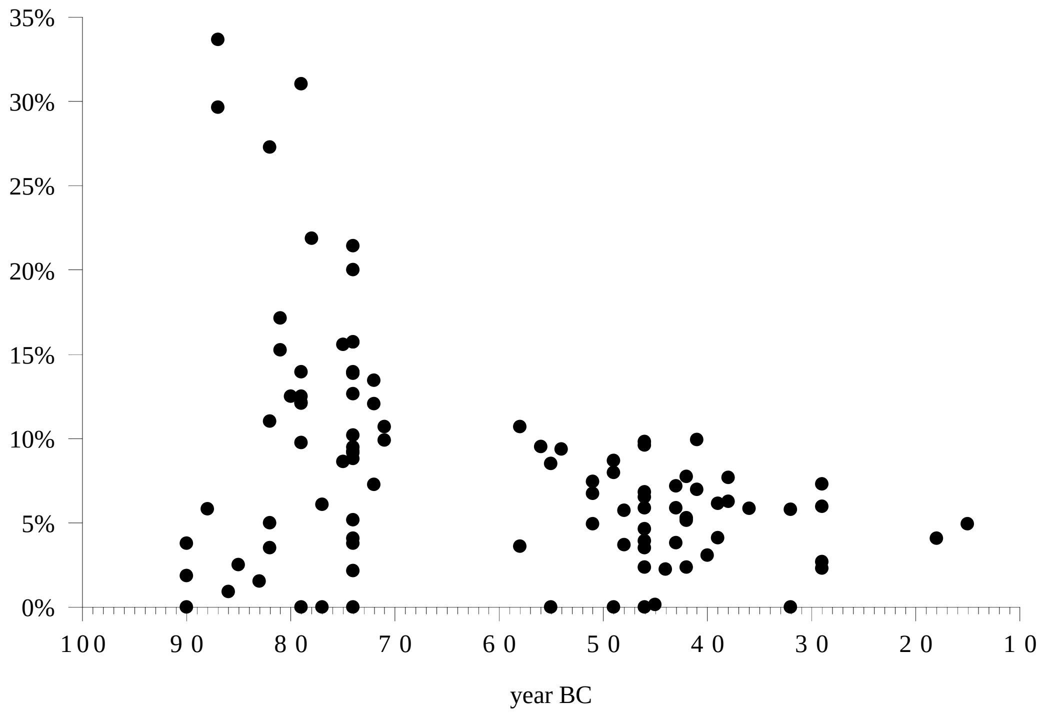
Figure 9.6: Line graph of the species scores from CA of data set `fin74.dat`. Solid line first axis, dashed line second axis, dash dot line third axis, dotted line fourth axis. Years with no coins in the data set cannot have a score and are thus omitted, hence irregular time gaps on the x-axis

9.4 Issue size and inter-hoard variability

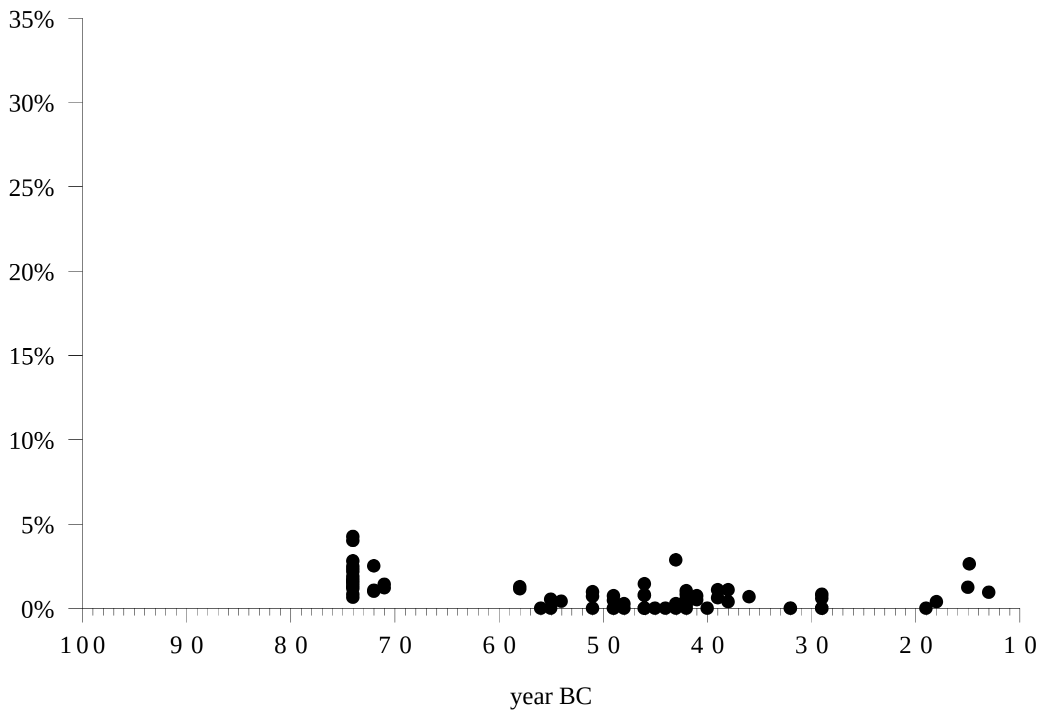
To explain this pattern we first need an appreciation of the relative size of some issues of coinage. Although the absolute sizes of coin issues during the Republic are disputed, the fact that there are periods of high coin issue and low coin issue is not. The period from the start of the Social War to *c.* 80 BC is a period of high coin issues, the 70s BC saw a decline in the size of issues, and the 60s and 50s were a period of very small issues. During the wars of the 40s BC large issues were again struck; the legionary issue of 32–31 BC is large and debased.

For present purposes, a satisfactory appreciation of the relative size of some coin issues can be gained by simply plotting the percentage that a year forms in a hoard against the closing date of that hoard. Fig. 9.7a shows these percentages for 90 BC in all Italian and Iberian peninsula hoards with more than thirty well identified *denarii*. As can be seen, at first the issues form between 1 and 34% of these hoards. Within the 15 hoards closing in or before 80 BC there is a bimodal distribution with 8 hoards having between 1–6% and 7 hoards having 11–34% (see Table 9.2). The proportion gradually falls over time as the coins are lost from the global coinage pool and/or the global coinage pool grows in absolute size. In 74 BC these coins form between 0 and 21.4% with a median of 10%. The distribution of these percentages shows no tendency for bimodality and, with all due caution as we are dealing with percentages, they appear to be normally distributed. By 46 BC these coins form between 0–9.8% of coin hoards (Table 9.2).

Contrast this to Fig. 9.7b which presents the same data for 74 BC. Coins struck in that year formed at most 4.3% of the coinage pool, and rarely more than 3% (Table 9.3). The list presented



(a) Coins of 90 BC in coin hoards



(b) Coins of 74 BC in coin hoards

Figure 9.7: Comparison of the size of issues from 90 and 74 BC in Italian and Iberian peninsula hoards with 30 or more well identified *denarii*.

code	hoard	country	'end date'	'good total'	coins of 90 BC (%)
OLE	Oleggio	Italy	86	221	0.9
FSL	Fossalta	Italy	83	259	1.5
FUS	Fuscaldo	Italy	90	811	1.8
PNT	Pantelleria	Nr. Sicily	85	40	2.5
BER	Berchidda	Sardinia	82	1395	3.5
HF1	'Hoffmann'	Italy	90	132	3.8
CAR	Carovilli	Italy	82	40	5.0
SYR	Syracuse	Sicily	88	1084	5.8
DOM	Santa Domenica di Tropea	Italy	82	109	11.0
PL1	Palestrina	Italy	80	64	12.5
CPL	Capalbio	Italy	81	59	15.3
BLC	Bellicello	Sicily	81	35	17.1
CER	Cervia	Italy	82	44	27.3
ALI	Alife	Italy	87	81	29.6
CAH	'Italy'	Italy	87	211	33.6
IT2	'Italy'	Italy	74	47	0.0
RIG	Rignano	Italy	74	92	2.2
POO	Poio	Portugal	74	211	3.8
SP2	'Spain'	Spain	74	246	4.1
ORI	Oristà	Spain	74	58	5.2
PON	Pontecorvo	Italy	74	942	8.8
LIC	Licodia	Sicily	74	120	9.2
PL2	Palestrina	Italy	74	357	9.2
MAC	Maccarese	Italy	74	1212	9.5
COS	Cosa	Italy	74	1999	10.2
CAB	Cabeça de Corte	Portugal	74	158	12.7
BDR	Barranco de Romero	Spain	74	65	13.8
TUF	Tufara	Italy	74	158	13.9
MAR	Rio Marina	Elba	74	43	14.0
CDR	Castro de Romariz	Portugal	74	70	15.7
PIC	Potenza Picena	Italy	74	439	15.7
CTR	Canturato	Italy	74	50	20.0
SMB	Las Somblancas	Spain	74	84	21.4
JAE	Jaén	Spain	46	65	0.0
PLI	Policoro	Italy	46	42	2.4
EL2	El Centenillo	Spain	46	57	3.5
SEN	Sendinho da Senhora	Portugal	46	76	3.9
CRO	Crotone	Italy	46	86	4.7
ECL	Mirabella Eclano	Italy	46	85	5.9
SUR	Surbo	Italy	46	138	6.5
SPN	Spoiano	Italy	46	264	6.8
MOR	Morrovalle	Italy	46	125	9.6
FDC	Fuente de Cantos	Spain	46	387	9.8

Table 9.2: Coins of 90 BC as a percentage of the 'good total' in hoards from 90–80 BC, 74 BC and 46 BC, from Italy and the Iberian peninsula. Minimum hoard size is 30 well identified *denarii*. Each group is in order of the percentage.

code	hoard	country	'end date'	'good total'	coins of 74 BC (%)
PON	Pontecorvo	Italy	74	942	0.6
SP2	'Spain'	Spain	74	246	0.8
SMB	Las Somblancas	Spain	74	84	1.2
CAB	Cabeça de Corte	Portugal	74	158	1.3
TUF	Tufara	Italy	74	158	1.3
CDR	Castro de Romariz	Portugal	74	70	1.4
BDR	Barranco de Romero	Spain	74	65	1.5
PIC	Potenza Picena	Italy	74	439	1.6
COS	Cosa	Italy	74	1999	1.6
LIC	Licodia	Sicily	74	120	1.7
ORI	Oristà	Spain	74	58	1.7
POO	Poio	Portugal	74	211	1.9
RIG	Rignano	Italy	74	92	2.2
MAR	Rio Marina	Elba	74	43	2.3
MAC	Maccarese	Italy	74	1212	2.5
PL2	Palestrina	Italy	74	357	2.8
CTR	Canturato	Italy	74	50	4.0
IT2	'Italy'	Italy	74	47	4.3
SEN	Sendinho da Senhora	Portugal	46	76	0.0
EL2	El Centenillo	Spain	46	57	0.0
CRO	Crotone	Italy	46	86	0.0
ECL	Mirabella Eclano	Italy	46	85	0.0
PLI	Policoro	Italy	46	42	0.0
JAE	Jaén	Spain	46	65	0.0
SPN	Spoiano	Italy	46	264	0.8
FDC	Fuente de Cantos	Spain	46	387	0.8
MOR	Morrovalle	Italy	46	125	0.8
SUR	Surbo	Italy	46	138	1.4

Table 9.3: Coins of 74 BC as a percentage of the 'good total' in hoards from 74 BC and 46 BC from Italy and the Iberian peninsula. Minimum hoard size is 30 well identified *denarii*. Each group is in order of the percentage.

does, of course, omit hoards which were deposited in 74 BC but have no coins of that year, and thus close at an earlier date. The proportion of the coinage pool that these coins form falls over time, and by 46 BC 60% of the hoards have no coins of 74 BC; only one hoard has more than 1%.

We can see, therefore, that the highly structured data set `fin87.dat` occurs in a period where recent coin issues form a large proportion of the coinage pool. Conversely, coins struck in the years immediately prior to 74 BC only form a small part of the pool and data set `fin74.dat` shows relatively less variation. If we look at the results of the CAs presented in the previous chapter we find that, in general, data sets from periods immediately after years when the coins struck form a large proportion of the coinage pool produce highly structured data sets (*e.g.*, `fin87.dat`, `fin32.dat`, sections 8.3.6 and 8.3.19); periods when low quantities of coins were struck are those where hoards all appear relatively similar (*e.g.*, `fin74.dat`, `fin72.dat`, sections 8.3.9–8.3.10).

This pattern can be explained as the result of two factors. The first factor can be demonstrated most easily using a diagram. Figure 9.8 shows the introduction of two issues of coinage into the coinage pool. As discussed before, the initial distribution is uneven. Over time the issue circulates

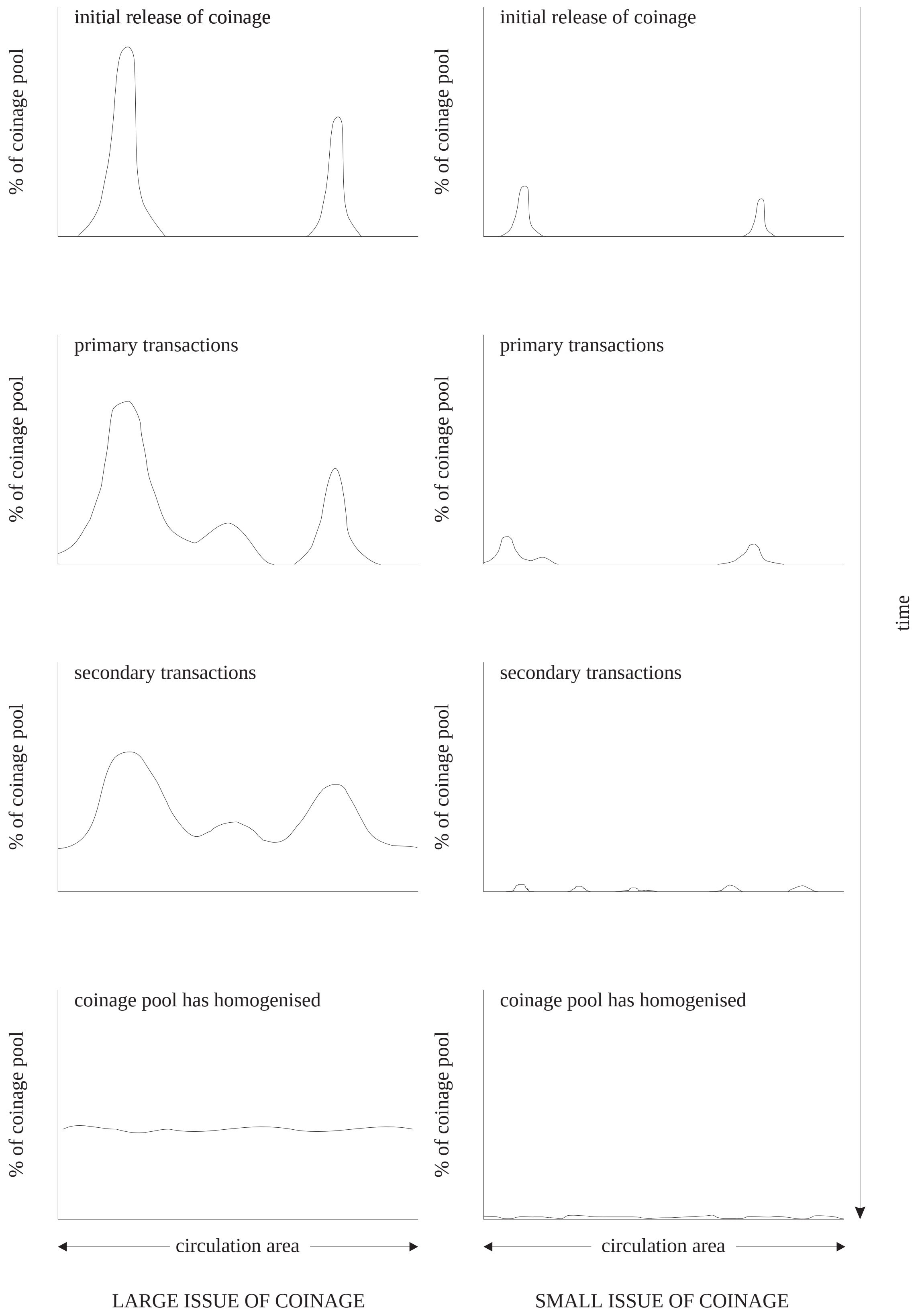


Figure 9.8: Comparison of the distribution of large and small issues of coinage over time. The left hand side shows how a large issue creates a high level of inter-hoard variability; the right side shows a small issue which creates little inter-hoard variability. Left-hand side, after Creighton (1992b, Fig. 1).

and eventually becomes evenly spread. The important point is the comparison of the large issue of coinage, which will produce major differences between hoards, and the small issue which will produce minor differences. If, as seems to be the case, we have *periods* of low issue, and periods of high issue, the contrast between high issue periods with high inter-hoard variability, and low issue periods with low inter-hoard variability, will be even more marked.

The second factor has to be demonstrated mathematically. Each hoard is a sample of the coins in circulation. However, the proportion of coins of a year in the sample is unlikely to be an accurate representation of the proportion in the population. An idea of how much variation we should expect — the sampling error — can be obtained by calculating the *standard error of the proportion* (Downie & Heath 1965) or by calculating or looking up confidence limits. The mathematically nervous should skip the next section and proceed to 'Worked examples', and take the results presented there at face value.

Mathematical details

The standard error of the proportion (Downie & Heath 1965) can be calculated by:

$$s_p = \sqrt{\frac{pq}{n}} \tag{9.1}$$

where n is the sample size, p is the proportion and $p - q = 1$. Cochran (1977, p. 57–8) gives another, more accurate, formula for calculation of the standard error:

$$s_p = \sqrt{1-f}\sqrt{\frac{pq}{n-1}} + \frac{1}{2n} \tag{9.2}$$

where $f = n/N$ and N is the population of interest. Cochran states, however, that in many cases use of the formula 9.2 rarely makes any appreciable difference. In this particular case the first term of Cochran's formula ($\sqrt{1-f}$) makes effectively no difference as N, the coin population is huge compared to the sample (hoard) size n so that $\sqrt{1-f} \approx 1$. With large hoards, division by $n-1$ in the second term of the equation, and addition of $\frac{1}{2n}$ in the last term of the equation will also make almost no difference.

To calculate confidence limits we can multiply the standard error by the normal deviate corresponding to the confidence probability required. For example, to obtain the 95% confidence limits we can multiply s_p by 1.96. However, this normal approximation to the binomial distribution is only valid in limited circumstances (Cochran 1977, p. 58 and Table 3.3). This is due to proportions being restricted to the range 0–1. A variety of other methods are available for the calculation of these limits (Cochran 1977, pp. 57–60). The most convenient method is, however, to look up the upper and lower limits in Table P of Rohlf & Sokal (1995).

In the following discussion, the figures for the standard error using formula 9.1 will be given along with the confidence limits derived from Rohlf & Sokal (1995). In the latter case, interpolation between sample sizes was achieved using the method given by Rohlf & Sokal (1995, pp. 92–3), and between the limits using linear interpolation (Rohlf & Sokal 1995, pp. xii–xiv).

Worked examples

In the following, two statistics are used: the standard error of the proportion which is calculated using formula 9.1 above, and the 95% confidence limits derived from statistical tables (Rohlf & Sokal 1995). In simple terms, the standard error gives a general indication of the size of the variation one should expect in the proportions (and thus percentages) — the larger the standard error, the larger the likely differences between samples of the same size. The confidence limits give an indication of the probability that the population proportion lies within those limits. For example, if an item (year of issue) forms 8% of a sample (hoard) of 1000 items (coins), the 95% confidence limits are 0.064 and 0.098 which means there is only a 1 in 20 chance that the true population proportion is less than 0.064 (6.4%) or higher than 0.098 (9.8%).

The Pontecorvo hoard (PON) has 8.8% of its total of 942 coins struck in 90 BC. The standard error of the proportion in this case is:

$$s_p = \sqrt{\frac{0.088 \times 0.912}{942}} = \sqrt{0.00008} = 0.009$$

The 95% confidence limits are 0.0712 and 0.1077, *i.e.,* there are 19 chances in 20 that coins of 90 BC form between 7.1%–10.8% of the coinage pool in 74 BC. Pontecorvo is, however, a very large hoard and we could compare the results with a smaller hoard. In the Rio Marina hoard (MAR) coins of 90 BC form 14% of the 43 coins. The standard error of the proportion in this case is:

$$s_p = \sqrt{\frac{0.14 \times 0.86}{43}} = \sqrt{0.002} = 0.05$$

The standard error of the proportion for small samples is, therefore, much larger than for large samples. The 95% confidence limits for this hoard are 0.0672 and 0.2679,[6] *i.e.,* there are 19 chances out of 20 that coins of 90 BC form between 6.7%–26.8% of the coinage pool in 74 BC. Although the range for the smaller hoard is much larger, the results from both hoards are in agreement.

Let us now compare these results to coins from 74 BC. In the Pontecorvo hoard these coins form 0.6% of the total. Substituting in the formula we obtain:

$$s_p = \sqrt{\frac{0.006 \times 0.994}{942}} = \sqrt{0.000006} = 0.002$$

Thus, where an issue forms a small proportion of the sample, it will have a smaller standard error than a larger issue in the same sample. The 95% confidence limits in this case are 0.0032 and 0.0127; *i.e.,* there are 19/20 chances that coins of 74 BC form between 0.3–1.3% of the coin population. Let us again compare this to the Rio Marina hoard where coins of 74 form 2.3% of the 43 coins:

$$s_p = \sqrt{\frac{0.023 \times 0.977}{43}} = \sqrt{0.0005} = 0.023$$

[6] Rohlf & Sokal (1995) do not show how one should interpolate confidence limits for samples between 30 and 50, *i.e.,* between the two difference types of table given. The figures given are for sample size 50 and are thus too small. The limits for 4 objects out of 30 (*i.e.,* 13.3%) are 0.0279 and 0.2978; the limits for 5 objects out of 30 (*i.e.,* 16.6%) are 0.0681 and 0.3475.

As is expected, we again have a larger standard error with the smaller sample. The 95% confidence limits in this case are 0.002 and 0.1111[7]; *i.e.,* there are 19/20 chances that coins of 74 BC form between 0.2–11.1%. Again the results from the two hoards are comparable.

Table 9.3 shows that the large Maccarese hoard has 2.5% from its total of 1212 coins date to 74 BC. This gives a s_p of 0.45%. The 95% confidence limits for a hoard of 1000 coins[8] would be 0.0169 and 0.0368, *i.e.,* 1.7%–3.7%. In this case the results do not appear to be in agreement with Pontecorvo hoard with its range of 0.3–1.3% although the ranges do overlap at the 0.99 level, *i.e.,* 99 chances out of 100. We must realise, however, that we are estimating the proportion in the *local* coinage pools. Irregularities between local coinage pools in this case are because we are examining the distribution of coins of 74 BC in hoards with a closing date of that year, *i.e.,* the coins have not been in circulation for very long and their distribution has not had time to homogenise.

9.5 Ramifications

We can therefore make the following conclusions. Issues of coinage which form a large proportion of the coinage pool will create large differences between hoards for the following reasons:

1. Immediately after the coinage has been released into the coinage pool there will be large differences between hoards as a result of the irregular distribution. This will be accentuated by sampling error.

2. Even after the distribution has become even, there will still be comparatively large differences between hoards due to a larger standard error of the proportion.

3. Differences between hoards will be further emphasised if small hoards are used — the smaller the hoard the larger the standard error and *vice versa*.

In contrast, in periods where the latest issues form a small part of the coinage pool, there will be small differences between hoards because:

1. Immediately after the coinage has been released into the coinage pool there will be small differences between hoards as a result of the irregular distribution — hoards will either have a small number of coins of that date, or will have none and the closing date will not reflect the actual deposition date.

2. When the coin distribution is even, sampling errors will only create a small variation between hoards.

3. Differences between hoards will still be emphasised if small hoards are used but the standard errors are still smaller than for larger issues.

[7] Again, these are the limits for sample size 50. The limits for 0 objects out of 30 are 0 and 0.1115; the limits for 1 object out of 30 (*i.e.,* 3.3%) are 0.0018 and 0.1772.

[8] A sample size of 1000 is the maximum given by Rohlf & Sokal (1995). For a hoard of 1212 the limits would be smaller than those given and thus would not effect the arguments presented.

As a result, *we cannot use the size of the differences between hoards across periods as an indicator of the speed of circulation* unless *the most recent issues of coinage form the same proportion of the coinage pool in all cases.* It is unlikely that this situation will ever occur. We should also note that only in those high issue periods are factors such as the collection method, or the supply patterns, likely to be visible in the hoard evidence. It is not an accident that the analysis of data set `fin87.dat` produced the clearest evidence for spatial patterning within a region.

These conclusions are extremely important and invalidate the majority of the conclusions drawn by Creighton (1992a). The differences in the structure of coin hoards, plotted as a series of period maps showing how archaic or modern hoards were, is a reflection of the variable supply of coinage to Britannia, not of changes in the speed of coin circulation as Creighton (1992a, pp. 78–103) proposes. The contingency coefficients, even if one ignores the manner in which they were calculated, similarly reflect supply rather than the speed of circulation (*cf.* Creighton 1992a, pp. 73–77), and almost certainly cannot be used to shed light on Icenian coinage (*cf.* Creighton 1992b). Creighton also uses the equation cited at the start of this chapter to explain changes in the structure of hoards in terms of the speed of circulation:

> [as a result of] the large Severan injection of *denarii* into circulation… [the] high velocity of circulation could not be sustained. The rate falls rapidly as an increased number of coins move around the system doing the same amount of 'work' as the previously smaller number did.
>
> (Creighton 1992a, p. 94)

The results of the above analyses suggest that the pattern he observes would be visible after a large injection of coinage into the system *even if the speed of circulation remained constant.* His interpretations cannot, as yet, be supported by his analyses as he has failed to appreciate this basic property of the system.

If it seems that I have spent some considerable time to demonstrate this point, it is because it is a fundamental concept, and one whose importance has been lost in the past because previous expositions have used die estimates and calculated coin populations, which are disputed (*e.g.*, Buttrey 1994). The problem of die estimates and calculated coin populations will be fully discussed in Chapter 11.

Is there a satisfactory means of estimating the speed of circulation? As yet, I cannot find a method that would allow us to do so in a manner that would be analytically useful. Although the rolling CA technique used above has allowed us to make an estimate for the early first century BC, other periods are not readily comparable. The large issues of 46 BC, for example, were minted in Spain; the legionary *denarii* were minted in the east. Also, although there are some large issues in the later periods, the number of coin hoards concealed in Italy falls whereas more hoards are available from Romania, France and Germany. Although finding a method for the estimation of coin velocity is an attractive proposition, it is not a trivial task and no technique so far proposed is reliable enough to provide analytically useful results.

Chapter 10

Comparing hoards — cluster analysis

10.1 Introduction

In Chapter 8, we divided the available data into 22 data sets. This was because a global correspondence analysis was dominated by the dates of the hoards (Figs. 8.2–8.3). It would, however, be useful to perform a global analysis which would enable the data to be divided into sets on the basis of their structure, rather than external criteria such as date or region. The results would enable us to examine the following:

1. how homogenous or heterogeneous regional and period-based groups are;
2. whether regional groups from one period have any similarity with regional groups from another period;
3. how archaic or modern individual hoards are;
4. the most likely date of hoards containing 'extraneous' coins;
5. patterns of supply of coinage from Italy to other regions.

Creighton (1992a) approached points 1 and 3 by creating a 'benchmark', in effect a series of coin populations over time to which hoards were compared. Unfortunately, the method by which this benchmark was created was not given in sufficient detail.[1] Creighton (1992a, pp. 81–89) compared hoards to his benchmark using the area between the hoard and population curves (see section 3.12.6). This method magnifies the problems associated with variable sample sizes, and especially small samples — Creighton uses hoards as small as five coins. The conclusions derived from Creighton's analysis were discussed in the previous chapter.

An attempt was made to produce a series of 'average' hoards which could be used in a manner similar to Creighton. Many problems were encountered of which the following were most important:

[1]Creighton (1992a, pp. 68–70) gives an outline of the method (see section 3.12.4) but the details of how the lines were plotted through the scattergrams are not given; Creighton simply states: "The values are based on interpolation (and for the AD 40–45 points extrapolation)" (1992a, p. 472).

- in periods where there is a single very large hoard, that hoard can dominate the pattern;
- some periods have high inter-hoard variability, some do not;
- some periods have large numbers of hoards, some do not;
- 'odd' hoards can adversely affect the 'average';
- the profiles of the average hoards of different periods should, in theory, not overlap if they are to represent the coin populations; in reality there are often overlaps because of sampling error.

An alternative method, which has many practical and theoretical advantages, is to compare hoards with each other rather than to a benchmark. We could plot hoards as cumulative percentage curves as in Chapter 8 but it would be difficult to compare all hoards with all other hoards in this manner. An alternative approach would be to calculate some measure of similarity or dissimilarity between hoards. Many such measures exist and Shennan (1988, pp. 198–208) discusses the commonest measures used in archaeology. In this context, we ideally want a measure which is insensitive to rare variables and could make full use of the ordinal nature of the data. No such measure was given in the literature consulted or in the computer packages available.

Application of the most appropriate significance test for this type of data, the Kolmogorov-Smirnov test (Shennan 1988, pp. 55–61), requires the calculation of *Dmax* defined as the largest difference between two cumulative proportion curves. Dmax is then compared to a critical figure for the desired probability level. It would be possible to use Dmax as a measure or coefficient of dissimilarity between hoards rather than as part of the test. To compare every hoard with every other hoard, $n(n-1)/2$ coefficients are needed, where n is the number of hoards to be compared. Lockyear (1989, section 2.2) compared the 24 hoards published by Crawford (1974) using the Kolmogorov-Smirnov test. This resulted in 276 comparisons; with the current database the number of comparisons is huge.

We therefore need a method which would enable us to handle such a large number of comparisons. Three possibilities exist.

1. Search for the nearest neighbours for each hoard; *i.e.,* for each hoard look for the smallest values of Dmax for a predetermined number of hoards. This would not be an efficient method.
2. Cluster analysis. This could be:
   (a) Hierarchical agglomerative methods such as single link cluster analysis (Orton 1980, pp. 43–52; Shennan 1988, pp. 190–225, Baxter 1994, chapter 7).
   (b) Partitioning methods, the most common of which is k-means (Orton 1980, pp. 52–54, Shennan 1988, pp. 225–228, Baxter 1994, pp. 147–149).
3. Principal co-ordinates analysis (Doran & Hodson 1975, p. 194, Shennan 1988, pp. 280–281, Wright 1989, 'DIRPCORD').

The use of the Dmax measure in the above techniques is a non-standard method which was thought, at the time of the analysis, not to have been used in this fashion previously. Leese (1983) and Middleton *et al.* (1985) use Dmax as a coefficient in multidimensional scaling, and Geman *et al.* (1990) use Dmax in image analysis. Ryan (1988, p. 72) had also used Dmax in a cluster analysis of coin assemblages although the results were not presented in detail. No theoretical objections to its use have been found. This coefficient could be criticised for ignoring much of the available information, as has the Chebychev measure (Norušis 1993, p. 97) which uses the absolute maximum difference between variables, but not the maximum *cumulative* difference. Leese (1983, p. 52) suggests that we could use the area between the curves. In her case this would be possible as she had control over her sample size; here we have no such control. The problem of variable sample (hoard) sizes can be minimised by not using very small hoards. However, in this case, we positively wish to lose some of the detail in the data and use of Dmax is sufficient for our purposes.

10.2 The analysis

A subset of 217 hoards with over 30 well identified *denarii*, and with a closing date between 211–29 BC, was extracted from the CHRR database using the YEARTOTS dBASE program. The necessary 23,436 Dmax values were then calculated with the dBASE program SMATALL[2] and the resultant table converted into symmetric and upper triangle matrices using the programs SYMTRIX and HALFTRIX respectively.[3] The matrix was analysed using hierarchical agglomerative methods using the HIERARCH module of MV-ARCH (Wright 1989). The results were plotted using HIERPLOT. Although it would be theoretically possible to use a k-means style technique it would require programming from scratch as k-means routines such as Wright's KMCALC work from a table of data, not (dis)similarity coefficients; the similarities between objects and between groups are calculated on the fly (Orton 1980, p. 53).

HIERARCH offers seven clustering methods. Of these, single link, average link (between groups), total link (or furthest neighbour) and Ward's method are the most well known (for a detailed explanation of each see Shennan 1988, pp. 212–220). The choice of method is not straightforward and has to be based on a number of practical and theoretical considerations. Orton (1980, p. 52) citing Jardine *et al.* (1967) notes that the average link method is:

> 'discontinuous', meaning that a small change in one of the coefficients could affect the dendrogram, not only in the immediate vicinity of the two objects, but also in some circumstances right across the pattern.

Wright (1989) however states:

> It is sufficient to say, two decades later, that a brief excursion into recent multivariate literature will assure you that the objections of Jardine *et al.* are no longer fashionable nor regarded as cogent. Group average does work.

[2]This took 11 3/4 hours but it was not felt worth writing this 'one off' program in a faster language.

[3]Although hoards Castelnovo (CST) and San Gregorio di Sassola (GRE) were included in the analysis, it was subsequently decided that there were serious problems with the quality of their data. These hoards have therefore been omitted from the various summary tables, although they are included in Table 10.2.

Suffice to say that common usage is not a very strong argument for statistical validity. Other methods, however, also have their problems. Single linkage clustering usually produces dendrograms which are 'chained' especially when we are dividing-up a continuum rather than identifying clearly defined groups. Using this method can result in having one large group and many singletons.[4] This is clearly not very useful. Wright notes that Ward's method, usually used with the squared euclidian distance measure, is a space dilating technique which produces dendrograms which appear to show strong groups even from random data (see also Baxter 1994, pp. 159–161). Wright strongly favours the use of the average linkage.

In the particular data set under consideration it is clear that we will not be dealing with a set of objects which can be clearly grouped. We have a continuum which we wish to divide in order to examine which hoards are most similar in their structure having minimised the time trend. Many validation techniques (Aldenderfer 1982; Shennan 1988, pp. 228–232) are, in this case, not particularly useful. Aldenderfer's suggestion that the cluster analysis results be compared to other multivariate methods can be achieved by using the results of the CAs presented in Chapter 8, or by performing a principal co-ordinates analysis on the dissimilarity matrix (section 10.4). A further possibility, *detrended correspondence analysis* will also be examined (section 10.5).

The matrix of Dmax dissimilarity coefficients was clustered using single link, Ward's method, and average linkage. An initial examination of the single link dendrogram revealed the expected chaining effect (Fig. 10.1) and this would be difficult to divide in a useful fashion. Ward's method (Fig. 10.2) produced a small number of clusters which was too coarse for the current task. Although using MV-ARCH's option not to have Ward's methods customary long stems improved matters (dendrogram not presented), it still appeared that the average link dendrogram was easiest to manipulate (Fig. 10.3). A quick examination of the groups revealed some believable grouping such as group *a* which contains the hoards of Actium (ACT), Delos (DEL) and Belmonte de Sannio (BDS), all of which close in 32 BC and have a large quantity of the legionary *denarii* of Mark Antony (*cf.* section 8.3.19). This dendrogram was therefore examined more fully.

The desire to have a moderately large number of groups, but not too many, led to the decision to 'cut' the dendrogram at a dissimilarity of 20. This gave 42 groups of which a number are singletons. A summary of these groups is presented in Table 10.1 and details of the group members are given in Table 10.2.[5]

As was noted, group *a* contains the three hoards closing in 32 BC containing many legionary *denarii*. These hoards have a distinctive composition and thus form a well defined group.

Group *b* contains the largest number of hoards. This group contains hoards from all across Europe. The overall range of end dates for this group is 82–32 with a median of 71.[6] The two countries best represented in this group are Italy (including Sicily) with 10 hoards and Romania with 21. Within the Italian group the hoard from Carovilli (CAR) closes in 82 BC; the rest close in the 70s BC.[7] All the hoards from Spain, Portugal, the former Yugoslavia, France, Greece and

[4]'Singleton' is used here to refer to a group or cluster with only one member.

[5]When the detailed information from the agglomeration schedule was examined, it was found that the cut had actually been made at 18.9. As the cut was arbitary it was decided to continue with this number of groups.

[6]The medians (Tukey 1977, p. 29) given in Tables 10.1 and 10.3 use the notation 'h' for half (Tukey 1977, p. 5).

[7]Hoard CST has been omitted from this discussion.

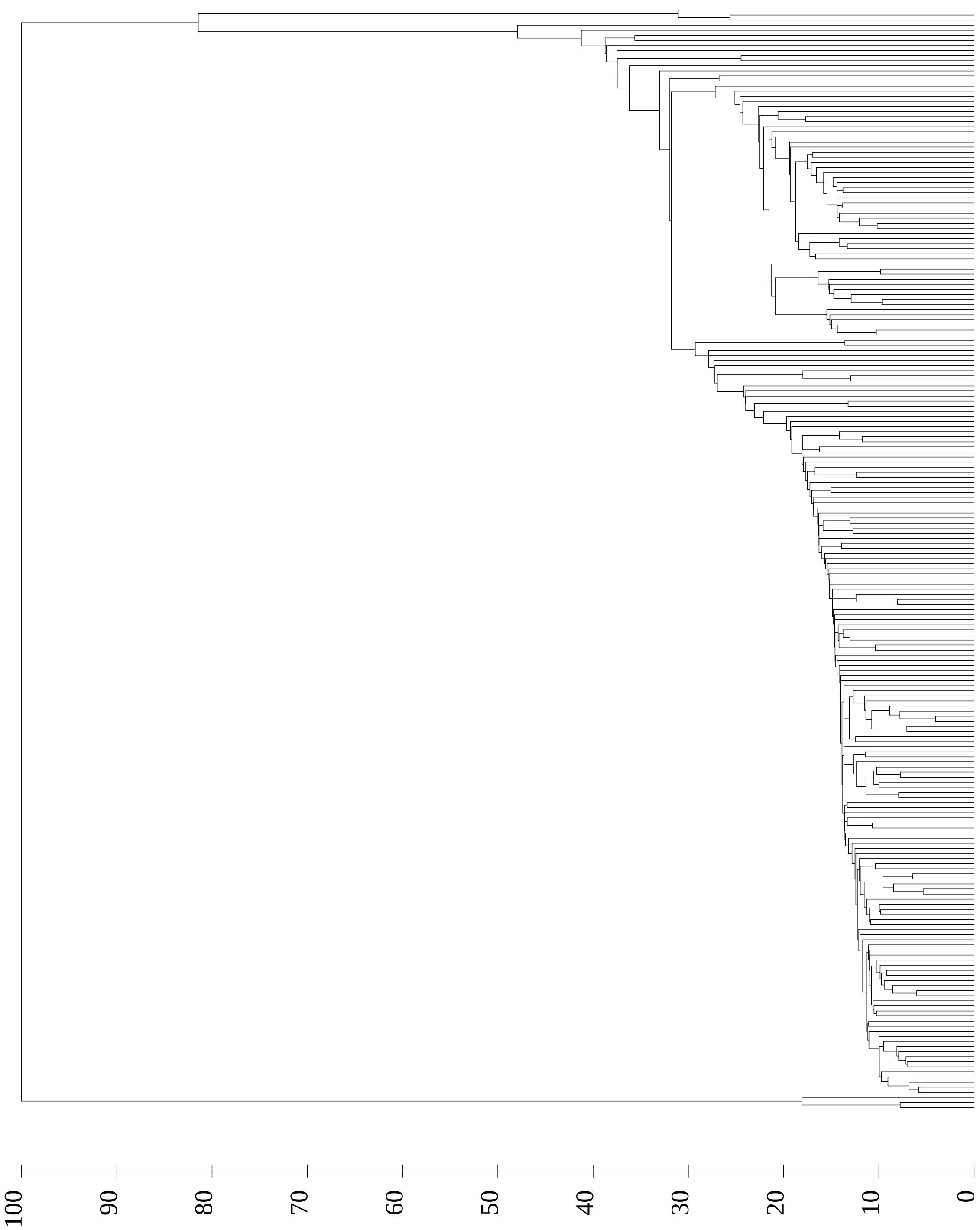


Figure 10.1: Dendrogram from cluster analysis using Dmax as a dissimilarity coefficient, and the single link agglomeration method.

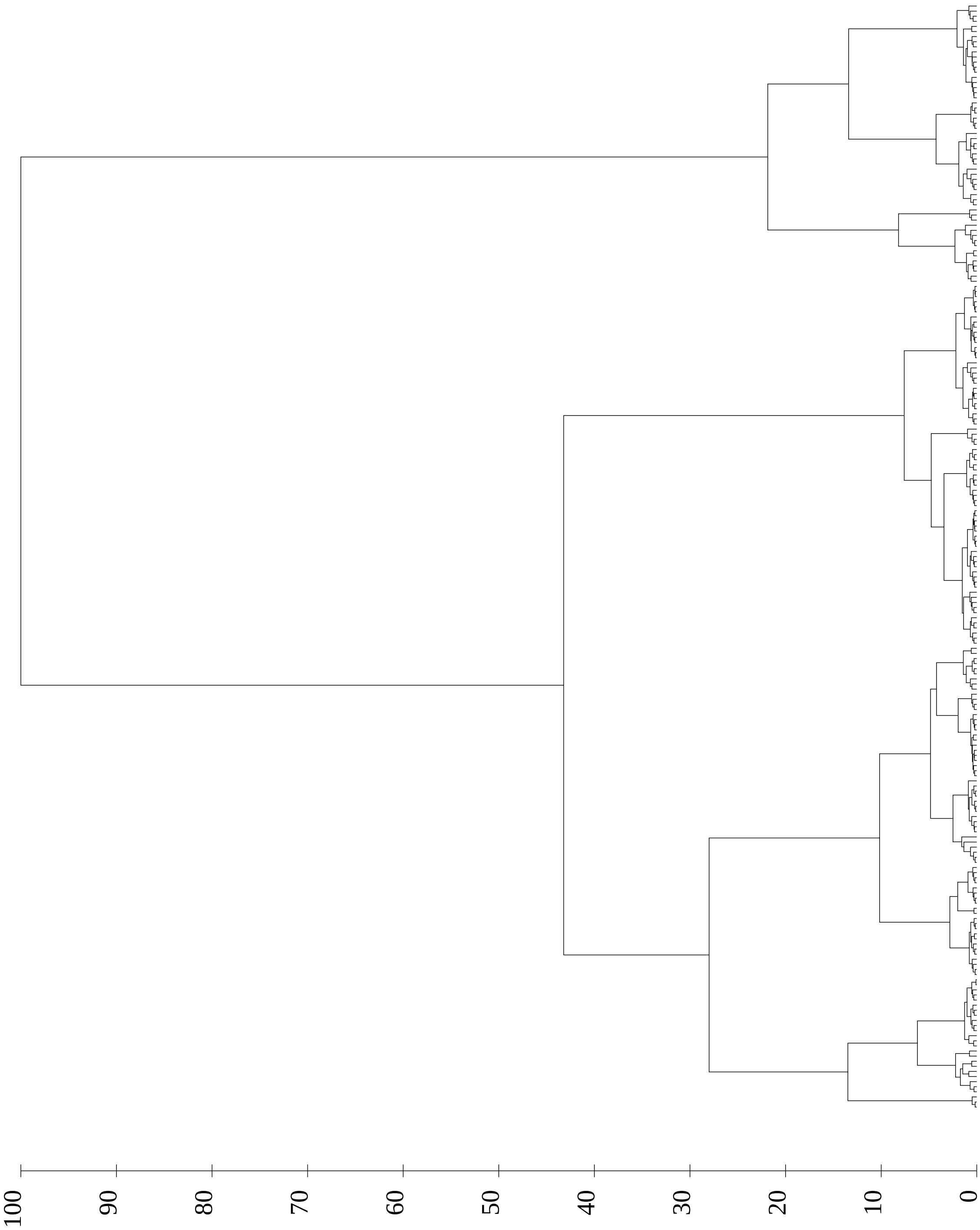


Figure 10.2: Dendrogram from cluster analysis using Dmax as a dissimilarity coefficient, and Ward's agglomeration method.

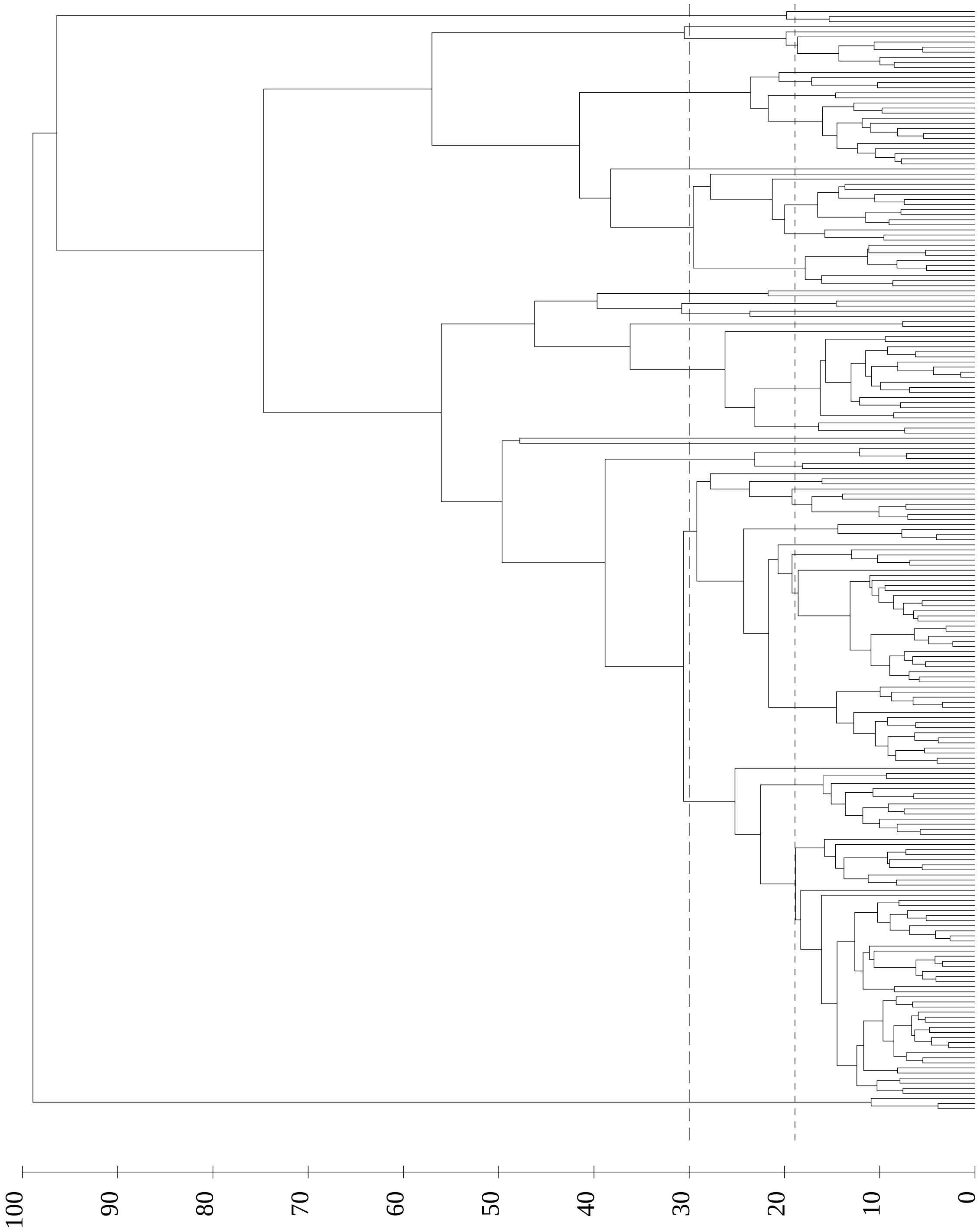


Figure 10.3: Dendrogram from cluster analysis using Dmax as a dissimilarity coefficient, and the average link agglomeration method. The order of the sites in Table 10.2 is identical to the order of the prongs from left to right in this figure. The short-dash line shows the cut for the groups, the long dash line shows the cut for the supergroups.

cluster	No. of members	Next cluster	level	'end dates' range	median
a	3	b–ρ	95.229	32–32	32
b	40	c	18.992	82–32	71
c	10	b	18.992	81–63	76
d	13	b–c	22.474	82–32	74
e	1	b–d	25.041	–	74
f	16	g–i	21.676	48–29	42
g	22	h	19.338	55–39	46
h	4	g	19.338	47–29	44
i	1	g–h	20.736	–	29
j	4	f–i	24.180	58–55	57
k	6	l	19.338	74–49	73
l	1	k	19.338	–	74
m	2	k–l	23.590	80–79	79h
n	1	k–m	27.501	–	79
o	2	p	23.063	87–81	84
p	3	o	23.063	87–82	86
q	1	r	46.556	–	46
r	1	q	46.556	–	74
s	3	t	23.055	40–29	29
t	17	s	23.055	46–29	41
u	1	s–t	26.034	–	46
v	2	s–u	35.522	49–48	48h
w	1	x	23.550	–	41
x	1	w	23.550	–	41
y	2	w–x	30.365	32–29	30h
z	1	α	21.736	–	43
α	1	z	21.736	–	45
β	9	γ–ζ	29.218	118–86	109
γ	3	δ	20.073	104–85	101
δ	9	γ	20.073	112–83	102
ϵ	1	γ–δ	21.310	–	104
ζ	1	γ–ϵ	27.495	–	115
η	1	β–ζ	37.474	–	113
θ	13	ι	21.723	100–82	92
ι	2	θ	21.723	46–41	43h
κ	3	λ	20.640	101–92	100
λ	1	κ	20.640	–	92
μ	7	ν	19.929	125–112	121
ν	1	μ	19.929	–	130
ξ	1	μ–ν	30.108	–	136
π	2	ρ	19.885	147–141	144
ρ	1	π	19.885	–	146

Table 10.1: Summary of cluster analysis results at a dissimilarity of 18.9. Columns three and four give the next cluster to which the listed cluster joins and at what dissimilarity level. The final two columns give the range of 'end dates', and the median. Where the median falls between two years, the notation 'h' has been used. Hoards CST & GRE omitted.

Table 10.2: Detailed results from the cluster analysis using average link. The order of the rows is the same as the order of the prongs on the dendrogram from left to right.

group	code	hoard	country	'end date'	'good total'
a	BDS	Belmonte del Sannio	Italy	32	53
a	DEL	Delos	Greece	32	648
a	ACT	Actium	Greece	32	40
b	ADM	Alba di Massa	Italy	77	82
b	RIZ	'Rizzi'	—	79	215
b	ION	Montalbaro Ionico	Italy	75	45
b	MAL	Maluenda	Spain	78	32
b	CDR	Castro de Romariz	Portugal	74	70
b	MAN	San Mango sul Calore	Italy	75	81
b	CLN	Călineşti	Romania	54	92
b	SDS	Sălaşul de Sus	Romania	54	103
b	SFI	Sfinţeşti	Romania	71	91
[*b*	CST	Castelnovo	Italy	46	394]
b	EMP	Alt Empordà	Spain	71	1122
b	SUC	Sucurac	Yugoslavia	74	165
b	PLC	Policoro	Italy	72	302
b	SAT	Satu Nou	Romania	49	125
b	GUR	Gura Padinii	Romania	32	232
b	SMC	Someşul Cald	Romania	56	115
b	DUN	Dunăreni	Romania	56	128
b	FA2	Fărcaşele II	Romania	42	113
b	FND	Frauendorf	Romania	56	563
b	ICN	Icland	Romania	56	33
b	ALN	Alungeni	Romania	59	32
b	PL2	Palestrina	Italy	74	357
b	CUC	Cuceu	Romania	48	484
b	LOC	Locusteni	Romania	48	88
b	ISL	Islaz	Romania	42	124
b	JEG	Jegălia	Romania	43	453
b	STP	Stupini	Romania	41	226
b	ODS	Orbeasca de Sus	Romania	48	137
b	PEY	Peyriac-sur-Mer	France	74	91
b	BON	Bonţeşti	Romania	62	36
b	COS	Cosa	Italy	74	1999
b	VPT	Villa Potenza	Italy	71	411
b	OSS	Ossero	Italy	72	465
b	ALX	Alexandria	Romania	77	32
b	LIC	Licodia	Sicily	74	120
b	TIN	Tincova	Romania	69	135
b	KER	Kerassia	Greece	78	47
b	MAR	Rio Marina	Elba	74	43
b	SMB	Las Somblancas	Spain	74	84
b	ZAT	Zătreni	Romania	75	41
b	CAR	Carovilli	Italy	82	40
c	AMA	Amaseno	Italy	79	123
c	TUF	Tufara	Italy	74	158
c	MNT	Montiano	Italy	79	56
c	BDR	Barranco de Romero	Spain	74	65
c	PIC	Potenza Picena	Italy	74	439
c	NOY	Noyer	France	78	51
c	CAB	Cabeca de Corte	Portugal	74	158
c	NER	Neresine, Lussino Island	Yugoslavia	78	42
c	BLC	Bellicello	Sicily	81	35
c	BAZ	Baziaş	Romania	63	36
d	AMN	Amnaş	Romania	56	155
d	COR	Cornetu	Romania	75	128

Table 10.2 continued from previous page…

grp	code	hoard	country	'end date'	'good total'
d	OBI	Obislav	Romania	32	50
d	INU	Inuri	Romania	77	37
d	KAR	Karavelovo	Bulgaria	54	35
d	ORI	Oristà	Spain	74	58
d	VAS	Văşad	Romania	46	53
d	JDI	Jdioara	Romania	74	67
d	POO	Poio	Portugal	74	211
d	MBR	Mihai Bravu	Romania	75	56
d	DOM	Santa Domenica di Tropea	Italy	82	109
d	BOB	Bobaia	Romania	79	41
d	STN	Stăncuţa	Romania	63	34
e	SP2	'Spain'	Spain	74	246
f	AGN	Agnona	Italy	41	272
f	AVE	Avetrana	Italy	38	1652
f	BOR	Borzano	Italy	42	582
f	SPN	Spoiano	Italy	46	264
f	ME1	Meolo	Italy	29	506
f	MOR	Morrovalle	Italy	46	125
f	SUR	Surbo	Italy	46	138
f	CR1	Carbonara	Italy	48	383
f	CRO	Crotone	Italy	46	86
f	SEI	Şeica Mică	Romania	29	346
f	BPT	Bran Poartă	Romania	42	59
f	CHI	Civitella in Val di Chiana	Italy	42	246
f	CR2	Carbonara	Italy	36	2371
f	ES1	Este	Italy	29	67
f	LIS	Lissac	France	42	52
f	MEN	Menoita	Portugal	42	97
g	BHR	'Bahrfeldt'	—	49	426
g	ISS	Puy D'Issolu	France	46	39
g	PIE	Piedmonte d'Alife	Italy	42	190
[*g*	GRE	San Gregorio di Sassola	Italy	44	529]
g	VIS	Vişina	Romania	41	139
g	SIN	Sînvăsii	Romania	46	43
g	PRE	Prejmer	Romania	42	149
g	BRA	Brandosa	Italy	49	415
g	GRA	Grazzanise	Italy	54	256
g	CAS	Casaleone	Italy	51	712
g	FDC	Fuente de Cantos	Spain	46	387
g	GRJ	La Grajuela	Spain	51	523
g	COM	Compito	Italy	55	929
g	SPR	Sprîncenata	Romania	46	110
g	PRS	Poroschia	Romania	39	541
g	ILI	Ilieni	Romania	46	108
g	NAG	Nagykagya	Romania	42	131
g	BUZ	Buzău	Romania	54	48
g	NB2	Nicolae Bălcescu II	Romania	42	43
g	TI2	Tîrnava	Romania	46	148
g	RAC	Răcătău de Jos II	Romania	39	53
g	BRO	Broni	Italy	51	81
g	TR2	Taranto	Italy	49	52
h	HAG	Haggen	Switzerland	42	61
h	JAE	Jaen	Spain	46	65
h	TRN	'Transylvania'	Romania	47	36
h	GAJ	Gajine	Yugoslavia	29	88
i	NIE	Niederlangen	Germany	29	62
j	KAV	Kavalla	Greece	58	59
j	MES	Mesagne	Italy	58	5940
j	SUS	Sustinenza	Italy	56	63

Table 10.2 continued from previous page…

grp	code	hoard	country	'end date'	'good total'
j	AN1	Ancona	Italy	55	42
k	HN4	Hunedoara IV	Romania	74	42
k	RIG	Rignano	Italy	74	92
k	MAC	Maccarese	Italy	74	1212
k	TOL	Tolfa	Italy	72	238
k	LCR	Licuriciu	Romania	62	63
k	ROA	Roata de Jos	Romania	49	35
l	CTR	Canturato	Italy	74	50
m	IT4	'Central Italy'	Italy	79	140
m	PL1	Palestrina	Italy	80	64
n	SPO	Spoleto	Italy	79	145
o	ALI	Alife	Italy	87	81
o	CPL	Capalbio	Italy	81	59
p	CER	Cervia	Italy	82	44
p	PEI	Peiraeus	Greece	86	42
p	CAH	'Italy'	Italy	87	211
q	ERD	Érd	Hungary	46	51
r	IT2	'Italy'	Italy	74	47
s	ALA	Cortijo del Álamo	Spain	29	130
s	LMP	Lampersberg	Austria	29	52
s	S03	West Sicily	Sicily	40	162
t	ALV	Alvignano	Italy	42	2335
t	PLI	Policoro	Italy	46	42
t	ARB	Arbanats	France	39	924
t	EL2	El Centenillo	Spain	46	57
t	TOP	Topolovo	Bulgaria	29	125
t	CAT	Catalunya	Spain	44	89
t	ECL	Mirabella Eclano	Italy	46	85
t	VLL	Villette	France	45	340
t	CTG	Contigliano	Italy	39	634
t	ME2	Meolo	Italy	39	1011
t	LOS	Mornico Losana	Italy	38	1088
t	VAL	San Pietro Vernotico	Italy	41	201
t	DRA	Dračevica	Yugoslavia	46	109
t	PAS	'Pasquariello'	Italy	43	105
t	FRN	Francin	France	41	43
t	BEA	Beauvosin	France	29	195
t	BEU	Mont Beuvray	France	32	32
u	SEN	Sendinho da Senhora	Portugal	46	76
v	ATH	Athens	Greece	49	47
v	P06	Padova	Italy	48	54
w	BOD	Bodrum	Turkey	41	62
x	TU3	'Turkey'	Turkey	41	70
y	CRR	Cerriolo	Italy	29	37
y	MOG	Moggio	Italy	32	69
z	P03	Padova	Italy	43	34
α	P07	Padova	Italy	45	655
β	LLO	Baix Llobregat	Spain	109	112
β	TDS	Terranova di Sicilia	Sicily	118	71
β	AN2	Ancona	Italy	90	100
β	COG	Cogollos de Guadix	Spain	104	83
β	MAD	Maddaloni	Italy	116	283
β	GER	Gerenzago	Sicily	118	49
β	OLE	Oleggio	Italy	86	221
β	TR1	Taranto	Italy	114	96
β	CSL	Castulo	Spain	101	47
γ	AZN	Aznalcollar	Spain	104	35
γ	RCN	Ricina	Italy	101	271
γ	PNT	Pantelleria	Nr. Sicily	85	40

Table 10.2 continued from previous page…

grp	code	hoard	country	'end date'	'good total'
δ	FSL	Fossalta	Italy	83	259
δ	OLM	Olmeneta	Italy	100	397
δ	LOR	San Lorenzo del Vallo	Italy	102	299
δ	RIO	Rio Tinto	Spain	102	44
δ	JUA	Torre de Juan Abad	Spain	105	476
δ	LAB	La Barroca	Spain	112	69
δ	SEL	Santa Elena	Spain	101	537
δ	SAR	Sarria	Spain	108	48
δ	SEG	Segaro	Spain	112	43
ϵ	PNH	Penhagarcía	Portugal	104	103
ζ	PZ1	Pozoblanco	Spain	115	79
η	CO1	Villanueva de Cordoba	Spain	113	127
θ	IMO	Imola	Italy	100	500
θ	MTR	Cergnano	Italy	91	300
θ	CRG	Crognaleto	Italy	97	137
θ	ORC	Orce	Spain	100	72
θ	BER	Berchidda	Sardinia	82	1395
θ	FUS	Fuscaldo	Italy	90	811
θ	GDM	Gioia dei Marsi	Italy	97	220
θ	CG2	Cerignola	Italy	100	96
θ	CLA	Claterna	Italy	92	53
θ	NOC	Nociglia	Italy	92	55
θ	HF1	'Hoffmann'	Italy	90	132
θ	SYR	Syracuse	Sicily	88	1084
θ	IAV	Idanha-a-Velha	Portugal	100	1340
ι	GUL	Gulgancy	Bulgaria	46	459
ι	ISA	Işalniţa	Romania	41	134
κ	MDI	Monteverde di Fermo	Italy	92	44
κ	PAT	Paterno	Sicily	100	149
κ	ELE	Elena	Italy	101	59
λ	CRP	Carpena	Italy	92	51
μ	BRG	Borgonuovo	Italy	112	215
μ	ZAS	Zasiok	Yugoslavia	120	162
μ	BEV	Bevagna	Italy	117	721
μ	SGI	San Giovanni Incarico	Italy	125	180
μ	STO	Stobi	Yugoslavia	125	497
μ	MAS	Maserà	Italy	125	1015
μ	FOS	Fossombrone	Italy	121	66
ν	BAN	Banzi	Italy	130	124
ξ	SY2	Syracuse	Sicily	136	59
π	PET	Petacciato	Italy	141	224
π	ROM	Rome	Italy	147	113
ρ	S01	West Sicily	Sicily	146	36

Elba also close in the 70s BC. Of the twenty-one hoards from Romania in this group only three come from the 70s. Two hoards come from the 60s, seven from the 50s, eight from the 40s and one from the 30s BC. As had been suspected from the year by year analyses and graphs, discussed in Chapter 8, it seems that the Romanian material is very archaic in comparison to contemporary material but bears a strong similarity to many hoards closing in the 70s BC from Italy and elsewhere.

Group *b* merges with group *c* at a dissimilarity of 19 — the lowest dissimilarity between the 41 groups. Only two hoards from this group of ten do *not* close in the 70s: Bellicello, Sicily (BLC), which closes in 81 BC and Baziaş, Romania (BAZ), which closes in 63 BC. None of the remaining hoards come from Romania. This clearly reinforces the pattern discussed above.

Group *d* merges with group *b–c* at the dissimilarity of 22.5. This group consists mainly of Romanian hoards closing between 79 and 32 BC. The Italian, Spanish and Portuguese hoards all close in the 70s. The remaining hoard, Karavelovo from Bulgaria, closes in 54 BC. Group *d* continues to reinforce the pattern noted in group *b* although it there appears to be a patterned difference as this group is dominated by Romanian hoards. Group *e* is a singleton containing an unprovenanced hoard from Spain closing in 74 BC. It joins groups *b–d* at a dissimilarity of 25.

Group *f* contains 16 hoards of which 14 are from Italy. These hoards date from 48–29 BC but the majority date from the 40s BC. There are only two Romanian hoards in this group, Şeica Mică (SEI) which closes in 29 BC and Bran Poartă (BPT) which closes in 42 BC.

Group *g* contains 21 hoards of which 7 come from Italy and 11 come from Romania. The Italian hoards date from 52–42 BC with a median of 51, whereas the Romanian hoards date from 54–39 BC with a median of 42. Group *h* only contains 4 hoards, one from Romania (TRN) closing in 47 BC. Group *i* is a singleton containing Niederlangen (NIE; closes 29 BC). Groups *g–i* combine at a low level of dissimilarity. Of the 12 Romanian hoards in these three groups, 9 close in the 40s BC. Group *f* combines with this group at 21.5.

The fact that many Italian hoards closing in the forties occur in group *f* with a couple of Romanian hoards, whereas Romanian hoards dominate group *g* which also contains a few Italian hoards of the late 50s–40s, demonstrates that although these Romanian hoards have much more modern profiles than their contemporary but archaic structured hoards in group *b*, there are still important differences.

Group *j* contains four hoards, three from Italy and all closing 58–55 BC. It combines with *f–i* at 24.1. All non-Romanian hoards closing in the 50s BC occur in either group *g* or *j*.

If we combine groups *b–e* and *f–j* we can see that the first set of groups is characterised by hoards of the 70s BC from Italy and elsewhere, but with a substantial addition of archaic hoards from Romania. The second set of groups is mainly characterised by hoards from the 40s BC including 14 from Romania although 11 of those are from group *g*. The pattern for non-Romanian hoards is, as one might expect, for hoards of basically the same ending date to be grouped together. However, within the Romanian material, the groups are not defined in this way. The members of groups *b–e* have a 70s BC Italian profile despite closing as late as 32 BC (Gura Padinii, GUR and Obislav, OBI). In group *f–j* the hoards have a profile much more in keeping with their counterparts from further west. To illustrate this four hoards each from groups *b*, *f* and *g* have been plotted as cumulative percentage curves in Fig. 10.4. The possible significance of this pattern will be discussed (section 10.6).

Groups *k–m* contain six Italian hoards and three Romanian. The Italian hoards date from the 70s and 80s BC, the Romanian hoards from 74, 62 and 49 BC. Following these, groups *n–s* are a number of small groups and singletons including some oddities. The hoard from Érd has been noted to be odd previously (page 154). Here it forms a singleton, group *q*, as does the unprovenanced hoard from Italy (IT2), group *r*.

Group *t* is the next of any size containing 17 hoards, mainly from Italy, with a range of 46–29 and a median of 41. It contains no hoards from Romania but does contain five out of the eight hoards from France. There is a slight tendency for these to have a later closing date than the Italian

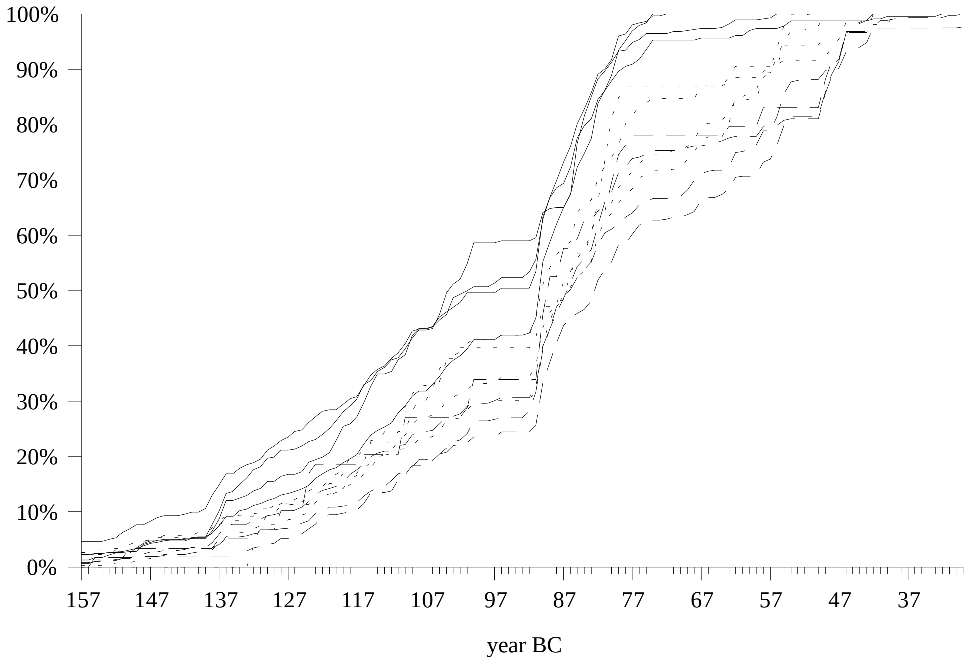


Figure 10.4: Cumulative percentage curves of groups *b* (solid line), *f* (dashed line) and *g* (dotted line) from the cluster analysis. Four from each group are plotted and within each group there are two Italian and two Romanian hoards. Hoards used are: group *b*: COS, PLC, FND, & GUR; group *f*: BOR, ME1, BPT, & SEI; group *g*: NAG, RAC, BRA, & GRE.

hoards. This group should be seen in the light of groups *f* and *g* which also contained hoards of this date. It is interesting to note the lack of Romanian hoards in this group, *cf.* groups *f* and *g*. To understand the division between groups *f* and *t* the CA results from Chapter 8 are useful. For example, Policoro and Mirabella Eclano (PLI & ECL) occur in group *t*, and are the most modern of the Italian hoards in data set `fin46.dat` (section 8.3.14, page 211); Crotone, Morrovalle, Spoiano and Surbo (CRO, MOR, SPN & SUR) all occur in group *f* and are average hoards in the data set. It would therefore appear that group *t* hoards are characterised by having relatively large numbers of coins of the mid-40s BC.

Group *s* joins *t* at 23.1 and contains three hoards, two of which date to 29 BC and come from Austria and Spain. The last comes from Italy and dates to 40 BC. Taking *t* and *s* together, the nine Italian hoards close between 46–38 BC whereas the eleven others close between 46–29 BC with the four hoards closing in 29 BC coming from Spain, France, Bulgaria and Austria.

Groups u–α are all very small or singletons. The fact that *z* and α, both singletons which join at a dissimilarity of only 21.7, are both from Padova (P03 and P07), and close in 43 and 45 BC respectively, lends confidence to the technique. Also groups *w*–*x* contain both the Turkish hoards closing in 41 BC (*cf.* section 8.3.17).

Group β contains nine hoards from Italy, Sicily and Spain dating between 118–86 BC with seven hoards between 118–101 BC. This group appears to be quite distinct as it does not join groups γ–ζ until 29.2. Groups γ and δ contain eleven hoards from Spain and Italy (but not Sicily) with dates overlapping with β (112–79 BC) but with a trend for them to close later.

Hoards Penhagarcía, Pozoblanco and Villanueva de Córdoba (PNH, PZ1 & CO1), all from the Iberian Peninsula, form three singleton groups (ϵ, ζ, η), with the latter two especially being quite dissimilar from other hoards.

The last large group, θ again contains hoards from Italy and the Iberian Peninsula but of a date slightly later than groups β and γ–δ (100–82 BC). Interestingly, group ι containing hoards Gulgancy (Bulgaria, GUL) and Işalniţa (Romania, ISA), joins β at a dissimilarity of 21.7 despite having closing dates of 46 and 41 BC respectively. This pattern of much later hoards from Bulgaria and Romania being similar to Italian material from much earlier has been noted above. The Romanian hoard in group ι varies from those in group *b* by being even more archaic in structure and most similar to hoards from Italy closing in the 90s BC.

Groups λ and κ are similar in composition to β–ι. Group μ contains early hoards mainly from the 120s. The remaining groups contain scattered early hoards.

10.3 Discussion of results

We can see from the above that the representation of hoards in groups by country varies from region to region. Table 10.3 gives the range of `end_date`s and medians for each of the groups by three regions. Generally, the ranges for Italian hoards are quite small, usually less than twenty years, and often about 10 years, depending on the size of the group. The Romanian groups have larger ranges and later medians; *e.g.*, 46 years for group *b* with a median of 54 compared to a range of 12 years and a median of 74 for the Italian. Romanian hoards also occur in only a few groups, 8 compared to 31 for Italy. We can tentatively group the Romanian hoards into two classes. The first class contains those hoards which are most similar to Italian hoards from the 90s–70s BC despite closing as late as 32 BC. These are groups *b, c, d, k* and ι. The second class contains hoards similar to Italian hoards between 55–29 BC. They are often archaic when compared with Italian hoards but not in such an extreme fashion. This class includes groups *f, g,* and *h*. There are 49 Romanian hoards in this analysis of which 35 (71%) are in class 1 and 14 (29%) in class 2. Of the 103 Italian hoards only 40 (39%) are in groups with Romanian hoards. Of those, 20 are associated with class 1 Romanian hoards and 20 with class 2. The Spanish material is generally very similar to the Italian material with very small date ranges and broadly similar medians. The relative scarcity of later hoards from Spain and Portugal makes identifying patterns in the material difficult.

To make the coarser patterning clear Table 10.4 lists seventeen 'supergroups' created by taking a dissimilarity level of 30%. Two supergroups are of the greatest interest: B and Γ. Supergroup B contains 64 hoards of which sixteen come from Italy and 31 come from Romania; the Italian hoards close 82–71 BC whereas the Romanian hoards close 79–32 BC with a median of 56 BC. Group Γ contains 57 hoards of which 29 come from Italy and 17 come from Romania. The range of closing dates was surprisingly large for the Italian hoards: 80–29 BC, although the median was 46 BC. Consulting the agglomeration schedule it was found that the groups *f*–*i* and *k*–*n* merged at a level of 29%. Splitting supergroup Γ into two at this level resulted in supergroup Γ_1 containing 47 hoards, and supergroup Γ_2 containing 10 hoards. Of the 47 hoards in supergroup Γ_1, 22 came from Italy and had a range of 58–29 BC with a median of 46 BC. Γ_1 also contained 14 Romanian hoards with

	Italy *etc.*			Romania			Iberian penisula			Total		
Grp.	tot.	range	med.	tot.	range	med.	tot.	range	med.	tot.	range	med.
ρ	1	–	146	–	–	–	–	–	–	1	–	146
π	2	147–141	144	–	–	–	–	–	–	2	147–141	144
ξ	1	–	136	–	–	–	–	–	–	1	–	136
ν	1	–	130	–	–	–	–	–	–	1	–	130
μ	5	125–112	121	–	–	–	–	–	–	7	125–112	121
β	6	118–86	115	–	–	–	3	109–101	104	9	118–86	109
δ	3	102–83	100	–	–	–	6	112–101	106h	9	112–83	102
κ	3	101–92	100	–	–	–	–	–	–	3	101–92	100
γ	2	101–85	93	–	–	–	1	–	104	3	104–85	101
λ	1	–	92	–	–	–	–	–	–	1	–	92
θ	11	100–82	92	–	–	–	2	100–100	100	13	100–82	92
p	2	87–82	85h	–	–	–	–	–	–	3	87–82	86
o	2	87–81	84	–	–	–	–	–	–	2	87–81	84
d	1	–	82	9	79–32	74	2	74–74	74	13	82–32	74
m	2	80–79	80h	–	–	–	–	–	–	2	80–79	80h
c	5	81–74	79	1	–	63	2	74–74	74	10	81–63	76
n	1	–	79	–	–	–	–	–	–	1	–	79
b	10	82–71	74	21	77–32	54	4	78–71	74	40	82–32	71
l	1	–	74	–	–	–	–	–	–	1	–	74
k	3	74–72	74	3	74–49	62	–	–	–	6	74–49	73
r	1	–	74	–	–	–	–	–	–	1	–	74
j	3	58–55	56	–	–	–	–	–	–	4	58–55	57
g	7	55–42	51	11	54–39	42	2	51–46	49h	22	55–39	46
v	1	–	48	–	–	–	–	–	–	2	49–48	49h
α	1	–	45	–	–	–	–	–	–	1	–	45
z	1	–	43	–	–	–	–	–	–	1	–	43
t	8	46–38	42h	–	–	–	2	46–44	45	17	46–29	41
f	12	48–29	42	2	42–29	36h	1	–	42	16	48–29	42
s	1	–	40	–	–	–	1	–	29	3	40–29	29
a	1	–	32	–	–	–	–	–	–	3	32–32	32
y	2	32–29	31h	–	–	–	–	–	–	2	32–29	31h
e	–	–	–	–	–	–	1	–	74	1	–	74
h	–	–	–	1	–	47	1	–	46	4	47–29	44
i	–	–	–	–	–	–	–	–	–	1	–	29
q	–	–	–	–	–	–	–	–	–	1	–	46
u	–	–	–	–	–	–	1	–	46	1	–	46
w	–	–	–	–	–	–	–	–	–	1	–	41
x	–	–	–	–	–	–	–	–	–	1	–	41
ϵ	–	–	–	–	–	–	1	–	104	1	–	104
ζ	–	–	–	–	–	–	1	–	115	1	–	115
η	–	–	–	–	–	–	1	–	113	1	–	113
ι	–	–	–	1	–	41	–	–	–	2	46–41	44h

Table 10.3: Cluster analysis — date ranges and median ‘end date’ for groups by region. Ordered by median ‘end date’ for Italian (including Sicilian and Sardinian) hoards. Where the median falls between two years, the notation ‘h’ has been used. Hoards CST & GRE omitted.

S-grp.	Grps.	Italy *etc.* tot.	range	med.	Romania tot.	range	med.	Iberian penisula tot.	range	med.	Total tot.	range	med.
A	*a*	1	–	32	–	–	–	–	–	–	3	32–32	32
B	*b–e*	16	82–71	74h	31	79–32	56	9	78–71	74	64	82–32	74
Γ	*f–n*	29	80–29	49	17	74–29	46	4	51–42	46	57	80–29	46
Γ_1	*f–i*	*22*	*58–29*	*46*	*14*	*54–29*	*42*	*4*	*51–42*	*46*	*47*	*58–29*	*46*
Γ_2	*k–n*	*7*	*80–72*	*74*	*3*	*74–49*	*62*	–	–	–	*10*	*80–49*	*74*
Δ	*o–p*	4	87–81	84h	–	–	–	–	–	–	5	87–81	86
E	*q*	–	–	–	–	–	–	–	–	–	1	–	46
Z	*r*	1	–	74	–	–	–	–	–	–	1	–	74
H	*s–u*	9	46–38	41	–	–	–	4	46–29	45	21	46–29	41
Θ	*v*	1	–	48	–	–	–	–	–	–	2	49–48	48h
I	*w–x*	–	–	–	–	–	–	–	–	–	2	41–41	41
K	*y*	2	32–29	30h	–	–	–	–	–	–	2	32–29	30h
Ω	z–α	2	45–43	44	–	–	–	–	–	–	2	45–43	44
Λ	β–ζ	11	118–83	101	–	–	–	12	115–101	104h	23	118–83	104
M	η	–	–	–	–	–	–	1	–	113	1	–	113
N	θ–λ	15	101–82†	92	1	–	41	2	100–100	100	19	101–41	92
Ξ	μ–ν	6	130–112	123	–	–	–	–	–	–	8	130–112	123
Π	ξ	1	–	136	–	–	–	–	–	–	1	–	136
Υ	π–ρ	3	147–141	146	–	–	–	–	–	–	3	147–141	146

Table 10.4: Cluster analysis — date ranges and median ‘end date’ for supergroups by region. Where the median falls between two years, the notation ‘h’ has been used. Hoards CST & GRE omitted. †Only one hoard, from Sardinia (BER), closes in 82 BC; without this hoard the range is 101–88.

a range of 54–29 BC and a median of 42. Supergroup Γ_2 contains 7 Italian hoards closing 80–72 BC and three Romanian hoards closing in 74, 62 and 49 BC. The only Romanian hoard not in either supergroups B or Γ was Işalniţa (ISA) which occurs in supergroup N with Italian hoards of 101–82 BC, despite closing in 41 BC.

The other supergroups clearly show the dynamic nature of the Italian coinage pool with a supergroup for most decades. The Iberian peninsula evidence tends to be limited to fewer supergroups but there are only 32 Iberian peninsula hoards in the data set and all the large groups do contain Spanish hoards. Some of the other supergroups also make archaeological sense, *e.g.*, supergroup I only contains two hoards, both of which come from Turkey and close in 41 BC (*cf.* section 8.3.17). The archaeological interpretations of these results will be discussed in section 10.6 and Chapter 14.

It can be seen that the use of Dmax-based cluster analysis has produced results which, when compared with the original data and what has already been discovered about this material, are readily intelligible. Regional and temporal patterns can be observed in both groups and supergroups which complement the information obtained from the CAs presented in Chapter 8.

How robust the measure is can be observed in the manner in which hoards Castelnovo and San Gregorio de Sassola (CST & GRE) were handled. The data for both hoards were in error: in the former case, coins which are almost certainly extraneous were included (*cf.* section 8.3.14), in the latter some coins had been wrongly entered to the database. In the former case the ‘oddness’ of the hoard had already been noted and it was suggested that it should date to 71 BC; the cluster analysis placed the hoard in group *b* with other Italian hoards of that date. In the latter case, the error was first noticed as a result of this analysis — the hoard’s original `end_date` was unusual for an Italian hoard in group *g*.

Aldenderfer (1982) has noted the need for cluster analyses to be validated. One method he proposes is a comparison to factor or principal components analyses. For this data set, this has been pre-empted by the series of CAs presented in Chapter 8. Another possibility, is to compare the results with a *principal co-ordinates analysis.*

10.4 Comparing hoards — principal co-ordinates analysis

Principal co-ordinates analysis, also known as classic metric multidimensional scaling, is a method of data reduction with broadly similar aims to PCA, CA and factor analysis (Doran & Hodson 1975, p. 194, Shennan 1988, pp. 280–281, Wright 1989, 'DIRPCORD'). Unlike these techniques it requires a matrix of similarity or dissimilarity coefficients as input rather than the original data. This has the disadvantage that no equivalent of component loadings in PCA, or 'species scores' in CA, is available. Scores are produced for objects which can be plotted as with PCA and CA and usually it is hoped that two or three axes will be able to display the majority of the variation in the data.

Normally, there are two occasions when PCO would be used. Firstly, as noted by Wright (1989), older literature often contains tables of similarities or correlations but not the original data. Secondly, by using the Jaccard coefficient (Shennan 1988, pp. 203–4) or Gower's general coefficient of similarity (Shennan 1988, pp. 206–208) one can analyse tables of presence/absence, or multistate data (Doran & Hodson 1975, p. 194). In the present case we wish to see if this technique can reveal structure in the matrix of Dmax dissimilarities, and if the results reflect the groups proposed in the cluster analysis.

The analysis was performed using the DIRPCORD module of MV-ARCH.[8] The program derived three axes 'explaining' 76.4%, 16.6% and 5.5% of the variation in the data (cumulative total of 98.5%). The maps from this analysis are presented in Figs. 10.5–10.6. In these figures the symbols are the cluster groups discussed above (see Tables 10.1 and 10.2).

Both figures clearly show that the hoards form a continuum of variation rather than a series of clearly defined groups. In Fig. 10.5 the first axis is dominated by groups which generally contain few hoards, *e.g., a,* π & ρ. The cluster analysis groups are not perfectly defined within the map but do form reasonably coherent groups, *e.g.,* θ & β. Many groups, especially *b, f, g* and *t* are in a large confused group at the top of the second axis. Fig. 10.6 however, clearly shows these groups separated on the third axis and the combination of axes 2 and 3 generally produces the clearest map. As we have seen with other multivariate methods such as CA, odd objects can dominate the results but the problem can be resolved either by removing the objects, or by examining lower-order axes.

The PCO analysis has helped to add further confidence to the results of the Dmax-based cluster analysis. It also illustrates the fact that the clusters are subdivisions of a continuum and that slight changes in the details of a hoard *could* result in it being reassigned to another group. The analysis

[8] Initial examination of the results was achieved via MV-ARCH's PLOT module using colour and label codes derived from the database. Publication plots were written in raw POSTSCRIPT by the author. The *pco* module of the MS-DOS version of IASTATS was tried but this program could not cope with more than 66 cases.

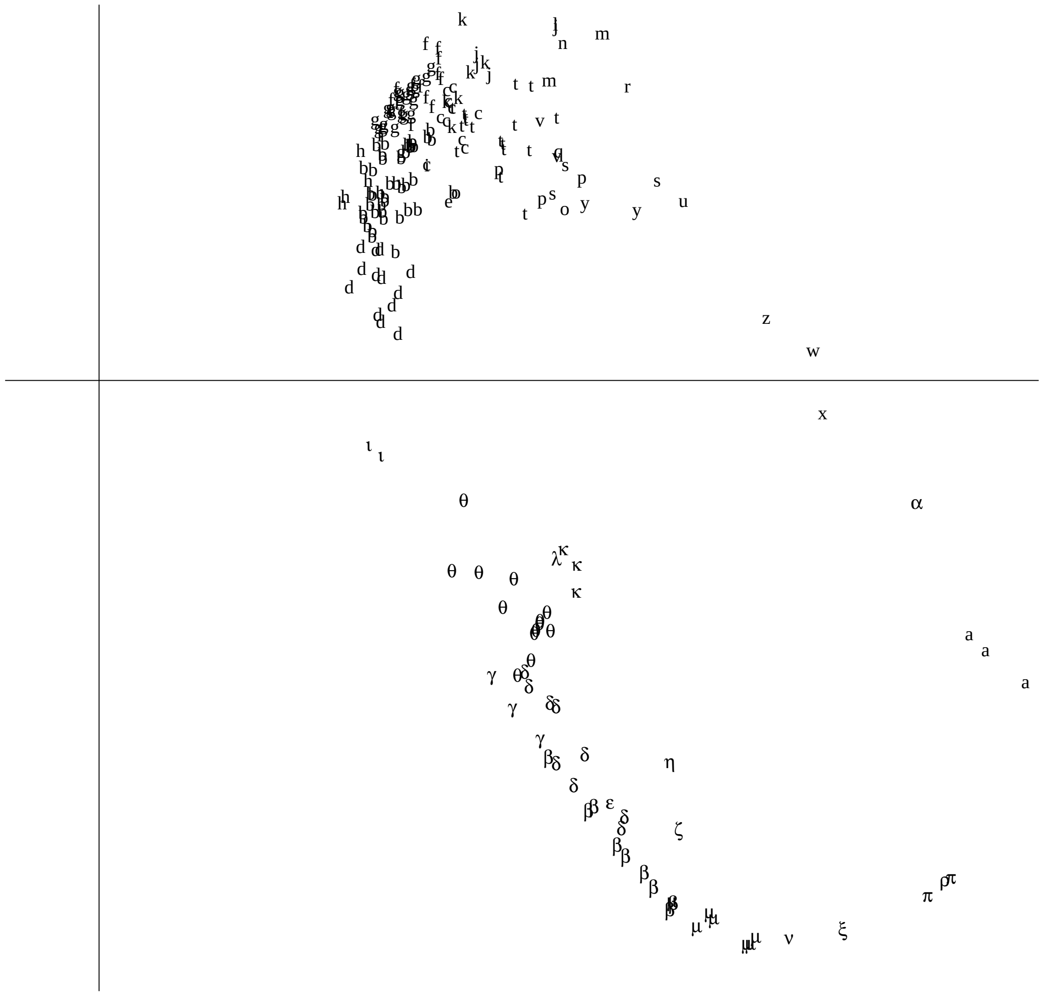


Figure 10.5: Plot of the first (horizontal) and second axes from principal co-ordinates analysis of the Dmax dissimilarity matrix of 217 hoards. Labels are groups derived from average link cluster analysis — see Tables 10.1 and 10.2.

has not added to our understanding of the data itself. The technique is less useful than CA or PCA as no information is given concerning the variables.[9]

10.5 Comparing hoards — detrended correspondence analysis

As has been shown (page 150) correspondence analysis will seriate hoards quite well, even when this is not what is desired. It has been suggested (A. Scott *pers. comm.*) that an alternative to the various approaches outlined above is *detrended* correspondence analysis. The technique, originally developed by Hill & Gauch (1980) attempts to eliminate the horseshoe effect (Baxter 1994, p. 120). Beck & Shennan (1991) use the technique to examine amber artefact assemblages from bronze age Britain. However, the technique is treated with some caution by Greenacre:

[9] Mike Baxter has kindly pointed out that the PCO plot is actually an excellent seriation of the hoards, and is one of the best seriated sequences he has seen.

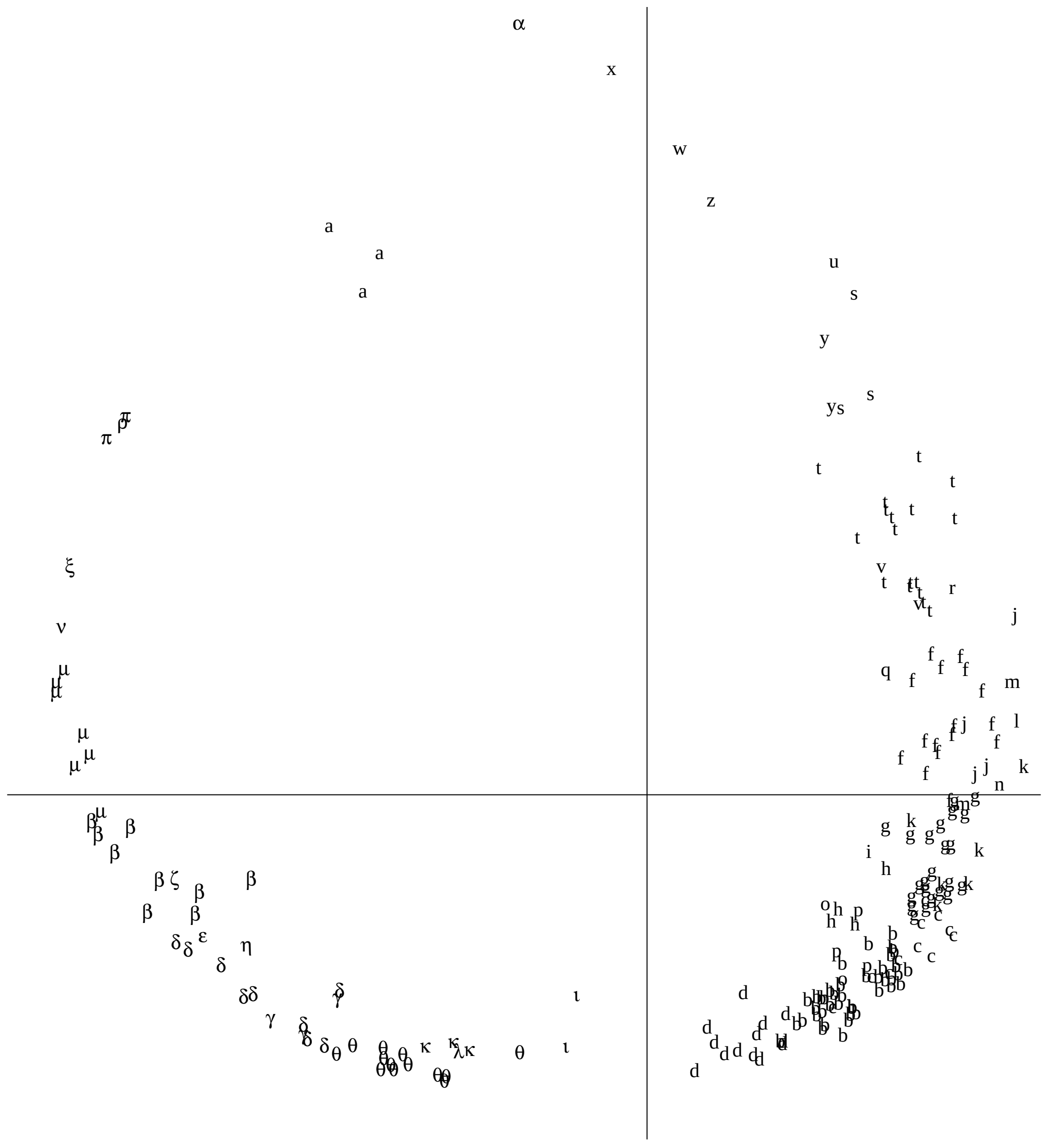


Figure 10.6: Plot of the second (horizontal) and third axes from principal co-ordinates analysis of the Dmax dissimilarity matrix of 217 hoards. Labels are groups derived from average link cluster analysis — see Tables 10.1 and 10.2.

> In the process [of detrending], however, control over the geometry is lost and it is possible that... the detrending might introduce further artifacts into the results. (Greenacre 1984, p. 232).

Baxter is also unenthusiastic about the method (Baxter 1994, p. 120). It was decided to look at the technique's applicability here by analysing a set of 24 hoards totalling 11,161 *denarii* from groups *b*, *f* and *g* using CANOCO. The hoards used in this analysis are listed in Table 10.5. As with the cluster analysis only well identified *denarii*, *i.e.*, those with a query code of 1, 5 or 6 were used. Three analyses were performed: the first as normal, the second using detrending, the last using the normal method but choosing the option to let CANOCO automatically down-weight rare variables.

Where appropriate, asymmetric scaling option 2 ('species scores are weighted mean sample scores') was used. This option does not alter the relative positions of the hoards, but does spread them out further on the resultant maps.

Group	code	hoard	country	'end date'	'good total'
b	CAR	Carovilli	Italy	82	40
b	COS	Cosa	Italy	74	1999
b	CST	Castelnovo	Italy	71	391†
b	OSS	Ossero	Italy	72	465
b	PL2	Palestrina	Italy	74	357
b	VPT	Villa Potenza	Italy	71	411
b	CUC	Cuceu	Romania	48	484
b	FA2	Fărcaşele II	Romania	42	113
b	FND	Frauendorf	Romania	56	563
b	GUR	Gura Padinii	Romania	32	232
b	SDS	Sălaşul de Sus	Romania	54	103
b	SFI	Sfinţeşti	Romania	71	91
f	BOR	Borzano	Italy	42	582
f	CR1	Carbonara	Italy	48	383
f	CR2	Carbonara	Italy	36	2371
f	SPN	Spoiano	Italy	46	264
f	BPT	Bran Poartă	Romania	42	59
f	SEI	Şeica Mică	Romania	29	346
g	CAS	Casaleone	Italy	51	712
g	GRA	Grazzanise	Italy	54	256
g	ILI	Ilieni	Romania	46	108
g	PRS	Poroschia	Romania	39	541
g	TI2	Tîrnava	Romania	46	148
g	VIS	Vişina	Romania	41	139

Table 10.5: Details of the hoards used in the correspondence analyses discussed in section 10.5, data set `detrend.dat`. † Hoard CST assigned to 71 BC.

10.5.1 Analysis one — 'ordinary' CA

Fig. 10.7 gives the species score map and Fig. 10.8 the sample score map for the first and second principal axes of inertia. Table 10.6 gives the first four eigenvalues for all three analyses.

All the group *b* hoards occur in a tight group in the bottom left quadrant of the sample map (Fig. 10.8). As can be seen from Table 10.5 this group contains six hoards from Italy closing between 82–71 BC and six hoards from Romania closing between 56–32 BC. These twelve hoards were chosen from group *b* simply on the basis of hoard size. This analysis confirms once more the extreme similarity of the hoards in group *b*.

The four hoards (TI2, VIS, ILI & PRS) in the top left quadrant are all in group *g* and are from Romania. The other two hoards in group *g* are Casaleone (CAS) and Grazzanise (GRA), both from Italy. Despite being in cluster group *g* this analysis suggests that the Romanian hoards here still have a strong similarity to the material from Italy in the 70s BC. An examination of Fig. 10.4 shows group *g* hoards in an intermediate position between groups *b* and *f*, which is reflected in their position on the first axis of Fig. 10.8.

The final six hoards are from group *f*. All lie to the right of the plot although quite spread out. The two hoards from Romania (Şeica Mică, SEI, and Bran Poartă, BPT) seem to float in the middle of the plot. They appear to be pulled away from their more expected position towards the large group on the left. These two hoards will be discussed further below.

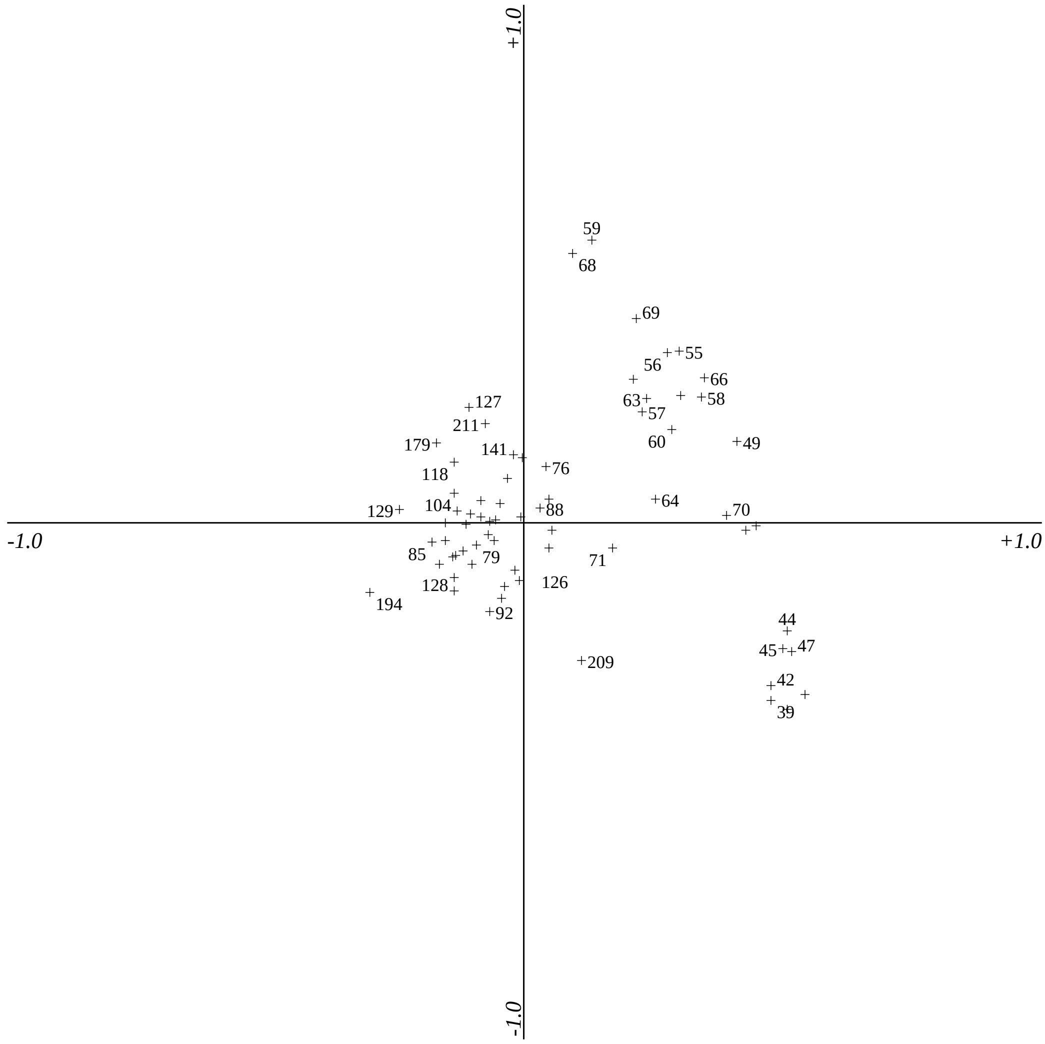


Figure 10.7: Species map derived from ordinary CA of 24 hoards as listed in Table 10.5. Data points are years of issue. First (horizontal) and second axes of inertia.

If we imagine the plot without the Romanian material, it is quite easy to draw a horseshoe curve from CR2 up to CAS and back to the large group which would seriate the hoards almost perfectly. This is what one would expect. The Romanian material, however, groups tightly with the Italian material from the 70s BC. It is possible to draw non-overlapping boundaries around each of the cluster analysis groups but these do not seem to be the natural boundaries as suggested by CA. However, if we acknowledge that the cluster analysis is dividing up a continuum rather than identifying discrete clusters, and that the CA is using all the data rather than one statistic derived from it, then this is not a problem.

It was noted that a time sequence can greatly affect CA and dominate the results. This was the reason for attempting the cluster analysis. Why does this analysis produce such good results? Firstly, the cluster analysis provided us with a helping hand in selecting hoards for analysis and was also used in the interpretation of the plots. Secondly, hoard size was generally very good with only three hoards with less than 100 coins. The results will be discussed further in section 10.5.5 below.

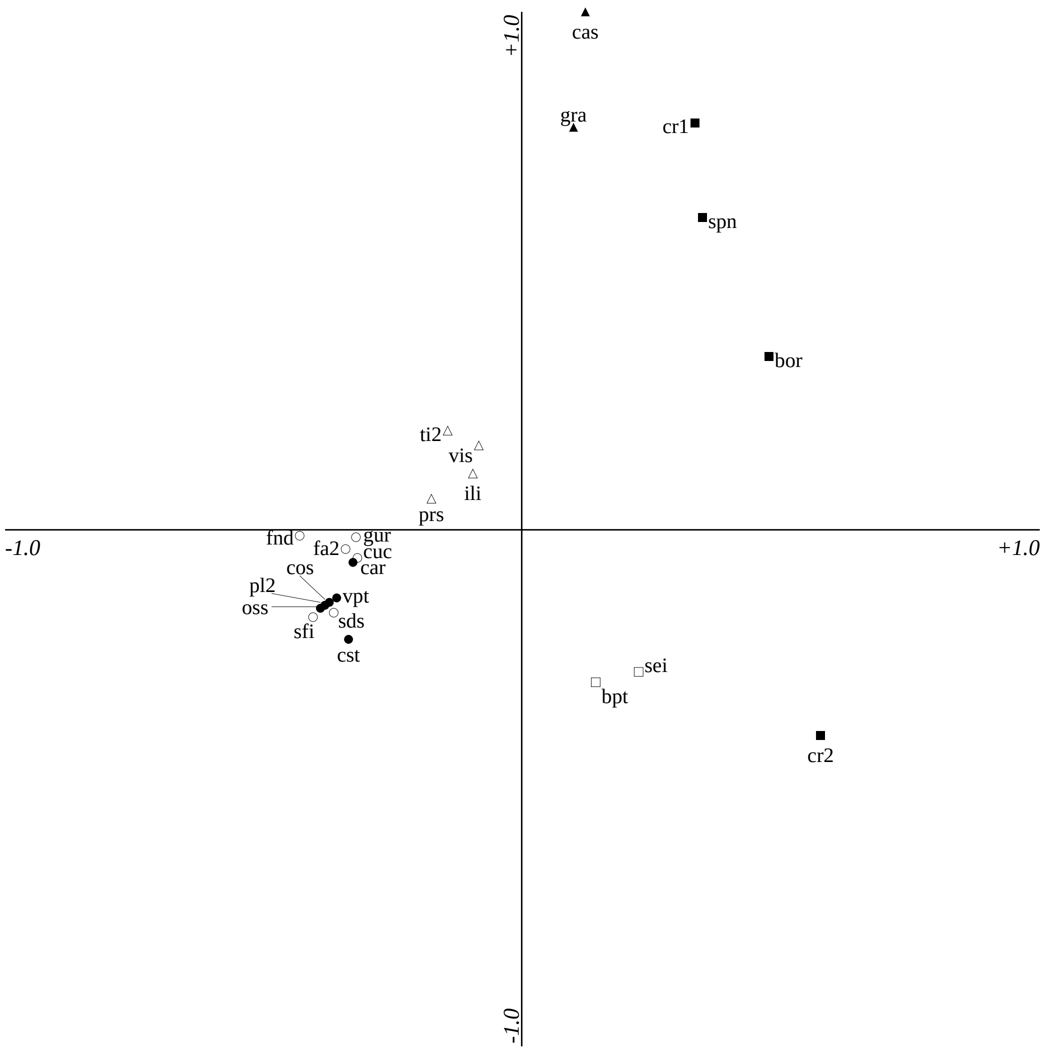


Figure 10.8: Sample map from ordinary CA of 24 hoards as listed in Table 10.5. Data points are coin hoards — circles are cluster group *b*, squares group *f*, triangles group *g*, filled symbols Italy, empty symbols Romania. First (horizontal) and second axes of inertia.

10.5.2 Analysis two — detrended CA

It was decided to evaluate the usefulness of this technique on purely empirical grounds. Two questions were asked:

1. Does the technique remove the horseshoe curve?
2. In doing so, is anything useful gained from it?

CANOCO offers two types of detrending: detrending by segments and detrending by polynomials. ter Braak (1990, p. 30) notes that detrending by polynomials is not successful and recommends the use of the former option. It was decided to try compare the two techniques.

	Axis 1	2	3	4	Total
Analysis one	0.217	0.080	0.049	0.039	0.616
Analysis two (a)	0.217	0.035	0.017	0.012	0.616
Analysis two (b)	0.217	0.052	0.022	0.016	0.616
Analysis three	0.193	0.070	0.047	0.039	0.571

	Axis 1	2	3	4	Total
Analysis one	35.2	48.2	56.1	62.4	62.4
Analysis two (a)	35.2	40.8	43.7	45.6	45.6
Analysis two (b)	35.2	43.7	47.2	49.7	49.7
Analysis three	33.8	46.0	54.2	61.1	61.1

Table 10.6: Eigenvalues (top) and cumulative variance explained (bottom) from the analyses on the data set listed in Table 10.5, see section 10.5.

Detrending by segments

With this technique a number of extra choices have to be made. These are:

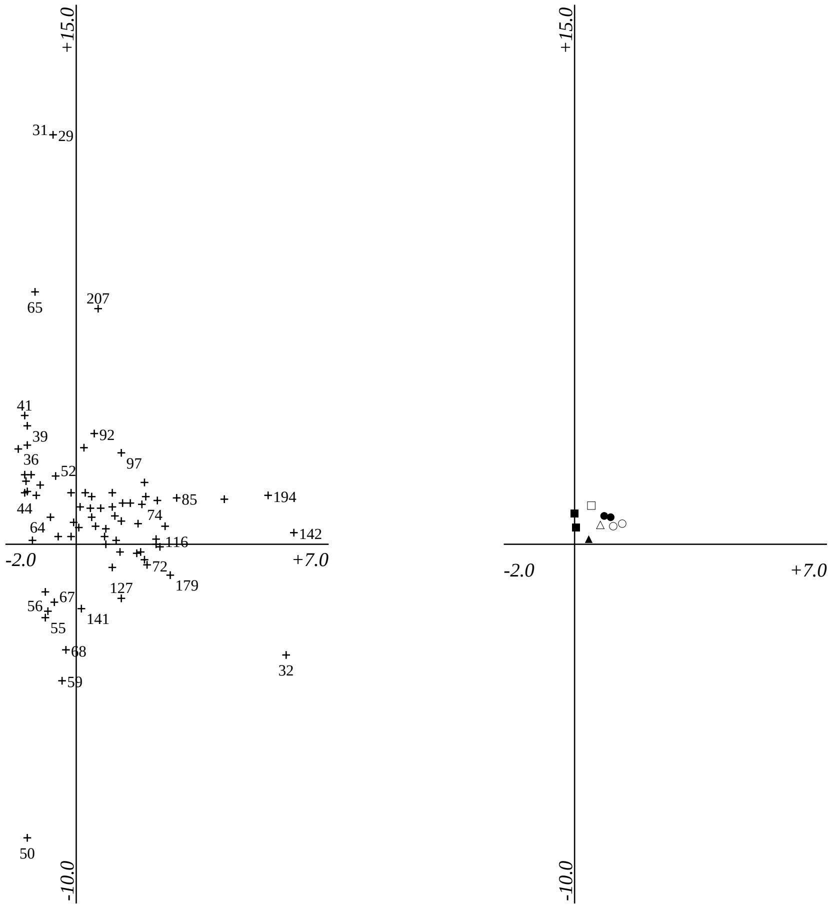
- How many segments should be used in the detrending?
- Should non-linear rescaling be used?
- If so, what rescaling threshold should be used?

A number of runs using the defaults, or a variety of options, resulted in generally the same result. All the hoards are plotted at the centre of the sample map (Fig. 10.9b) and therefore interpretation is difficult. This is partly due to only an asymmetric scaling option being available. The first four eigenvalues for the default analysis are in Table 10.6, analysis 2a. For the purposes of this data set this technique is of little use.

Detrending by polynomials

As with ordinary CA, scaling option 2 was used. It was decided to detrend by second order polynomials, the default. The first four eigenvalues are shown in Table 10.6. As can be seen from Figs. 10.10a–10.10b the results visually are much more successful and amenable to examination.

The technique has removed the horseshoe pattern from the distribution of hoards on this plot. Within group *f* the Italian hoards (SPN, CR1, BOR & CR2) now cluster tightly whereas the two Romanian hoards (SEI & BPT) form an isolated pair at the top of the plot. The twelve hoards from group *b* are on the left of the plot. They split into two groups with five Romanian hoards with negative scores on the second axis, and the six Italian hoards have positive scores on the second axis. Cuceu (CUC) has a negative score but is nearer to the Italian group. The final group, *g*, falls between the other two groups on the first axis but is spread along the second with, notably, the two Italian hoards in this group separated from the Romanian hoards and the latter group clustering near to the Italian hoards of group *b*.



(a) Species map: data points are years of issue.

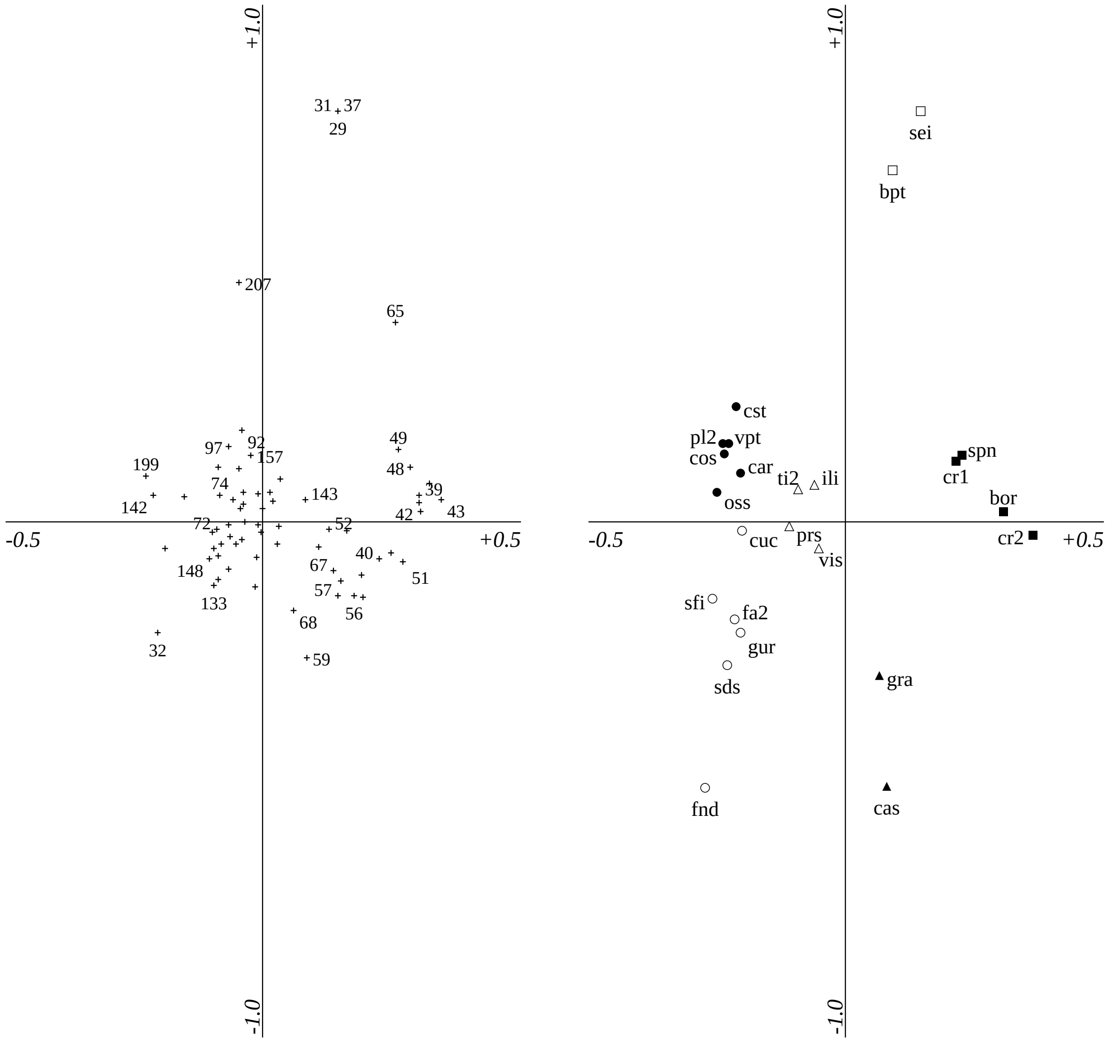
(b) Sample map: data points are coin hoards. Symbols as for Fig. 10.8.

Figure 10.9: Maps from CA detrended by segments of data set `detrend.dat` as listed in Table 10.5. First (horizontal) and second axes of inertia.

This raises a number of questions including:

1. In what way are Şeica Mică and Bran Poartă (SEI & BPT) similar to each other?
2. In what way are they different from the other hoards including those in their own group?
3. Is the division within group *b* real, and if so what is it?

Five years (species) have extreme values for the second axis: 29, 31, 37, 207 and 65. Şeica Mică has one coin from each of these years. Only Cosa (COS) has a coin of 207 BC and Carbonara (CR2) has a coin of 65 BC. This explains the position of Şeica Mică on the sample map, but not Bran Poartă (BPT). $Dmax_{obs}$ for these two hoards is 11.1% and the application of the Kolmogorov-Smirnov test shows no significant difference at the 0.01% level. Plotting these two hoards as cumulative frequency curves reveals their inherent similarity over the whole of the curve which, when allowing for variation due to Bran Poartă's small size, results in the two hoards appearing on the plot in



(a) Species map: data points are years.

(b) Sample map: data points are hoards. Circles: cluster group *b*; squares: group *f*; triangles: group *g*; filled symbols: hoards from Italy; open symbols hoards from Romania.

Figure 10.10: Maps from CA detrended by second order polynomials, of data set `detrend.dat` as listed in Table 10.5. First (horizontal) and second axes of inertia.

much the same location — see Fig. 10.11, *cf.* Fig. 10.10b.[10] This clearly demonstrates the danger of interpreting symmetric maps without reference to the original data or diagnostic statistics. As Greenacre (1984, p. 65) states:

> The display of each cloud of points indicates the nature of the similarities and dispersion within the cloud, while the joint display indicates the correspondence between the clouds. Notice, however, that we should avoid the danger of interpreting distances between points of different clouds, since no such differences have been explicitly defined.

This analysis is a classic example of the problem.

[10]Note that Fig. 10.11 also emphasises the folly of using the total area between curves as a measure of difference between hoards when the sample sizes are small; *cf.* Creighton (1992a, pp. 78–103) and section 3.12.6.

The second question is how do these two hoards vary from the others in group *f*? Fig. 10.11 shows that the Italian hoards have relatively more new coin and relatively less old coin. The maximum cumulative difference being reached in 74 BC. The extremely jagged nature of the maximum difference line is mainly due to the small sample size of Bran Poartă.

The last question is, are the two sub-groups of *b* really different? To examine this problem Fig. 10.12 plots eight of the hoards from that group. As can be seen, the Romanian hoards have relatively more old coin when compared to the Italian hoards which have relatively more new coin. This is despite the fact that three of the Italian hoards have early closing dates. Carovilli (CAR) has no coin until 136 BC but closes first in 82 BC. This hoard is, however, the smallest in the analysis and it is not surprising that it has little of the older coinage. The maximum difference between hoards is reached in *c.* 117 BC and remains relatively level until hoards start closing in the 70s.

10.5.3 Analysis three — down-weighting rare variables

CANOCO allows one to either down-weight or make passive species and/or samples. This can either be done explicitly, or by allowing CANOCO to perform this automatically on species. The latter was tried as an experiment. There was little difference in the results when compared to analysis one (section 10.5.1). The first four eigenvalues are presented in Table 10.6 and the sample score map in Fig. 10.13.

10.5.4 Global detrended CA

Having seen that detrending by second order polynomials is reasonably effective with a small data set, a detrended analysis of all hoards was attempted. The data set used was same as presented in Figs. 8.2–8.3. The sample map is presented in Fig. 10.14. As can be seen, the map is almost completely unintelligible with only a very small number of hoards away from the origin. The method has removed the horseshoe curve which dominated with original analysis but has not replaced it with a more useful pattern.

10.5.5 Discussion of the results

When analysing data set `detrend.dat`, detrending by second order polynomials removed the effect of the variation in closing dates, a primary factor in the results of the first analysis discussed above (section 10.5.1). When the results were used in conjunction with the cumulative percentage graphs, some quite subtle differences between and within the cluster analysis groups could be seen. For example, the differences between Italian and Romanian hoards in group *b* could not be seen in the ordinary CA (Fig. 10.8), but are visible in the CA detrended by second order polynomials (Fig. 10.10b and Fig. 10.12). Another feature of CA of hoard data which was observed in Chapter 8 (page 264) was that variations between hoards with a closing date at the end of the range in a data set tended to be clearly shown whereas variations between hoards at the start or middle of the date range were not so clearly shown. In the first analysis here (section 10.5.1) the second axis was primarily representing variation between the four Italian hoards from group *f*, *i.e.*, the four most modern hoards in this data set. The detrended analysis, however, has minimised the variation in

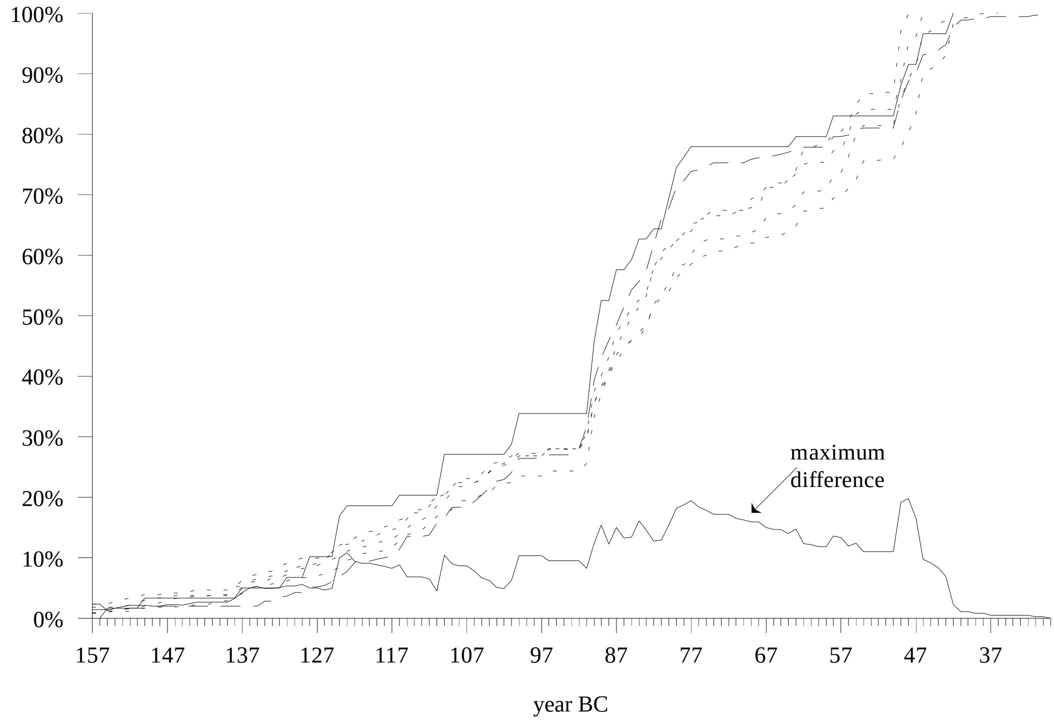


Figure 10.11: Cumulative percentage curves for BPT (upper solid line), SEI (dashed line), SPN, CR1, BOR, & CR2 (dotted lines). Bottom solid line is the maximum difference between hoards.

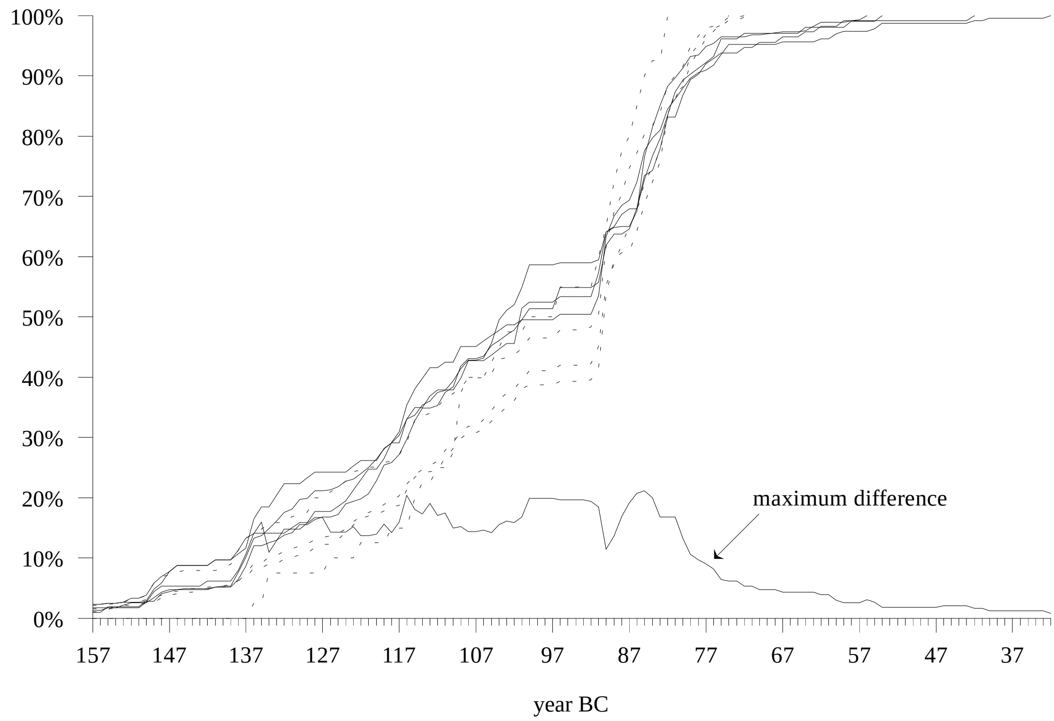


Figure 10.12: Cumulative percentage curves for eight hoards from cluster group *b* used in detrended correspondence analysis. CAR, COS, CST and OSS from Italy (dotted line) and FA2, GUR, FND and SDS from Romania (solid line). Bottom solid line is the maximum difference between hoards.

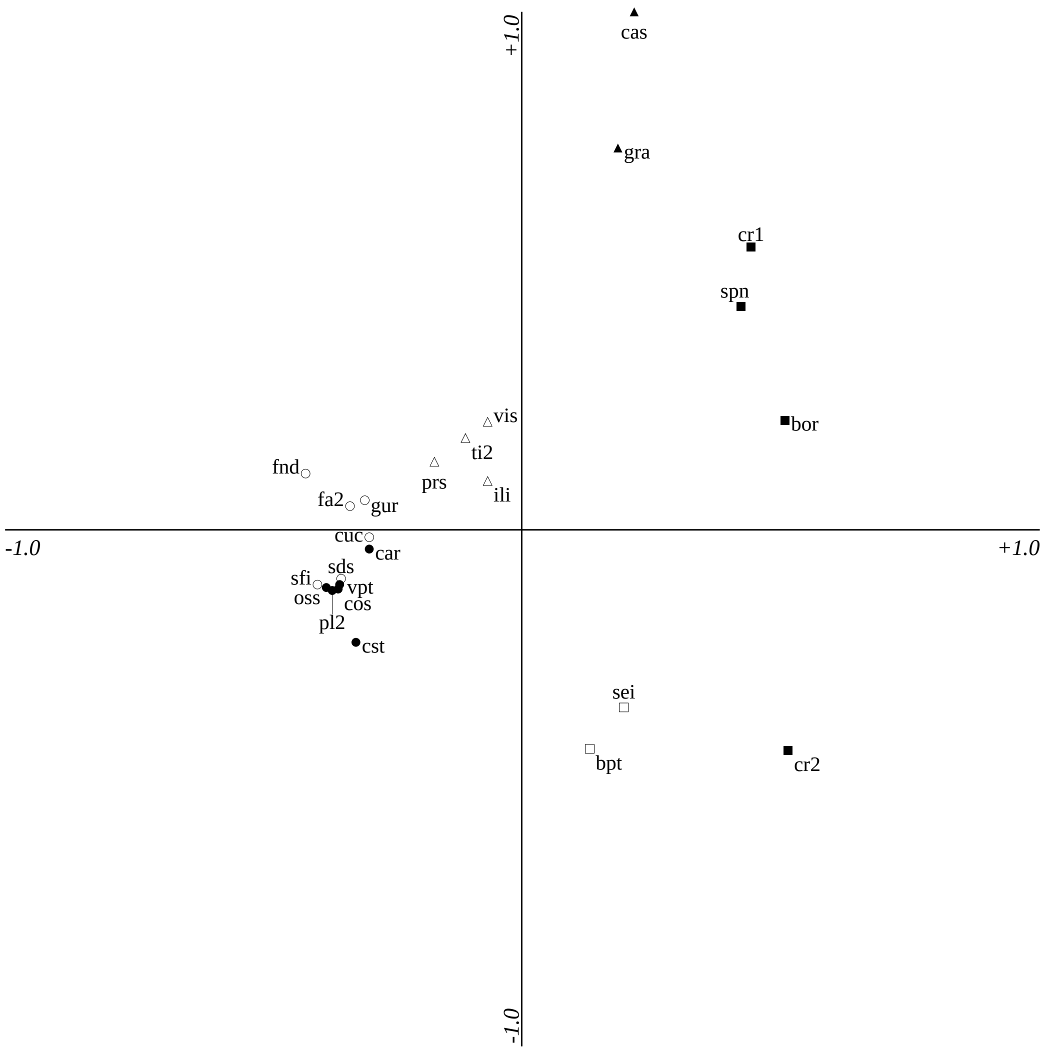


Figure 10.13: Sample map from CA as Fig. 10.8 but with down-weighted rare species. Data points are coin hoards — circles are cluster group *b*, squares group *f*, triangles group *g*, filled symbols Italy, empty symbols Romania. First (horizontal) and second axes of inertia.

these hoards while highlighting variation in the group *b* hoards. The technique was, however, much less successful when used on all the hoard data.

The technique would therefore appear to be useful in comparing the cluster analysis groups in order to assess the defining attributes of those groups, but is less useful in larger analyses. It is also useful in those situations when ordinary CA is highlighting minor differences between the most recent hoards in a data set as with `detrend.dat` and some of sets from Chapter 8, *e.g.*, `fin147.dat` and `fin56.dat`. I would recommend that the technique always be used in conjunction with ordinary CA, as well as the usual cumulative percentage curve graphs. Extra caution should be taken in the interpretation of the results.

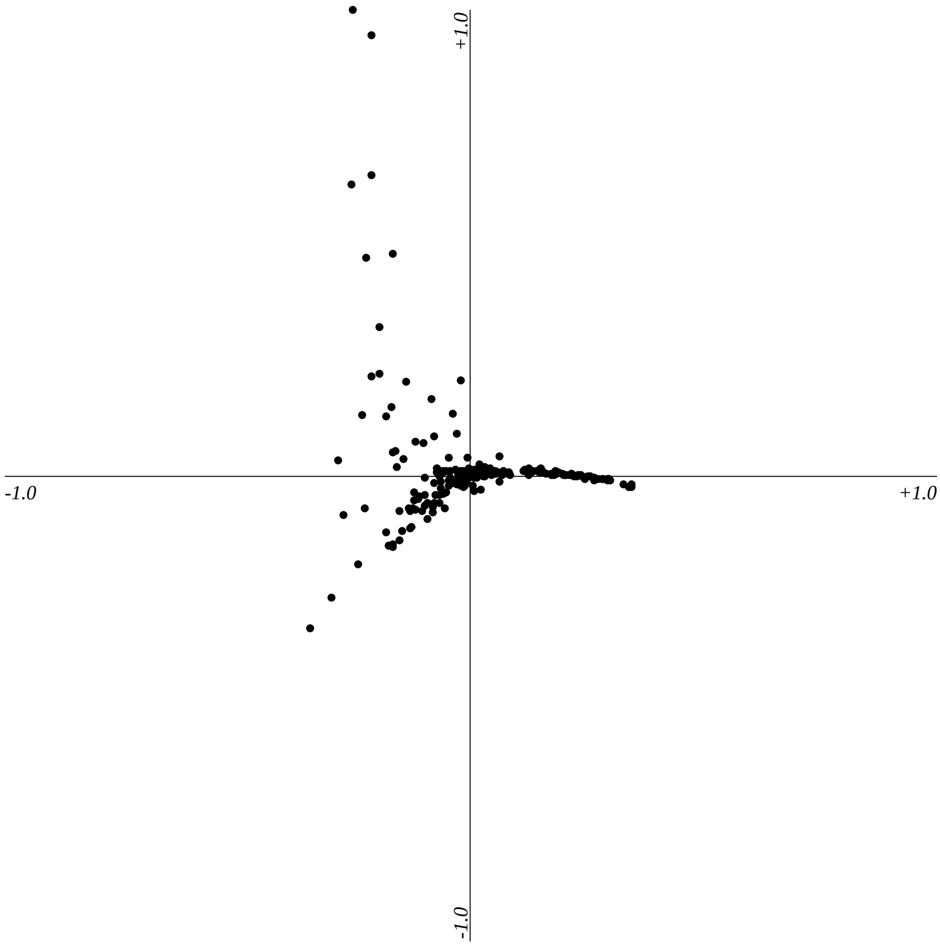


Figure 10.14: Sample map from CA detrended by second order polynomials. Data points are 241 hoards; *cf.* Fig. 8.2, page 151.

10.6 Conclusions and discussion

10.6.1 Archaeological and numismatic results

The primary archaeological purpose of the cluster and subsequent analyses was the examination of Romanian hoards. In the analyses presented in Chapter 8 we saw that the Romanian hoards of the 70s BC were similar to Italian hoards of the same date. However, over time the Romanian hoards became increasingly less like the contemporary Italian material and by the end of the 50s BC were archaic in structure. During the 40s and onwards however, Romanian hoards became less homogeneous with some hoards having slightly archaic to average profiles, but some hoards still having very archaic profiles. The question posed was: are the archaic Romanian hoards unlike any of the other hoard material, or do they resemble hoards from other regions but of another date? The cluster analysis clearly demonstrated that the archaic Romanian hoards are very similar to Italian hoards of the 70s BC with the main difference being the addition of relatively small amounts of later coinage. It is not until the 40s BC that *some* Romanian hoards again start to resemble contemporary Italian material, but even then, at a detailed level, there are differences. From *c.* 46 BC there appear to be two classes of Romanian hoards, those with a 70s BC Italian profile with minor additions, and those with a more modern profile which approximates to the more archaic Italian profiles of *c.* 46–29 BC.

It is in the context of the debate surrounding the date and nature of the coinage supply to ancient Dacia, roughly modern Romania, that these results are of importance. This debate will be reviewed in detail in Chapter 14 and the detailed interpretations given. In summary, the interpretations offered are:

- Republican *denarii* started to enter the region in quantity in the 70s BC.
- After *c.* 65 BC the supply of *denarii* decreased, possibly dramatically.
- In the mid-40s BC there was a renewed supply of coinage.
- Prior to this renewed supply, Romanian hoards look similar to each other because they were extracted from a homogenous Italian coinage pool in the 70s and early 60s BC.
- After this renewed supply, there are wide differences between hoards suggesting that the circulation of coinage was slow and erratic.

The decrease in coinage supply in the late 60s and 50s BC is *not* only due to the small quantities of coinage minted at that time as shown by the increasingly archaic nature of Romanian hoards. Similarly, the influx of coinage in the 40s is not just a product of increased coin production at that time.

For the Italian material, the cluster analysis underlines the conclusions in Chapter 8. The Italian coinage pool is a continuous and dynamic system with a continuous, if variable, input from the mint and a continuous, if variable, output in the form of lost coins, hoards and 'exports'. This is clearly shown in the sequence of both groups and supergroups: there is generally a group for each decade.

For the Iberian peninsula material, the hoards are generally concentrated in fewer groups reflecting the more erratic supply of coinage to the area. The division of hoards also reflects the variable structure of the Iberian Peninsula hoards; *e.g.*, the four Iberian Peninsula hoards closing in 46 BC are split across four groups: Jaen (JAE) is in group *h* with archaic hoards, Fuente de Cantos (FDC) is in group *g* with average hoards, El Centenillo (EL2) is in group *t* with more modern structured hoards and Sendinho da Senhora (SEN) forms a singleton, group *u*, because it has an exceptionally modern structure. The problematic nature of the late second century BC material is also highlighted by hoards Penhagarcía, Pozoblanco and Villanueva de Córdoba (PNH, PZ1 & CO1) forming three singleton groups, (ϵ, ζ & η). As was stated on pages 249–257, the Iberian peninsula material is deserving of a case study of the depth which will be presented in Part III, which unfortunately is beyond the scope of this thesis.

The cluster analysis has also highlighted some other cross-period regional groupings; *e.g.*, the five French hoards in group *t*. It would also be possible to re-examine groups of hoards using CA or even detrended CA, the latter method sometimes being more sensitive to smaller patterned differences in groups. A useful off-shoot of the cluster analysis has been the detection of hoards with data quality problems such as extraneous coins or mis-typed entries and in the case of the former problem it can suggest a correct closing date for the hoard.

So far we have managed to answer four of our five original questions. The question of measuring how archaic or modern an individual hoard is less easy to answer. It could be possible to measure the deviation as the difference between an individual hoard's closing date and the median date of the group. This method has some serious flaws: in the case of an odd hoard which occurs in a group by itself, this deviation would be zero, and in the case of a period which has large numbers of hoards and large inter-hoard variation, there are several cluster analysis groups and one would be measuring the deviation from other archaic, average or modern hoards within a period. If a single measure of archaicness or modernity is required, another method would have to be found. Given the results of Chapter 9, however, one could question the archaeological usefulness of such a measure.

The strength of the cluster analysis lies in its use with the results from the CAs presented in Chapter 8. The cluster analysis suggests a number of cross-period groups which would be worth investigating futher using CA and DCA. Also, whenever a new hoard is added to the database, it is now possible to place that hoard, using correspondence and cluster analysis, into its regional and temporal context, and to assess the hoard's structure in those terms.

There is much potential for further analysis, although more detailed work on, for example, the French material would require the CHRR database to be enhanced. Many more questions about coin supply and use could be posed and scholars more familiar with particular regions may see patterning and be able to offer interpretations beyond those presented here. The patterns within the Romanian hoards will be discussed in more detail in the following Part. The importance of this work lies in the creation of a detailed numismatic context in which old and new hoards can be examined both within periods and across periods, although the detailed interpretation of the results also requires a knowledge of the archaeological and historical background.

10.6.2 The statistical methods

Although it is dangerous to suggest the validity of a statistical technique solely on the basis of the archaeological credibility of the results, the cluster analysis using Dmax as a dissimilarity coefficient has produced results which make sense both in archaeological terms, and in comparison to the results of Chapter 8. It would seem, therefore, that the method could be used successfully with other data sets where the descriptive variables were of an ordinal data type.

The principal co-ordinates analysis was only useful as a check on the results of the cluster analysis. As would be expected given the nature of the data, the results are not entirely in agreement but in general show a good level of coherence in the cluster analysis groups.

Detrended CA appears to be a rather hit or miss technique; sometimes the results are meaningless, sometimes they reveal subtle differences in the data that are masked by the horseshoe effect in standard CA. Given the reservations of Greenacre (1984, p. 232) and Baxter (1994, p. 120), I would strongly recommend that the technique be used in comparison to ordinary CA and not in isolation. With both CA and DCA, comparison to visual summaries of the data, such as the cumulative percentage graphs, diagnostic statistics if available, and the data itself is also vital.

I hope that this chapter has further demonstrated the usefulness of the considered application of multivariate statistical methods to hoard data, and to archaeological data in general. With care, a combination of methods can reveal aspects of the data at both a detailed and broad level, and can be interpreted in archaeological terms.

Chapter 11

Modelling coinage supply and loss

11.1 Introduction

This chapter focuses on a numismatic problem which has been the subject of quite vigorous debate in recent years — can hoard evidence be used to estimate the absolute or relative size of coin issues, and can changes in the size of the coinage pool be calculated from these estimates? The various methods and formulæ for estimating the number of dies used to strike an issue have been briefly discussed in section 3.13.2. The problem with these methods is that they only provide estimates for a limited number of issues. Crawford developed a method which enabled him to produce estimates for issues of *denarii* from 157 BC until the end of the Republic (section 3.13.4) which he then tried to correlate with expenditure on the army (Crawford 1974, Table LVIII). This method was widely criticised, particularly the correlation with military expenditure (Frier 1976; Hersch 1977; Mattingly 1977; Burnett 1987; Buttrey 1989, 1993, 1994). Hopkins then went on to use Crawford's figures in his seminal article *Taxes and Trade in the Roman Empire* (Hopkins 1980) where he attempted to demonstrate the growth of the coinage pool.

Buttrey's criticisms go beyond Crawford's work, attacking the whole process of estimating the size of issues from die counts, comparing issue sizes and calculating the size of the coinage pool (Buttrey 1993; 1994; see section 3.13.8). He is particularly concerned that some of the figures used by Crawford have entered the literature as established facts, *e.g.*, the average of 30,000 coins struck per obverse die (Buttrey 1993, p. 341 & p. 347, ftn. 21), whereas they are in reality based on very flimsy evidence. To recap, his criticisms are:

1. Crawford's die estimates are based on combining hoards of different dates. Even hoards which are of the same date are not necessarily similar and some when tested using the χ^2 test are statistically significantly different (Buttrey 1989, pp. 73–4; 1993, pp. 336–7).

2. The average figure of 30,000 coins minted per die is little more than a rough estimate derived from the size of the issue of C. Annius (RRC 366; see also RRC, p. 694) and is unlikely to be accurate (Buttrey 1989, p. 74; 1993, pp. 339–345; 1994, pp. 342–352).

3. Even if this figure is correct for the silver *denarius* issues, it cannot be applied to other issues, especially those struck in another metal such as bronze. Thus, die counts for a bronze issue

cannot be used to compare the size of that issue with, for example, an issue of pure silver *denarii* (Buttrey 1994, pp. 342–352).

4. Multiplication by any constant, even within a similar series of issues, will result in the size of some issues being over-estimated, and the size of others being under-estimated, and is thus a misleading and incorrect procedure (Buttrey 1993, pp. 343–8).

5. Crawford's die estimates do not account for the 'attrition' (decay) rate (Buttrey 1993, pp. 336–8).

6. The figure of 2% so widely used for the decay rate is derived from Patterson's (1972) work on 19th century American coinage and is thus not applicable to the ancient world (Buttrey 1993, pp. 346–7).

7. The decay rate was not stable as shown by the varying number of hoards buried in each year (Buttrey 1993, pp. 345–6; *cf.* Fig. 7.1).

8. As a result of the above points, Hopkins' attempt to show the growth of the total coinage pool during the Republic (Hopkins 1980, see especially Fig. 2) cannot have any credibility (Buttrey 1989, pp. 73–4; 1993, pp. 336–8 & p. 347).

Buttrey therefore rejects any work which uses die counts, estimates the size of issues, or attempts to model coinage supply and circulation using any of the parameters discussed above (Buttrey 1993, pp. 347–9). I have discussed many of his points elsewhere (section 3.13.8); we can now add that the analyses presented in Chapter 9 show clearly the causes of inter-hoard variability and thus, at least partially, negate his worries over the differences between hoards. I would also add that I agree that comparisons based on die counts, between issues struck in different metals, or of widely different periods or regions which may have had different levels of technological and metallurgical competence, are highly unlikely to be valid. Given all this, has Buttrey thrown the proverbial baby out with the bath water? Can anything be salvaged? In the rest of this chapter I will demonstrate that all is not lost, and with many caveats and much caution, some useful information can be gleaned.

11.2 Testing Crawford's die estimates and the model

11.2.1 Introduction

The method chosen to investigate this problem builds on the simulation studies previously performed (Lockyear 1989; 1991; see section 3.5). In the computer simulation it was noted that the simulated hoards bore a close resemblance to real hoards, but that this could not be used as evidence for the accuracy of the die estimates as they were derived from the real hoards with which the simulated hoards were being compared — the argument would be circular. We now have, however, many more than those original 24 hoards and we could compare hoards not used in Crawford's estimates with either calculated coinage pools (*i.e.*, the samples with an derived population), or if we wished, simulated hoards with real hoards. There is a limited possibility that the arguments continue to be circular in that the estimates are *still* derived from hoards, even if they are *different* hoards. I would argue, however, that if some or all of Buttrey's criticisms are valid, there should be little or no correlation between the calculated coin population for any one date and real hoards of the same date. If the estimates and methods used have some validity, the coin population should fall in the middle of the spread of real hoards, with variations being attributable to sampling error or variations in the local coinage pool.

We can also use this opportunity to examine various factors including the effect of changing the decay rate or using a variable one, the effects of varying the introduction delay, and the use of die counts derived from the regression analysis of Lockyear (1989, section 2.3). Firstly, I shall discuss each stage of the procedure in detail, and then I shall compare the results with real hoards from various periods. Finally, I shall investigate the results of changing the various parameters.

11.2.2 Modelling the coinage pools

The manner in which Crawford estimated the die counts for all the Republican series has been discussed (section 3.13.4). These estimates have been challenged and been shown to be wrong in some circumstances. As we are here interested in whether these figures can be used to model the coinage pool at any date, rather than their accuracy as a die estimate in any single case, I shall refer to these estimates as *relative issue size coefficients* (RISC, ρ). Simply put, we are going to test if an issue with a RISC of 100 is ten times larger than an issue with a RISC of 10.

To get to the absolute size of an issue the RISC figure has to be multiplied by the average number of coins struck per die (κ). I do not believe that an accurate figure can be given to κ. We can, however, work with relative figures, as was noted by Hopkins (1980, p. 107). It would be possible to work with the RISC figures directly but for computational ease I have multiplied them by 'a very large number.' This number has no validity as an estimate of the actual value of κ, and as I do not want to either add credibility to an existing estimate, or to create another fictitious estimate, the value of κ will not be given. Varying the value of κ makes no difference to the results and conclusions presented below.

As a starting point, the decay rate (δ) was set at 2%. The results of either varying δ as a constant, or using a variable value for δ, will be examined. The introduction delay (ι) is a measure of how long it takes an issue to reach its maximum abundance in the local coinage pool and is measured in years.

In this analysis, the RISC figures for each issue were grouped into years.[1] The coinage curve for an issue year (Y_i) was modelled in the following manner:

1. The total number of coins was calculated and then divided by the introduction delay ($x = \frac{\rho\kappa}{\iota}$)
2. For each year from the issue year to the end of the introduction delay ($Y_{i \ldots \iota}$) x coins were added to the total in circulation.
3. For each year after the year of issue, $\delta\%$ of the total were removed from circulation.

[1]As usual, the year is defined as the `date_from` field in the database.

This procedure was then repeated for every year Y_i for $i = 157 \ldots 50$. The results could be presented as a table with years of issue as the rows, and the dates as columns. By reading along the row one would see the changes in the numbers of coins of a year of issue over time. By reading down a column one sees the composition of the coinage pool for a particular date. Converting the columns to percentages enables the plotting of cumulative percentage curves of the derived populations to which real hoards could be compared. It would also be possible to plot the rows as curves for comparison with the numbers of coins of that issue year found in hoards.

11.2.3 Comparing the results

To examine the calculated coin populations they will be compared to hoards previously analysed in Chapter 8. In this chapter, however, all coins prior to 157 BC have been removed and thus there will be minor differences in the hoard profiles and totals. All hoards used in this section are listed in Table 11.1.

Comparisons between hoards and the population curves can be tested using the one-sample Kolmogorov-Smirnov test (Lindley & Scott 1984, p. 70). This test will show if there is a statistically significant difference between the hoard (sample) and the theoretical population. Unfortunately, statistical significance arises from two factors, the size of the hoard (sample) and the strength of the relationship. Consequently, significance tests on large samples often result in a statistically significant result even if the strength of the relationship is weak (Shennan 1988, pp. 77–8). We should also note that if the null hypothesis of no difference is accepted, *i.e.*, there is no statistically significant difference, this does *not* mean that the distributions are the same — we can only say “there does not appear to be a ‘case to answer’ ” (Shennan 1988, p. 61).

If we wish to compare a hoard with multiple populations, we cannot use the results of this test. We could use Dmax as in the cluster analysis presented in the previous chapter, but Dmax is a comparatively insensitive measure of similarity. As we will be comparing a single hoard with variable populations we could use the area between the two curves as proposed by Leese (1983). The problem of variable sample (hoard) size which led to the rejection of this method in the previous chapter is not a factor here. The calculation of the area between two curves is a tedious task, but the small size of x-axis categories allows use to make an acceptably accurate approximation by summing the difference between each year. I have called this measure *Dsum*. This is a similar measure to the city block metric (Shennan 1988, p. 201) except that we are summing the differences between cumulative proportions rather than variables.

11.2.4 Testing Crawford’s RISC figures (ρ)

It seemed prudent initially to compare the results of the simulation with hoards from periods where there was little inter-hoard variability. As high inter-hoard variability can be associated with a combination of large recent issues and the effects of the introduction delay, choosing periods of low inter-hoard variability should mean that the introduction delay (ι) would have little influence on the population curves. The first data set chosen was `fin72.dat` (section 8.3.10) which contained four Italian hoards dating from 72–1 BC. Two of these hoards, Ossero and Villa Potenza (OSS & VPT, see Fig. 8.38, page 200) are remarkably similar, and despite their large size, 460 and 407 coins

code	hoard	country	'end date'	'good total'†	
From `fin72.dat`					
OSS	Ossero	Italy	72	460	
PLC	Policoro	Italy	72	293	
TOL	Tolfa	Italy	72	238	
VPT	Villa Potenza	Italy	71	407	
From `fin51.dat`					
BHR	'Bahrfeldt'	—	49	424	
BRA	Brandosa	Italy	49	406	
BRO	Broni	Italy	51	80	
CAS	Casaleone	Italy	51	710	
CR1	Carbonara	Italy	48	374	(324‡)
P06	Padova	Italy	48	54	
TR2	Taranto	Italy	49	51	
From `fin105.dat`					
CG2	Cerignola	Italy	100	89	
IMO	Imola	Italy	100	497	
OLM	Olmeneta	Italy	100	383	
PAT	Paterno	Sicily	100	145	
From `fin87.dat`					
BER	Berchidda	Sardinia	82	1385	
BLC	Bellicello	Sicily	81	35	
CAR	Carovilli	Italy	82	40	
CER	Cervia	Italy	82	44	
CPL	Capalbio	Italy	81	56	
DOM	Santa Domenica di Tropea	Italy	82	107	
FSL	Fossalta	Italy	83	253	
From `fin92.dat`					
ALI	Alife	Italy	87	81	
CAH	'Italy' (Cahn)	Italy	87	211	

Table 11.1: Hoards used in the simulation studies. †'Good total' for years 157 BC onwards. ‡Total of coins for 157–50 BC.

respectively, the two-sample Kolmogorov-Smirnov test shows them not to be significantly different at the 0.05 level.[2] The four Italian hoards in this data set have been plotted in Fig. 11.1 along with the population curve generated for this year using Crawford's RISC figures with a decay rate of 2% per annum and an introduction delay of 1 ($\delta = 2; \iota = 1$). As can be seen there is a remarkable degree of fit between the population curve and the Ossero and Villa Potenza hoards. Comparing these two hoards to the population curve using the one sample Kolmogorov-Smirnov test shows no statistically significant difference at the 0.05 level.[3] The remaining two hoards, Policoro and Tolfa (PLC & TOL) do show significant differences with the population curve[4] and this is presumably attributable to local variations in the coinage pool.

[2] $\mathrm{Dmax_{obs}} = 0.059$; $\mathrm{Dmax}_{0.05} = 0.093$; therefore accept H_0.

[3] For Ossero, $\mathrm{Dmax_{obs}} = 0.057$; $\mathrm{Dmax}\sqrt{n} = 0.057\sqrt{460} = 1.123$. For Villa Potenza $\mathrm{Dmax_{obs}} = 0.048$; $\mathrm{Dmax}\sqrt{n} = 0.048\sqrt{407} = 0.928$. Upper 0.05 level with sample size $\infty = 1.358$ or upper 0.1 level with sample size $\infty = 1.223$ (Lindley & Scott 1984, Table 23). Therefore accept H_0 in both cases.

[4] For Policoro, $\mathrm{Dmax_{obs}} = 0.148$; $\mathrm{Dmax}\sqrt{n} = 0.148\sqrt{293} = 2.533$. For Tolfa $\mathrm{Dmax_{obs}} = 0.197$; $\mathrm{Dmax}\sqrt{n} = 0.197\sqrt{238} = 3.039$. Upper 0.05 level with sample size $\infty = 1.358$ or upper 0.01 level with sample size $\infty = 1.628$ therefore reject H_0 in both cases.

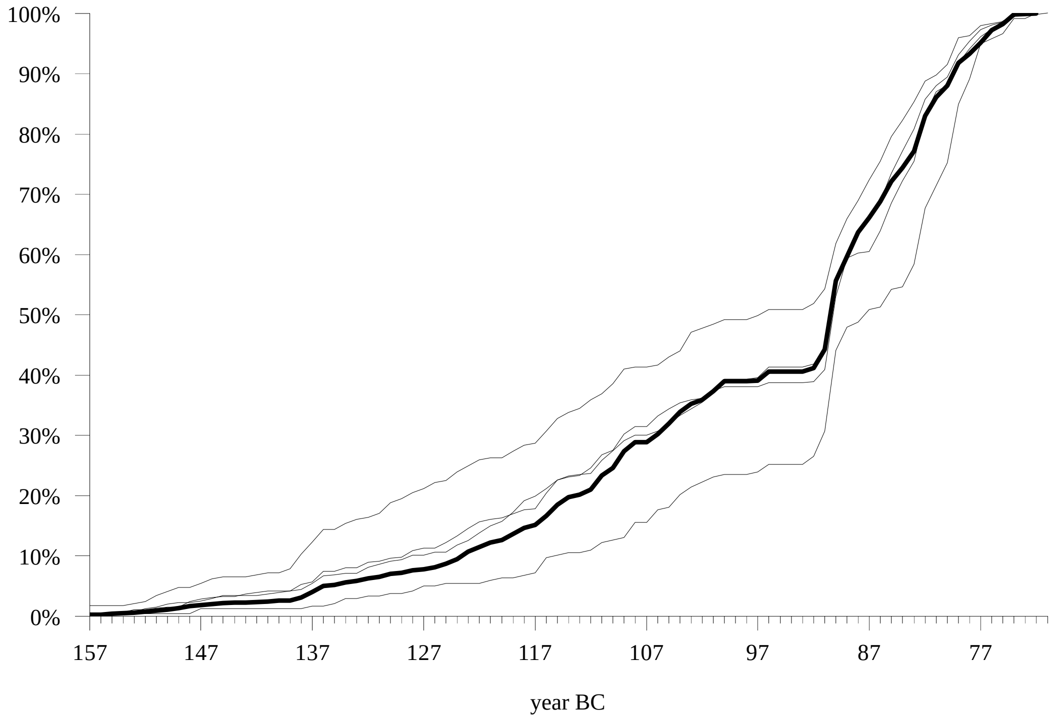


Figure 11.1: Four Italian hoards closing 72–1 BC compared to simulated coin population for 72 BC using Crawford's RISC figures and $\delta = 2; \iota = 1$. See text for details.

For further comparison a second set of hoards were chosen. Data set `fin51.dat` contained seven hoards from Italy[5] closing between 51–48 BC. Although the population curves have not been calculated for years after 50 BC it was felt appropriate to examine the curves at the end of the range under consideration. Fig. 11.2 shows the seven hoards and the population curve calculated from Crawford's RISC figures with $\delta = 2$ and $\iota = 1$. The composition of the Padova hoard (P06) is fairly unusual as was demonstrated in the cluster analysis where this hoard was placed in group *v* with only one other hoard (Table 10.2; see also section 8.3.13, page 207). This hoard has therefore been removed from the following discussion. It should also be noted that the Casaleone (CAS) hoard is one of the 24 used to create the RISC figures by Crawford.

There seems to be a high level of agreement between the population curve for 50 BC and the hoards. Using the one-sample Kolmogorov-Smirnov test there is no significant difference at the 0.05 or 0.1 level between Brandosa and Taranto hoards (BRA & TR2) and the population curve[6], and no significant difference at the 0.01 level between Broni and Casaleone (BRO & CAS) and the population curves.[7] Carbonara (CR1) is significantly different but 13.4% of this hoard dates to 49–

[5] Strictly speaking the 'Bahrfeldt' hoard (BHR) is unprovenanced but it is most likely to be from Italy.

[6] For Brandosa, $\text{Dmax}_{\text{obs}} = 0.041$; $\text{Dmax}\sqrt{n} = 0.041\sqrt{406} = 0.826$; upper 0.05 level with sample size $\infty = 1.358$ or upper 0.1 level with sample size $\infty = 1.224$ therefore accept H_0. For Taranto $\text{Dmax}_{\text{obs}} = 0.171$; $\text{Dmax}\sqrt{n} = 0.171\sqrt{51} = 0.928$; upper 0.05 level with sample size $50 = 1.332$ or upper 0.1 level with sample size $50 = 1.199$ therefore accept H_0.

[7] For Broni, $\text{Dmax}_{\text{obs}} = 0.167$; $\text{Dmax}\sqrt{n} = 0.167\sqrt{80} = 1.494$; upper 0.05 level with sample size $80 = 1.338$ or upper 0.01 level with sample size $80 = 1.605$ therefore reject H_0 at the 0.05 level or accept H_0 at the 0.01 level. For Casaleone $\text{Dmax}_{\text{obs}} = 0.059$; $\text{Dmax}\sqrt{n} = 0.059\sqrt{710} = 1.572$; upper 0.05 level with sample size $\infty = 1.358$ or upper 0.01 level with sample size $\infty = 1.628$ therefore reject H_0 at the 0.05 level or accept H_0 at the 0.01 level.

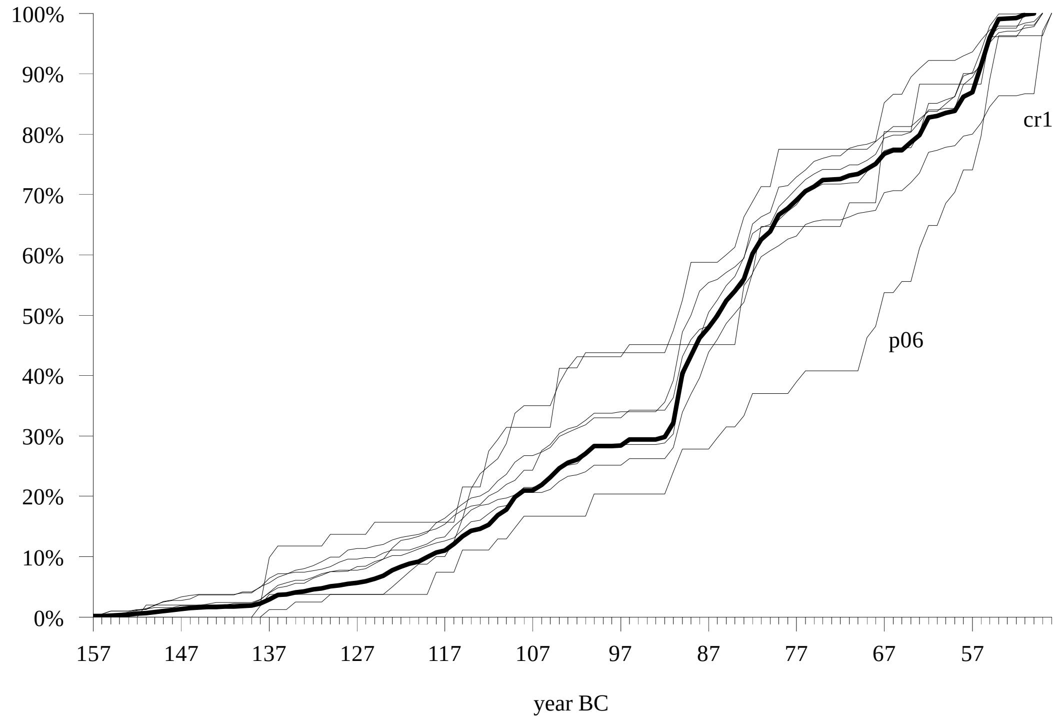


Figure 11.2: Seven Italian hoards closing 51–48 BC compared to simulated coin population for 50 BC using Crawford's RISC figures and $\delta = 2; \iota = 1$. See text for details.

48 BC, *i.e.*, after the date of the population curve. Removing these coins from Carbonara's profile results in this hoard not being significantly different at the 0.05 level from the population curve.[8] Finally, the only hoard which is statistically different from the population even at the 0.01 level is the unprovenanced 'Bahrfeldt' hoard (BHR).[9] We have, therefore, more evidence that the figures used in the construction of the population curves *do* have some validity.

One last data set with low inter-hoard variability was chosen — `fin105.dat`. Within this data set there are four hoards from Italy closing in 100 BC. These four hoards were therefore compared with the population curve for this year generated using Crawford's RISC figures, $\iota = 1, \delta = 2$. Fig. 11.3 presents the results. As can been seen, there is a good fit with three out of the four hoards. The Cerignola (CG2) hoard is not significantly different from the population curve at the 0.5 or 0.1 levels.[10] The Olmeneta hoard (OLM), as would be expected from looking at Fig. 11.3, is significantly different even at the 0.01 level, as is the large Imola hoard (IMO).[11] The Paterno hoard (PAT) is significantly different at the 0.05 level but not at the 0.01.[12]

[8]For Carbonara (all coins post 157 BC), $\text{Dmax}_{\text{obs}} = 0.134$; $\text{Dmax}\sqrt{n} = 0.134\sqrt{374} = 2.591$; upper 0.05 level with sample size $\infty = 1.358$ or upper 0.01 level with sample size $\infty = 1.628$ therefore reject H_0 at both levels. For Carbonara (coins from 157–50 inc.) $\text{Dmax}_{\text{obs}} = 0.064$; $\text{Dmax}\sqrt{n} = 0.064\sqrt{324} = 1.152$; upper 0.05 level with sample size $\infty = 1.358$ or upper 0.1 level with sample size $\infty = 1.224$ therefore accept H_0 at both levels.

[9]For 'Bahrfeldt', $\text{Dmax}_{\text{obs}} = 0.110$; $\text{Dmax}\sqrt{n} = 0.110\sqrt{424} = 2.265$; upper 0.05 level with sample size $\infty = 1.358$ or upper 0.01 level with sample size $\infty = 1.628$ therefore reject H_0 at both levels.

[10]For Cerignola, $\text{Dmax}_{\text{obs}} = 0.090$; $\text{Dmax}\sqrt{n} = 0.090\sqrt{89} = 0.849$; upper 0.05 level with sample size $90 = 1.339$ or upper 0.1 level with sample size $90 = 1.206$ therefore accept H_0 at both levels.

[11]For Olmeneta, $\text{Dmax}_{\text{obs}} = 0.326$; $\text{Dmax}\sqrt{n} = 0.326\sqrt{383} = 6.380$; upper 0.05 level with sample size $\infty = 1.358$ or upper 0.01 level with sample size $\infty = 1.628$ therefore reject H_0 at both levels. For Imola $\text{Dmax}_{\text{obs}} = 0.102$; $\text{Dmax}\sqrt{n} = 0.102\sqrt{497} = 2.274$; upper 0.05 level with sample size $\infty = 1.358$ or upper 0.01 level with sample size $\infty = 1.628$ therefore reject H_0 at both levels.

[12]For Paterno, $\text{Dmax}_{\text{obs}} = 0.131$; $\text{Dmax}\sqrt{n} = 0.131\sqrt{145} = 1.577$; upper 0.05 level with sample size $200 = 1.346$

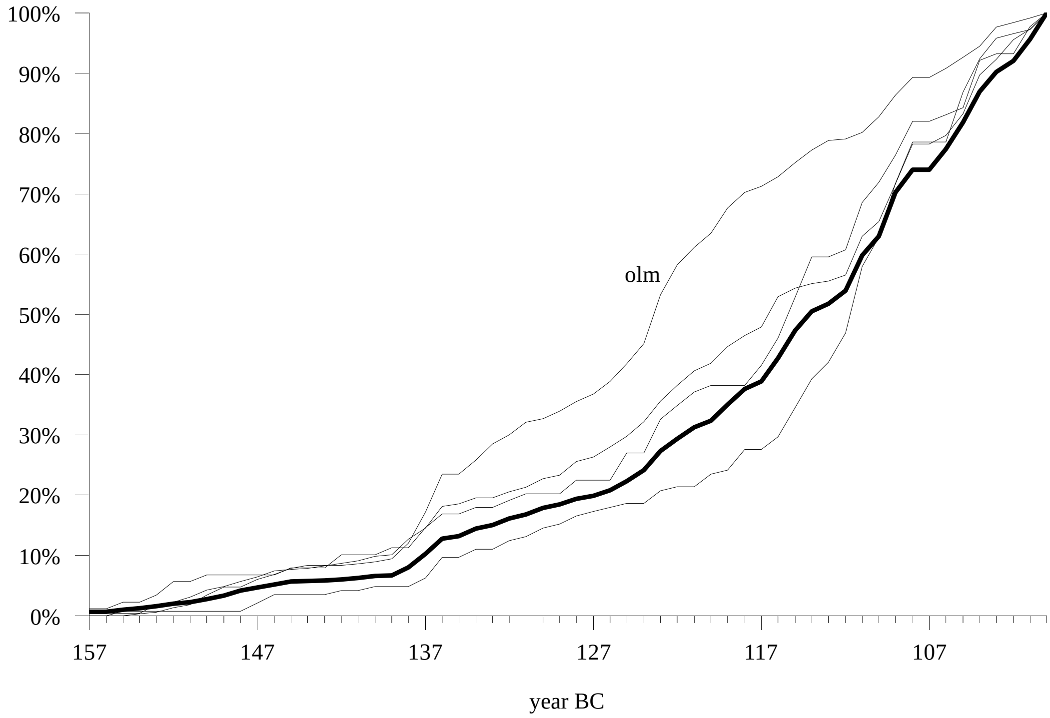


Figure 11.3: Four Italian hoards closing 100 BC compared to simulated coin population for 100 BC using Crawford's RISC figures and $\delta = 2; \iota = 1$. See text for details.

The three hoards which lie closely to the population curve on the graph nicely illustrate the problem of large samples and significance tests which has been mentioned previously. The largest hoard, Imola, is significant at the highest level used here (0.01), the middle-sized hoard, Paterno, at the 0.05 but not at the 0.01 level and the smallest, Cerignola, is not significantly different even at the 0.1 level.

In spite of the problems and the differences, I would still argue that the curve produced does represent a reasonable population curve, especially given that we have not accounted for effects due to regional variations.

All the comparisons discussed above are conclusive: it *is* possible, within a reasonably homogeneous series, such as the Republican *denarii* form, to calculate the relative size of issues, and to model the composition of the coinage pool. It should also be possible to demonstrate the growth of the coinage pool and I shall return to this later.

11.2.5 Examining the decay rate (δ)

Having demonstrated that the calculated populations using Crawford's RISC figures do have some validity, we can now examine the effects of varying the other parameters. To examine the effect of different values of δ coinage pools were generated for an introduction delay of 1, and δ of 0.5, 1, 2, 3, 4, 5, 7.5 and 10. Figure 11.4 shows the Ossero and Villa Potenza (OSS & VPT) hoards plotted against population curves with these values of δ. As can be seen there is a good fit between the

or upper 0.01 level with sample size $200 = 1.614$ therefore reject H_0 at the 0.5 level or accept H_0 at the 0.01 level. Conclusions are not changed by using levels for sample size $= 100$.

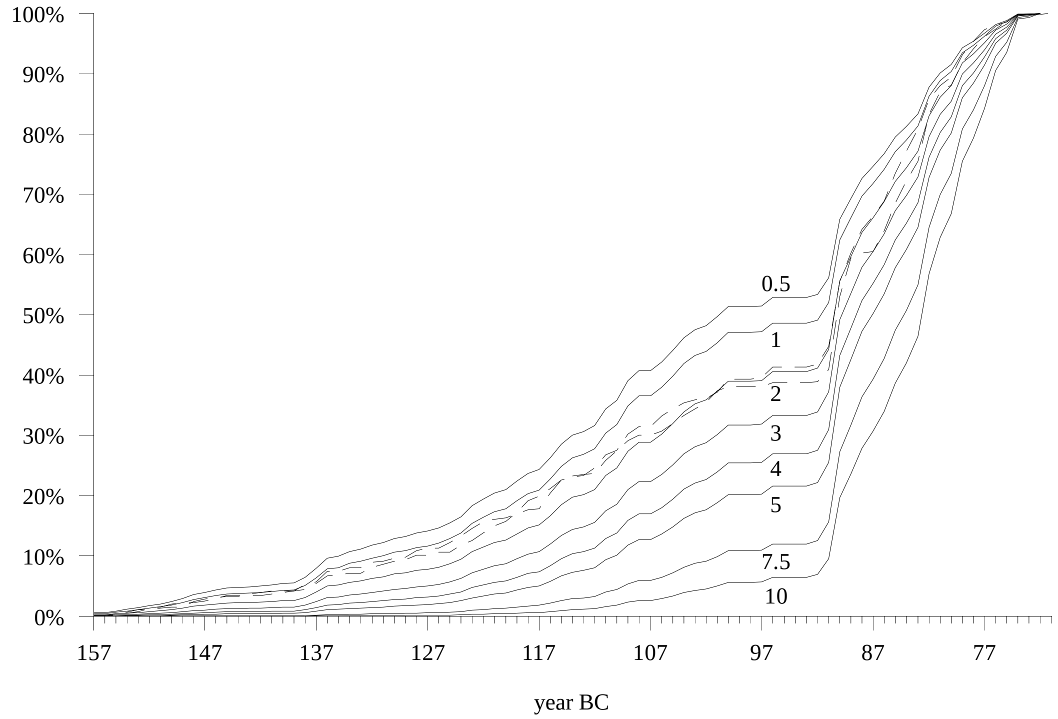


Figure 11.4: Two Italian hoards closing 72–1 BC compared to simulated coin population for 72 BC using Crawford's RISC figures, $\iota = 1$, and decay rates (δ) of 0.5–10. See text for details.

2% rate and the two hoards although the first part of the hoard profiles lie closer to the 1% curve. To formalise the degrees of fit between hoards and the various population curves, Tables 11.2–11.4 present Dsum values for each hoard in the three groups examined above with the eight population curves. Of the four hoards from 72–1 BC, two are closest to the 2% curve, one to the 0.5% line and one to the 4% line. Of the seven hoards from 51–48 BC, the best fit is with either the 1% or 2% lines. Only the anomalous Padova (P06) hoard appears to fit best with the 5% line. Of the four hoards from 100 BC Olmeneta fits best with the 0.5% line, Cerignola and Imola fit best with the 1% line and the Paterno hoard with the 3% line.[13]

From this we can suggest that 2% is a good average figure to use in this particular case. Use of this figure in other situations would have to be justified in each case. There is a suggestion that the decay rate for the period 157–100 BC is possibly nearer to 1% as shown by the hoards from that date (Table 11.4), and the systematic over-representation of coins of *c.* 157–100 BC in hoards Ossero and Villa Potenza when compared to the 2% line (Fig. 11.4). To test this a population curve for 72 BC was generated using Crawford's RISC figures, $\iota = 1$ but $\delta = 1$ for 157–100 BC and $\delta = 2$ for years thereafter. The results were inconclusive. The fit for Ossero was less good than with the 2% line (Dsum $= 1.654$) but improved for Villa Potenza (Dsum $= 1.136$). Similarly, for Policoro the fit improved but was less good for Tolfa (Policoro: Dsum $= 4.925$; Tolfa: Dsum $= 8.519$). It would be possible to attempt to fit other temporal patterns of variation in the value of δ, *e.g.,*

[13]The Dsum values cannot be used to compare the fit of different hoards, espcially of different periods, to different population lines, *e.g.,* although the Cerginola hoard has a Dsum of 0.924 with the 1% line, and the Broni hoard has Dsum value of 3.792, this does not mean that Cerignola has a better fit than Broni because Dsum for Broni is the sum of 107 differences between variables (years) and the population curve but Dsum for Cerignola is for only 57 differences.

δ	OSS	PLC	TOL	VPT
0.5	4.972	2.738	11.973	4.337
1	2.95	3.53	9.945	2.336
2	1.556	7.125	6.319	1.355
3	3.737	10.170	3.309	4.389
4	6.241	12.676	1.309	6.894
5	8.282	14.717	2.001	8.935
7.5	11.871	18.307	4.88	12.524
10	14.102	20.538	7.103	14.755

Table 11.2: Dsum comparisons between four hoards and the simulated populations for different values of δ for 72 BC.

δ	BHR	BRA	BRO	CAS	CR1	CR1 †	P06	TR2
0.5	4.539	7.179	4.339	6.603	11.456	6.293	19.499	5.578
1	2.542	4.412	3.729	3.582	8.422	3.481	16.46	5.281
2	4.665	2.006	6.037	2.426	3.883	3.077	10.769	6.602
3	9.767	6.899	10.211	7.308	4.168	8.149	6.284	9.705
4	14.232	11.365	14.514	11.796	8.44	12.64	4.876	14.16
5	18.075	15.201	18.293	15.622	12.179	16.507	4.548	17.992
7.5	25.286	22.363	25.451	22.882	19.209	23.727	10.177	25.119
10	29.744	26.821	29.912	27.349	23.549	28.194	14.62	29.555

Table 11.3: Dsum comparisons between seven hoards and the simulated populations for different values of δ for 50 BC . † Hoard CR1 without coins after 50 BC.

δ	CG2	IMO	OLM	PAT
0.5	1.288	0.813	4.76	4.878
1	0.924	0.766	5.455	3.958
2	2.166	2.345	7.223	2.407
3	3.85	4.006	8.852	1.405
4	5.319	5.466	10.299	1.722
5	6.594	6.732	11.561	2.729
7.5	9.088	9.232	14.045	5.197
10	10.866	11.01	15.82	6.974

Table 11.4: Dsum comparisons between four hoards and the simulated populations for different values of δ for 100 BC.

ι	BER	BLC	CAR	CER	CPL	DOM	FSL
1	14.994	4.569	1.925	4.372	4.288	3.788	22.969
3	13.816	5.71	1.859	4.801	5.07	3.189	21.787
5	13.051	6.487	2.213	5.297	5.834	3.224	20.992
7	12.322	7.253	2.710	6.024	6.575	3.369	20.225
9	11.513	8.119	3.576	6.888	7.408	3.580	19.359
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
25	4.978	14.949	10.405	13.718	14.019	7.307	12.529
29	3.881	16.103	11.559	14.872	15.154	8.193	11.375

Table 11.5: Dsum comparisons between seven hoards closing 83–1 BC and the simulated populations for different values of ι for 82 BC.

based on the numbers of hoards buried *per annum*. However, variation in the decay rate is only one possible source of inter-hoard variation and although altering parameters to attempt to produce the best possible fit between a population curve and an individual hoard is possible, it does not represent a particularly useful or meaningful proceedure.

11.2.6 Examining the introduction delay (ι)

So far we have concentrated on periods where hoards are relatively homogenous. We could now test populations with different introduction delays with relatively heterogeneous hoards. Within data set `fin87.dat` there are seven hoards closing 83–1 BC. This data set showed a high level of structure with wide differences between hoards. It is important when examining the results to note that many of these hoards are quite small especially when compared to others in this chapter. Population curves were generated for 82 BC using Crawford's RISC figures, $\delta = 2$ and $\iota = 1, 3, 5 \ldots 29$.

The original analysis showed three groups in the data, four archaic hoards, two 'average' hoards and a number of modern hoards (see section 8.3.6, especially Fig. 8.26, page 184). Dsum values were calculated between the population curves and the hoards (Table 11.5). Two hoards were most similar to the population with an introduction delay of three and these have been plotted in Fig. 11.7. These two hoards, Carovilli and Santa Domenica (CAR & DOM), were the hoards with average profiles in data set `fin87.dat`. These two hoards were not significantly different at the 0.1 level from the $\iota = 3; \delta = 2$ population although the large issue of 109 BC seen in the hoard profiles seems not to be well represented in the population profile.[14]

The most archaic hoards, Fossalta and Berchidda (FSL & BER), are more archaic in profile than the $\iota = 29; \delta = 2$ line (Fig. 11.8). Comparing Berchidda with this line shows that the large issues of 90 BC are still over-represented in the population curve but the subsequent issues are under-represented. It would appear that there are problems with the modelling of the introduction delay. This is borne out by the examination of the most modern hoards. Fig. 11.5 plots the three modern hoards against the $\iota = 1; \delta = 2$ line and we can see that all three hoards are more modern than the population curve: Cervia (CER) because it has more coins of 90 BC, Capalbio (CPL) because it has more coins of 88 BC and Bellicello (BLC) because it has more coins of 83 BC.

Before moving on to discuss the problems with the model of the introduction delay we should first look at the effects of the varying ι. Fig. 11.6 shows the population curves for $\iota = 1, 5, 9 \ldots 29$. Two points can be observed:

1. There is a large gap between the $\iota = 9$ and the $\iota = 13$ lines.

2. The difference between curves gradually becomes smaller from $\iota = 13$ onwards.

The first point is explained by the large issue of 90 BC and the date of the population curves, 82 BC. With an introduction delay of 9 all the coins of 90 BC will have entered the population, the last batch

[14] For Carovilli, $\text{Dmax}_{\text{obs}} = 0.063$; $\text{Dmax}\sqrt{n} = 0.063\sqrt{40} = 0.398$; upper 0.05 level with sample size $40 = 1.329$ or upper 0.1 level with sample size $40 = 1.196$ therefore accept H_0 at both levels. For Santa Domenica, $\text{Dmax}_{\text{obs}} = 0.115$; $\text{Dmax}\sqrt{n} = 0.115\sqrt{107} = 1.190$; upper 0.05 level with sample size $100 = 1.340$ or upper 0.1 level with sample size $100 = 1.207$ therefore accept H_0 at both levels.

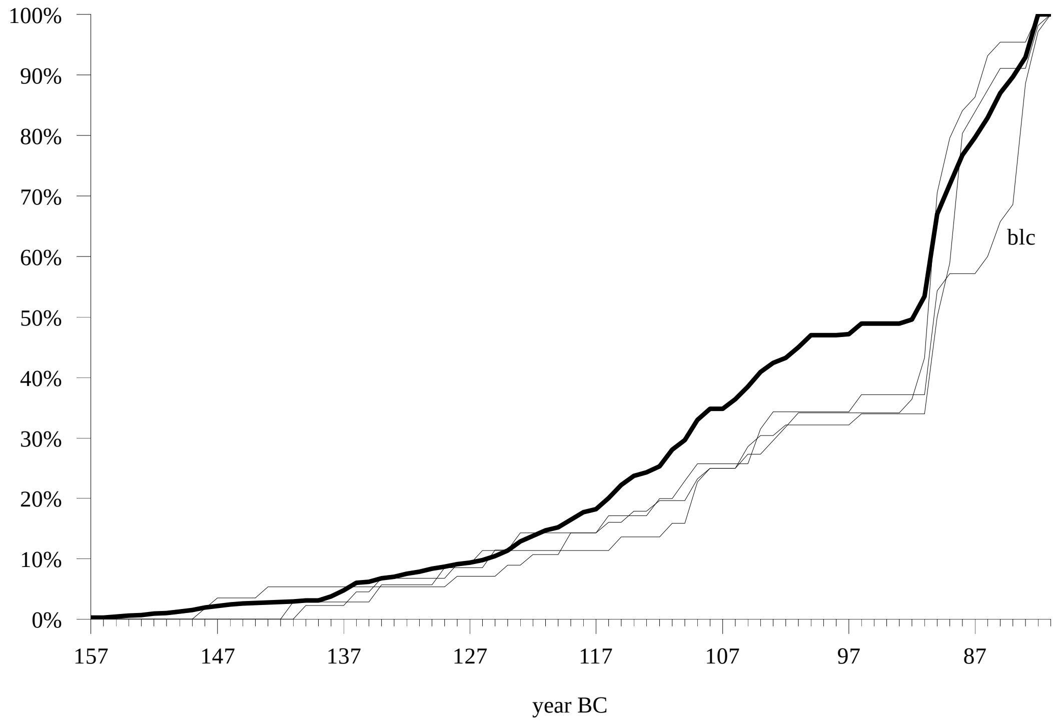


Figure 11.5: Three Italian hoards closing 82–1 BC compared to simulated coin population for 82 BC using Crawford's RISC figures, $\iota = 1; \delta = 2$.

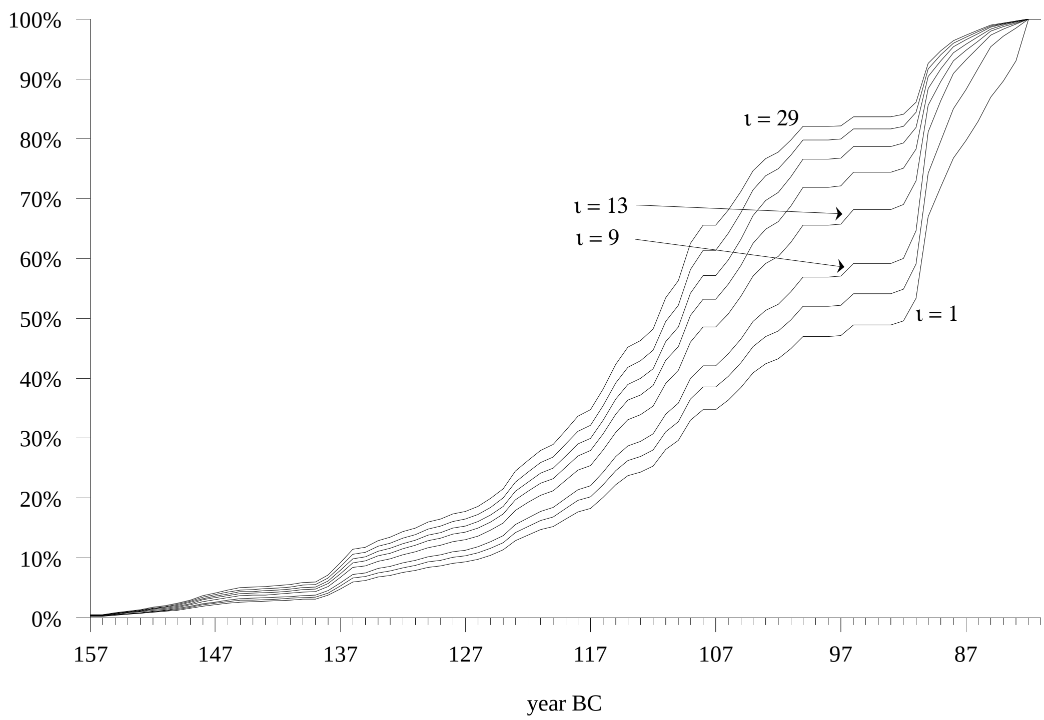


Figure 11.6: Simulated coin population for 82 BC using Crawford's RISC figures, $\delta = 2$ & $\iota = 1, 5, 9 \ldots 29$.

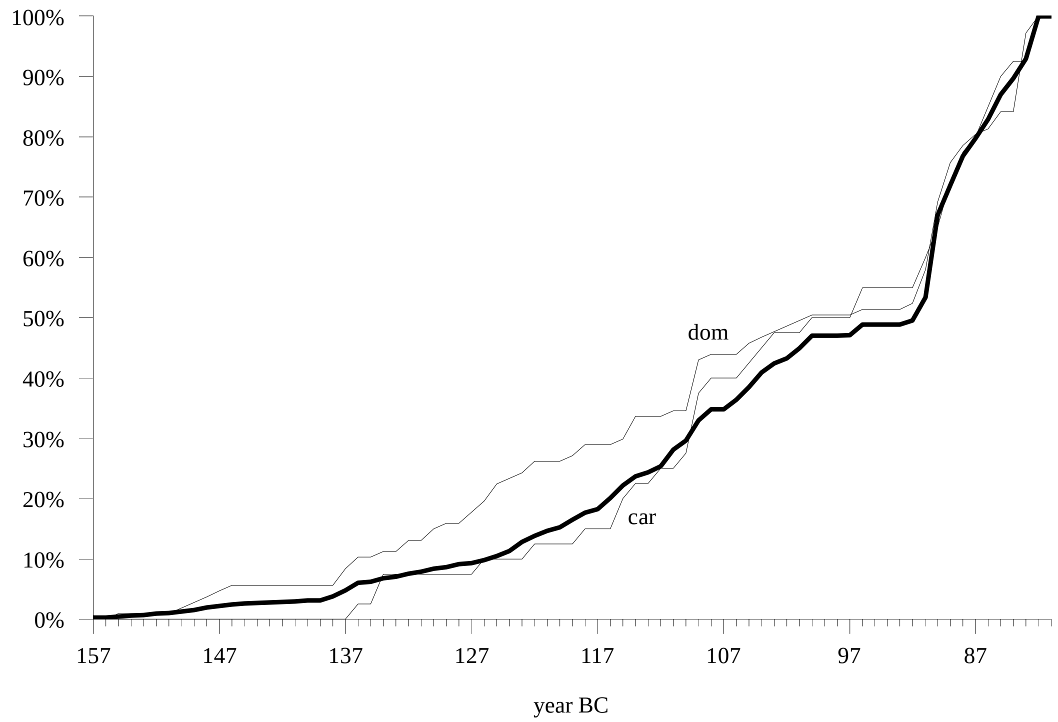


Figure 11.7: Two Italian hoards closing 82 BC compared to simulated coin population for 82 BC using Crawford's RISC figures, $\iota = 3; \delta = 2$.

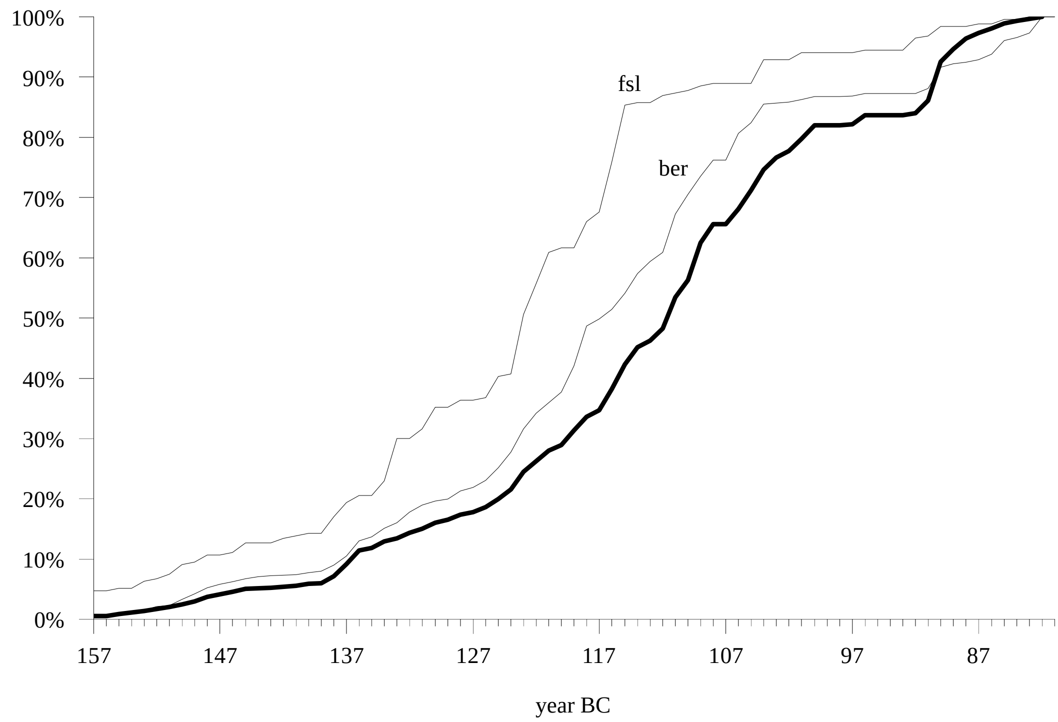


Figure 11.8: Two Italian hoards closing 83–2 BC compared to simulated coin population for 82 BC using Crawford's RISC figures, $\iota = 29; \delta = 2$.

in the final year, but with delay values above this a proportion of the issue would not have entered the population. If, for the sake of illustration, we say that 90 BC was of size 100κ, with $\iota = 9$ all coins have entered the population[15] by 82 BC but with $\iota = 13,\ \frac{4}{13}100\kappa = 30.8\kappa$ coins will not have entered the coinage pool, a difference of 69.2κ. However, if we use $\iota = 17,\ \frac{8}{17}100\kappa = 47.1\kappa$ will not have entered the pool, a difference of only 16.3κ. This effect will be true for all issues, whatever their size but is visible in the case of 90 BC due to its large size.

To explain the second point let us take a hypothetical issue of year Y_i and size 100κ. With an introduction delay of 1, 100κ coins enter the pool enter the coinage pool in year Y_i. With a delay of 2, $\frac{100\kappa}{\iota} = \frac{100\kappa}{2} = 50\kappa$ enter the pool in year Y_i, a difference of 50κ. For $\iota = 3,\ 33\frac{1}{3}\kappa$ coins enter the pool in year Y_i, a difference of $17\frac{2}{3}$. Continuing this sequence we can see that with $\iota = 25,\ 4\kappa$ enter the pool in year Y_i compared to 3.45κ for $\iota = 29$, a difference of only 0.55κ.

There are, however, some problems with the modelling of the introduction delay. What, in reality, is this factor modelling? It is in fact a compound of three factors:

1. The distance between the local coinage pool and the point(s) where the coinage was released into the global coinage pool.
2. The speed of circulation.
3. A possible delay in the release of the coinage from the mint.

The last point is impossible to examine but it seems inherently unlikely that there would have been much delay. The second point, which although important between periods, is unlikely to account for many problems in this context. It is the first point which is likely to be the main cause of the inter-hoard variability we are trying to model. However, by varying ι in the simulations above, we are modelling the three factors listed by varying the inherently unlikely third factor, delay in release from the mint. There are three areas where the simulation model departs from reality and thus fails to produce population curves which can account for observed patterns.

Firstly, the model presumes that the distance between release and collection points, and thus the delay ι, is a constant. In reality, it would seem unlikely that every new issue would be released in an identical location and, perhaps more importantly, that secondary exchanges or movements of coinage would also form an identical flow. It is more likely that within individual local coinage pools, the introduction delay for each coinage is likely to be different. With local pools a long way from the main areas of release and circulation this variation will have a minor effect, but within the main area, and in a period of large issues, this variation can have substantial and observable effects and is likely to be the explanation for the differences between Bellicello, Cervia and Capalbio.

The second problem concerns the effect of the interaction of the introduction delay and decay rates. The problem is that in, for example, the simulations for 82 BC, the number of coins minted in 90 BC in circulation in 82 BC rises as ι increases from 1 to 9. This is because the only the fraction of the coinage released into the pool in each year is decaying. In reality, it is likely that all the

[15] Note that as soon as a batch of coinage enters circulation, it is subject to decay. In this example, coins of 90 BC which entered the pool in that year would have been subject to 8 years of decay by 82 BC, coins of 90 entering the pool in 89 to 7 years and so on.

coins were released in one year, but only a fraction arrives in the local pool. We could model this by reducing the total number of coins by δ at each stage, not just the coins that have already been released.

The last problem is that we cannot generate with the present model populations which exhibit profiles as 'modern' as hoards with modern profiles. This can be seen in Fig. 11.5 and was noted in the original hoard simulation where the simulated hoards with an introduction delay of 1 where not as modern as the Fiesole (FIE) hoard (Lockyear 1991, p. 199 & Fig. 28.13). Fig. 11.9 shows the profiles of the Alife and 'Italy' hoards (ALI & CAH) from data set `fin92.dat`, along with the population curve for 87 BC, $\delta = 2; \iota = 1$. These hoards have an exceptionally modern profile due to the large issues of 90–88 BC; the population curve is considerably more archaic. Again, this can be explained by the poor modelling of ι. If we take figures from the $\delta = 2; \iota = 1$ simulation, approximately 9446κ coins are in circulation in 91 BC. The issues of the next four years total, using Crawford's figures, 4481κ. Under the current model, the largest proportion of the coinage pool that years 90–87 can form is 32%. This, however, is the largest proportion these coins can form in the *global* coinage pool. In reality, the existing population of 9446κ coins is spread out across the circulation area (Italy, parts of Spain and the former Yugoslavia *etc.*) whereas the new coinage will be released in a very limited area. Even if they were released over 10% of the circulation area, they would form 82% of the local coinage pools. Coins from 90–87 BC formed 72% of the Alife hoard and 55% of the 'Italy' hoard.

It would be possible to improve the modelling of the introduction delay but seems unlikely that anything new would be learnt from doing this. The failings of the model have in themselves revealed the above aspects of the circulation system and further programming is unnecessary.

11.2.7 Testing the regression-based RISC figures

The last item to be tested is whether the RISC figures derived from the regression analysis of Lockyear (1989, section 2.3) are an improvement on those of Crawford. Lockyear argued that the rather strange (to a statistician's eyes) method by which the multiplication ratios were derived by Crawford may be improved by using regression analysis but at the time had no possibility to test the results. Here, we can test these figures by generating populations using Lockyear's RISC figures and comparing them to real hoards used in the above analyses and seeing if the fit, as measured by Dsum, is improved. Populations were generated using Lockyear's RISC figures, $\delta = 2; \iota = 1$ and $\iota = 3$.

The results of these simulations are presented in Table 11.6 and Fig. 11.10. As can be seen from the table, the populations generated by the regression analysis have a better fit to only two of the 100 BC hoards, Cerignola and Imola. In every other case, Crawford's RISC figures produce 'better' coin populations. Fig. 11.10 shows, however, that the differences between the regression based RISC figures and Crawford's are in fact minimal. The details of both sets of RISC figures are given in Appendix C along with the dBASE program code. It would be perhaps better to have fitted some form of polynomial curve to the known die-count/hoard find ratios but given the relatively small number of points (*cf.* Lockyear 1989, Fig. 1.2 & 2.9) the validity of this could be questioned.[16]

[16]Crawford uses 20 issues to create his ratios between 'known' die counts and the number of specimens over 24 hoards

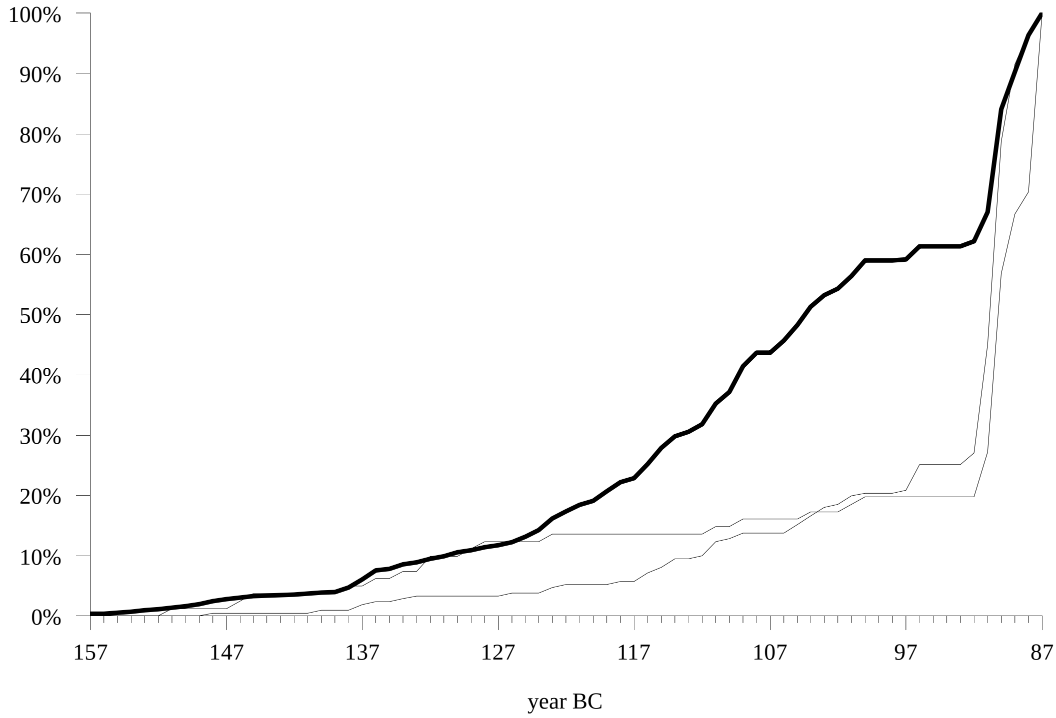


Figure 11.9: Alife and 'Italy' hoards (ALI & CAH) compared to simulated coin population for 87 BC using Crawford's RISC figures, $\iota = 1; \delta = 2$.

11.3 Implications and conclusions

Firstly, I wish to sound some notes of caution. The results presented above *do not* prove that Crawford's die estimates, or RISC figures as I prefer to call them, are accurate. In each individual case they are highly unlikely to be accurate, and in some cases they are likely to be very inaccurate. However, it would seem that the inaccuracies balance each other out over the whole series, as might be expected if they are simple random errors. I have also deliberately censored the 'very large number' I used as a nominal figure for 'coins struck per die.' I would argue that the above demonstrates that the use of a constant, *within a homogenous series of issues,* is a valid procedure, *contra* Buttrey (1993, pp. 343–8) and Howgego (1992, pp. 2–4). What this constant is, in the case of these issues at least, is yet unknown. I would also argue that although the decay rate can be assumed to be variable, again this generally evens out over a long period of time, and that this figure should lie, *in this period and for this coinage,* at most somewhere between 0.5 and 5%, but generally averaging at *c.* 2%. There is slight evidence, which could be investigated further, that it was less than 2% before *c.* 100 BC, which in itself could be interesting and will be discussed below. What cannot be done is:

1. Assume 2% is a constant for all periods and places.

2. Assume that the 'very large number' is a constant for all periods and all places.

3. Compare sizes of issues of different types of coins, *e.g., aurei* and *denarii*, or of coins minted in different places or periods.

(Crawford 1974, pp. 672–3). Ten of these are, however, estimated in some way and the regression analysis used only 10 issues. In reality, this is far too few points — as a rule of thumb one would normally hope for at least 30 points.

Date BC	Hoard	ι	δ	Dsum ρ = Lockyear	Dsum ρ = Crawford
100	CG2	1	2	1.968	2.166
100	IMO	1	2	1.011	2.345
100	PAT	1	2	4.877	2.407
87	CAR	3	2	3.644	1.859
87	DOM	3	2	4.738	3.189
72	OSS	1	2	2.272	1.556
72	VPT	1	2	2.327	1.335
50	BRA	1	2	4.020	2.006
50	CAS	1	2	4.424	2.246
50	TR2	1	2	7.685	5.281

Table 11.6: Results of simulations using Lockyear's and Crawford's RISC figures compared. The figures given are the Dsum similarities between the simulated population and the hoards.

The importance of this study lies beyond the confirmation of the validity of various estimates and techniques to the uses to which the figures have been put. There are two major debates in which these figures have been used.

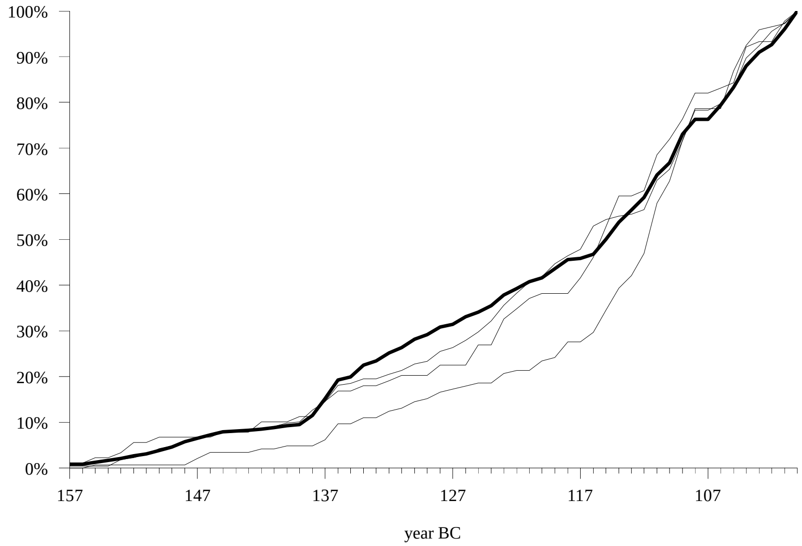
The first debate is Crawford's contention that Rome only struck coinage in order to make payments and did not care for the wider economic function of coinage:

> . . . It is also said that coined money had in the ancient world an economic reason for existence. Neither statement is true. Coinage was probably invented so that a large number of state payments could be made in a convenient form and there is no reason to suppose that it was ever issued by Rome for any other purpose than to enable the state to make payments, that is, for financial reasons. (Crawford 1970, p. 46)

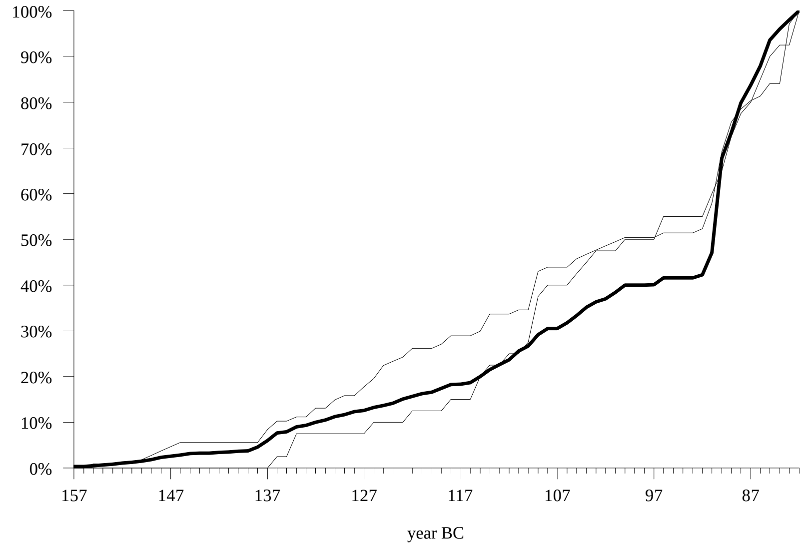
The estimation of the size of the Republican coinage was an attempt to demonstrate this by correlating the size of issues with military expenditure (Crawford 1974, pp. 633–707). The correlation was criticised on many counts, including both the estimates of the coinage and of the size of military expenditure (see especially Mattingly 1977). This argument has subsequently been attacked by a number of authors most notably Lo Cascio (1981) and Howgego (1990, 1992); the argument has been summarised by Greene (1986, p. 50). In some ways the debate is paralleled by the Keynesian *v.* monetarist debate in economics discussed by Hart (1986). Such polarised debates, such as the substantavist-formalist debate discussed in Chapter 2, rapidly become stale and unproductive and Hart attempts to provide a more fruitful line of research which would be useful in this case. The simulation studies above, cannot contribute to this debate in any great degree as the *absolute* size of the issues is unknown, only their relative sizes, and Crawford's figures for military expenditure are also in doubt.

It is Hopkins' (1980) use of the figures which can be more constructively examined. It is Hopkins' fifth proposition which we can examine and test; it states:

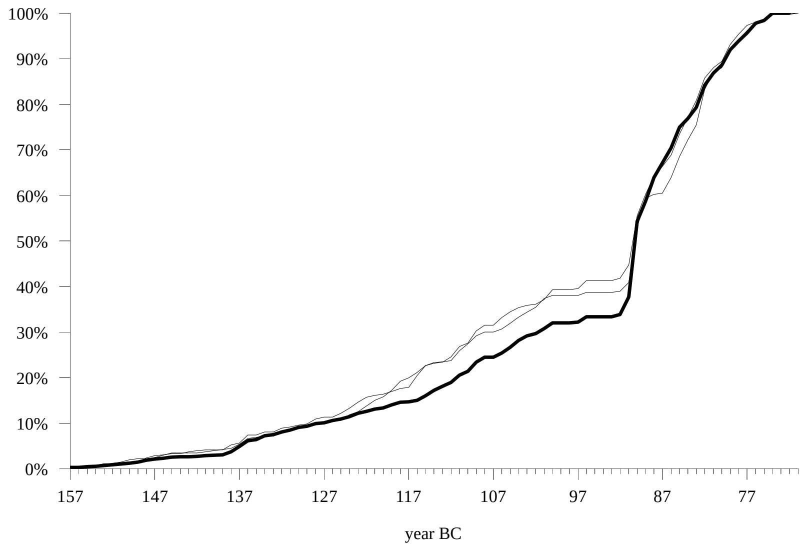
> Proposition 5 states that the supply of Roman silver coins increased enormously, perhaps tenfold, during a single century of the late Republic (157–50 BC). (Hopkins 1980, p. 106)



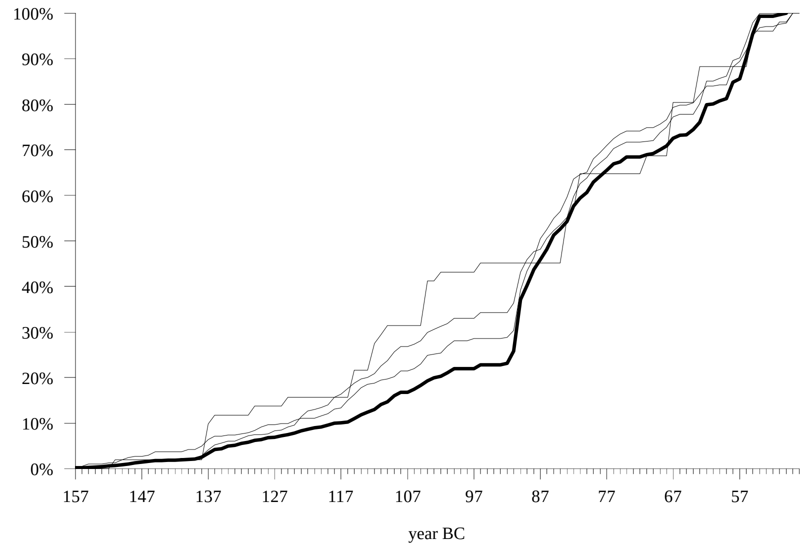
(a) 100 BC, CG2, IMO & PAT *v.* $\delta = 2; \iota = 1$



(b) 82 BC, CAR & DOM *v.* $\delta = 2; \iota = 3$



(c) 72 BC, OSS & VPT *v.* $\delta = 2; \iota = 1$



(d) 50 BC, CAS, BRA & TR2 *v.* $\delta = 2; \iota = 1$

Figure 11.10: Results of simulations using Lockyear's RISC figures derived from regression analysis compared to hoards used in previous simulations.

Hopkins goes on to show how he calculated the figures to produce his famous graph (Fig. 2, p. 109) reproduced by Crawford (1985, Fig. 65, p. 176). Although using the much criticised figure of 30,000 coins per die, he goes on to say:

> However, it is worth stressing that the credibility of Figure 2 no way depends on the acceptance of this average number. Providing that we accept that the average number of coins struck per die was roughly stable throughout the period 157–50 BC, then we can regard Figure 2 as being drawn on a ratio scale, with the exact values on the vertical scale being unknown. It is enough to say that, in this period, the volume of the Roman silver coinage in circulation rose over tenfold. (Hopkins 1980, p. 107)

Hopkins then introduces the controversial figure for the decay ('loss') rate of 2%, deriving this figure from (Patterson 1972). However, Hopkins does go on to say:

> Alternative rates of loss, 1 per cent per year or 3 per cent per year, even of 5 per cent per year, do not radically change the shape of the growth curve in Figure 2. (Hopkins 1980, p. 107, see also ftn. 21)

The last questionable assumption Hopkins admits concerns the size of the coinage stock in circulation at the beginning of the period he is examining. Again, he regards this as relatively unimportant as the number of *denarii* already in circulation would have halved in 35 years. The most questionable assumption that Hopkins makes, however, is not acknowledged by him, and that is that Crawford's die estimates had any validity in the first place.

In the above analyses, I have clearly shown that although Crawford's figures are unlikely to correct in detail, they are correct in their general trends. Buttrey's (1993, pp. 336-8) criticism that he has not included the decay rate in his estimates is not valid — a major adjustment of the die estimates suggested by Buttrey would result in coin populations very different from those that the hoards were evidently selected from.

We are now in a position to examine the effect of varying the decay rate (δ) on the Hopkins graph. Fig. 11.11 shows the total numbers of coins in circulation over time generated using Crawford's RISC figures, $\iota = 1$ and $\delta = 0.5, 1, 2, 3, 4, 5$ & 7.5. This graph does not include coinage minted before 157 BC. We can see that there is, in fact, quite a large difference from one population to the next. With a 0.5% decay rate the quantity of coinage in circulation rises by fourteen-fold from 140 to 50 BC; with a 2% decay rate it rises by eight and three-quarters. However, in the least likely scenario (based on the results above) of a decay rate of 5%, the coinage pool grows only four and half-fold between 140 and 50 BC. This, however, makes no allowance for coinage minted from before 157 BC. An adjustment can be made by calculating the percentage of pre-157 coins in real hoards and using this as a correction factor. Hoards of *c.* 140 BC contain a median of *c.* 14%, hoards of 74 BC *c.* 2% and hoards of *c.* 50 BC *c.* 1%. Using these correction figures we get a twelve-fold increase if the decay rate is 0.5%, a seven and a half-fold increase at 2% but only a four-fold increase at 5%. The raw and adjusted figures are given in Table 11.7. Given the results of the various simulation studies presented above, it seems most likely that the increase in the total coinage pool was between five- and ten-fold. Although this is a very wide range, it is at least an estimate which rests upon firm foundations, and is considerably more than Buttrey would allow.

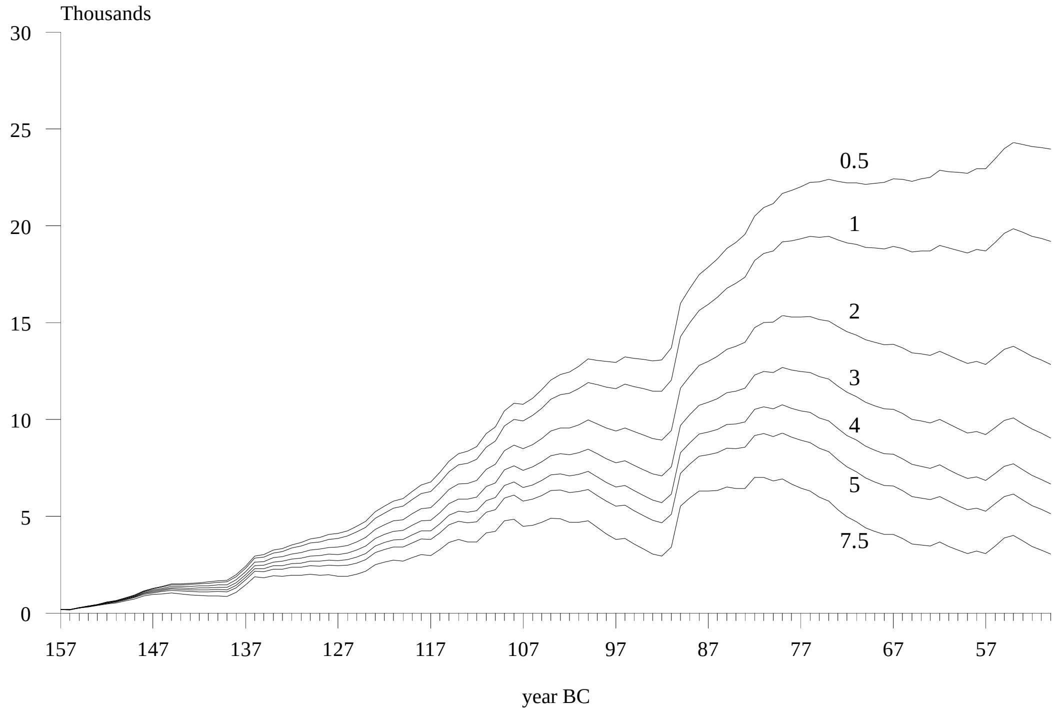


Figure 11.11: Total numbers of *denarii* in circulation expressed in κ units. Figures generated using Crawford's RISC figures, $\iota = 1; \delta = 0.5, 1, 2, 3, 4, 5,$ & 7.5.

year	0.5δ	1δ	2δ	3δ	4δ	5δ	7.5δ
unadjusted							
157	187	187	187	187	187	187	187
140	1683	1606	1466	1339	1225	1122	906
74	22400	19463	15095	12082	9929	8338	5779
50	23952	19189	12837	9042	6670	5124	3054
increase 140–50							
	14.2	11.9	8.75	6.75	5.5	4.6	3.4
adjusted							
140	1957	1867	1705	1557	1424	1305	1053
74	22857	19860	15403	12329	10132	8508	5896
50	24194	19383	12967	9133	6737	5176	3085
increase 140–50							
	12.4	10.4	7.6	5.9	4.7	4.0	2.9

Table 11.7: Total numbers of *denarii* in circulation generated by the simulation study using Crawford's RISC figures, $\iota = 1; \delta = 0.5, 1, 2, 3, 4, 5$ & 7.5. Totals are units of κ. Adjusted figures calculated by assessing proportion of pre-157 coinage in circulation in any one date. For example, in *c.* 140 BC, hoards generally contained 14% pre-157 coinage. Therefore the figure of 1683κ coins for $\delta = 0.5$ is adjusted by $(1683 \times 100)/86$ to give 1957κ coins in total. Figures for 74 BC adjusted by 2% and 50 BC by 1%.

There is a further possible use for the simulated coin populations: as a benchmark of the type that Creighton constructed for Imperial coin hoards from Britain. This would be a more consistent method than attempting to use the results of the cluster analysis but would still suffer from problems of interpretation due to the effects of a variable coinage supply discussed in Chapter 9. In this case, Dmax, *not* Dsum, between hoards and population curves could be used a a measure of modernity or archaicness. I am unsure, however, of the usefulness of a such a simplistic measurement, and would suggest that it be used in conjunction with the results of multivariate methods, not as a substitute.

This chapter has concentrated on a primarily numismatic problem, but one which has wider consequencies for the study of the Roman economy. Whether one accepts the conclusions drawn by Crawford and Hopkins or not, the viability and validity of the methods outlined cannot now be denied. The origins of the anti-statistical/numerical stance taken by Howgego (1992, especially pp. 3–4) and Buttrey (1993, 1994) can be clearly seen in the misuse of statistical methods, but this misuse should not be cause of the rejection of methods wholesale. I hope that this thesis clearly demonstrates the falsity of Howgego's (1992, p. 3) assertion that:

> Quantification on the basis on coin finds is likewise of little help in determining the variations in the use of money between different regions or different periods.

To draw valid conclusions from coin data one *must* have a large data set in order that regional and temporal patterns can be seen above random variations in hoard composition. The only viable way to handle such large data sets is with the use of statistical and numerical methods.

Chapter 12

Summary and Conclusions from Part II

12.1 Introduction

This chapter presents a brief overview of the major conclusions reached in this Part. The conclusions are divided into the three categories outlined in Chapter 4

12.2 Computer-based and statistical methods

The time taken to design and construct the database in a relational format was amply rewarded by the relative ease that information in a variety of formats could be extracted both for presentation as tables and graphs, and analysis via a variety of statistical packages. The system of data entry helped to minimise errors by providing a number of checks. The query code system proved efficient for present purposes although it did result in some minimal loss of information in the case of poorly identified issues. The usefulness of the CHRR database continues beyond the current project.

Cumulative percentage graphs were found to be an ideal way of comparing a small number of hoards — the patterns become confused if more than 10–12 hoards are plotted on a graph. It was often found useful to use the facilities of the plotting package in an exploratory fashion using colour to highlight certain hoards, or to examine groups by only plotting selected examples. The ability to explore data in this fashion is an unsung but important contribution of computers to data analysis.

Mass comparisons using significance tests were avoided for theoretical and practical reasons (page 146), although selected comparisons using the one- and two-sample Kolmogorov-Smirnov tests did provide useful extra information when necessary. The χ^2 test, Φ^2 and Yule's Q were only used in the analysis of the Spanish finds (page 255) as in all other situations the data being examined were ordinal. The χ^2 and Kolmogorov-Smirnov tests were often strongly influenced by sample size. In some cases Φ^2 and Yule's Q (page 255) can be useful for the comparison of tables although their interpretation is not straightforward.

A variety of multivariate methods were used. Correspondence analysis proved to be extremely useful for examining and comparing hoards in detail. CA was compared empirically with principal components analysis and found to be a more suitable technique for analysing hoard data (section 8.2.5). A number of observations were made about the technique's behaviour especially in regard to the influence of unusual types or hoards (section 8.4.3). The ordinal nature of the data being examined allowed the plotting of line graphs of variable scores (*e.g.,* Fig. 9.2) — an innovative technique which was successful in highlighting aspects of hoard structure. A method was developed where a series of partial CAs were performed on a data set — a method only suitable for ordinal data (section 9.2). Although this method was unsuccessful in its primary aim it did highlight important aspects of the data. An extension of the method — detrended correspondence analysis — helped to identify aspects of hoard structure in some data sets but was often found to be unhelpful (section 10.5). It is recommended that the technique be used only in conjunction with ordinary CA.

Greenacre's method for testing the significance of an axis of inertia (page 160) was occasionally used and found to be a useful indicator. It is, however, uncertain how much this method is affected by the sparse tables which were common throughout most analyses (Orton, *pers. comm.*).

Cluster analysis (Chapter 10) was employed to enable global comparisons of the hoards relatively uninfluenced by unusual hoards or types. The use of Dmax, the maximum difference between two cumulative percentage curves, as a dissimilarity coefficient in conjunction with the average link agglomeration algorithm, produced results which were interpretable in archaeological terms and in agreement with the results of the CAs. Cluster analysis, at least in the form used here, does not give information about the variables which define each group. Here, the detailed CAs were of help in interpreting the results, along with the country of origin of the hoards and their closing dates. It is recommended, therefore, that cluster analysis is best run in addition to another data reduction technique such as CA, PCA or factor analysis. The aim of this cluster analysis was not to divide the hoards into unequivocal groups, but to divide up a continuum of variation on the grounds of the structure of the hoards, rather than external criteria. The archaeological conclusions discussed below are of some importance.

Principal co-ordinates analysis was performed to provide a check on the results of the cluster analysis (section 10.4). In this limited aim, the method proved to be useful. From a broader perspective, however, the technique is not very useful as it does not provide information regarding the variables (*cf.* CA and PCA), and does not always enable easy division into groups (*cf.* cluster analysis). The technique should only be employed when other methods are unsuitable.

The final computer-based method employed in this Part was computer simulation (Chapter 11). The simulation method employed was essentially similar to that developed previously (Lockyear 1989; Lockyear 1991), although the stochastic element had been removed. The aims were, however, substantially different — see below. In this case, the simulation was highly successful in addressing the problem. Simulation studies in archaeology have become increasingly complex in recent years (*e.g.,* Biskowski 1992) but this analysis shows that there is a place for simple simulations in addressing limited, specific problems.

This Part has conclusively shown the value of the systematic collection and analysis of large data sets in archaeology. Too often, broad conclusions have been drawn from small, inadequately analysed, data sets leading to erroneous conclusions which often reappear in secondary works as facts. All archaeological data has to be seen in a broad context, and an assessment made as to how significant that variation is. This can be most easily achieved using well designed and constructed databases and suitable statistical methods as this work, and the *Animal Bone Metrical Archive Project* at Southampton (Isles, *pers. comm.*), have clearly demonstrated.

12.3 Contribution to numismatics

Four questions of direct interest to numismatists were posed. The first was: could the speed of circulation of coinage be estimated from the hoard data? Chapter 9 addressed this problem and concluded that, as yet, no method has been devised which can produce useful results. The CAs performed in Chapter 8 suggest that coin circulation was faster in the 40s–30s BC than in the 80s BC. This is, however, only suggested by the analyses and is impossible to directly substantiate.

Questions two and three, the value of the decay rate and the validity of Crawford's die estimates, were addressed by computer simulation in Chapter 11. The analyses were very successful showing that the decay rate was between 1–3% *per annum*, and that for most purposes, 2% is an acceptable average. Crawford's die estimates for any issue are wrong. However, the errors over the series tend to cancel each other out and if used in a general way to show the pattern of minting, and the growth of the coinage pool, the estimates are acceptable. Multiplication by 30,000 coins per die cannot be justified on the present evidence although multiplication by a constant is justified.

The last question, how valid are Buttrey's criticisms, is partly answered by the above (see also section 11.3). Buttrey, in a justified attempt to prevent the unthinking use of certain methods and figures, *e.g.*, 2% per annum decay rate, 30,000 coins per dies *etc.*, has rejected both the good and the bad wholesale. Most of his criticisms are entirely fair, but with care and thought, useful and interesting insights into aspects of monetary economies can be obtained as was demonstrated.

12.4 Archaeological conclusions

Chapters 8 and 10 successfully revealed spatial and temporal patterning in the data. For the first time we have an explicit and detailed picture of this variation for the period 150–2 BC. New hoards can now be seen in this context and their interpretation and discussion can be developed within a secure framework. The need for such a framework has long been acknowledged — Bahrfeldt, for example, discussed hoards in the context of other contemporary material (*e.g.*, Bahrfeldt 1901a). This work, however, has produced the most detailed and comprehensive picture, although much work remains to fill in gaps. The archaeological conclusions derived from this pattern are extensively discussed in sections 8.4 and 10.6. The Italian pattern, although unspectacular, is predictable with the observed inputs to the coinage pool having identifiable and explicable effects on the outputs. The Romanian pattern, seen against the Italian baseline, is somewhat different and will be discussed in detail in the following Part. The Iberian peninsula pattern in also somewhat different to the Italian and although some tentative conclusions have been reached this material requires further examination which is beyond the scope of this thesis.

The most important addition to our understanding of hoard formation processes was discussed in Chapter 9. It was shown that large inter-hoard variation at any one date can be caused by the pattern of minting, and that a simple correlation between variation and the speed of coin circulation is naïve and wrong.

Parts of Hopkins' (1980) model for the growth of the Roman coinage pool were tested (section 11.3). Although Hopkins appears to have underestimated the effect of certain parameters, his basic assertion that the Roman coinage pool grew substantially from 150–50 BC can be supported. This is, however, only one small part of his model and cannot, therefore, be used to confirm the whole.

This work has reinforced the fact that all archaeological data must be seen *in context*. The major weakness of the analyses presented so far is that many are divorced from their archaeological context — a situation which will be remedied in the Part III for the Romanian data. It does amply show the value of the collection of large *corpora* of data (Beck & Shennan 1991, pp. 11–12) which, although possibly leading to the 'fetishising [*sic.*] of the data' (Beck & Shennan 1991, p. 12), is an essential first step towards analysis and interpretation.

Part III

Coins in Context: Republican *denarii* from Romania

Chapter 13

Coins in context

13.1 Introduction

Thus far we have looked at the distribution of *denarii* in broad terms, and investigated various aspects of their production and supply. Basic mathematical modelling has helped us interpret patterning observed in the data and to identify aspects which cannot be simply explained by mathematical concepts such as sampling error. *Denarii* are not, however, merely numbers. They are objects which were valued and used by past peoples. So far we have looked at these objects in quite abstract terms for very good reasons — to observe patterns and to identify aspects of those patterns which are less archaeologically interesting. We now need to reverse this process and to put the *denarii* back into their archaeological and historical context, to put the flesh back on the bones.

To examine the detailed archaeological context of *denarii* over two centuries across the whole of Europe is too ambitious to be practical. A case study, examining the problems of *denarii* from the territory of modern Romania, was therefore chosen. There were several reasons.

- As has been noted on page 36, very large numbers of *denarii* have been found in this area dating to 200–100 years before the Roman conquest in Trajan's two Dacian wars (AD 101–2, 105–6; Crawford 1977a; Berciu 1981; Crawford 1985).

- There is excellent evidence for the copying of *denarii* at a scale, and in way, unknown from elsewhere (*e.g.*, Lupu 1967; Poenaru Bordea & Ştirbu 1971; Chiţescu 1980).

- There is a major disagreement between Romanian scholars, and the only western scholar who has recently examined the problem, over the significance of the *denarii*, and the scale and significance of the copies (Chiţescu 1980; 1981, *cf.* Crawford 1977a; 1980, 1985)

- The fall of Niculae Ceauşescu in December 1989, shortly before this project began, presented an opportunity for conducting original research on this topic which would have been impossible previously.

It quickly became obvious that putting the 'coins in context' has several levels of meaning. One can put the coins back into their archaeological and numismatic context. To do this obviously requires detailed knowledge of the literature. However, the literature makes little sense unless one understands the context in which it was written. Therefore, one needs to know a little about the academic, political and historical context of the texts, before one can start to assess the information they can provide. Recent theoretical perspectives in archaeology argue that *no* text can be divorced from the context in which it was written, and no interpretation is uninfluenced by the authors' circumstances. In the case of Romania, and presumably other former communist states, the influences were overt, and the consequences of ignoring them could be severe.

The rest of this chapter will therefore provide a thumbnail sketch of Romanian geography and political history. Following this, the main features of the Iron Age historical and archaeological evidence will be described with special reference to the sites found in south-western Transylvania. Finally, the main interpretations of the evidence for this period, and the influences under which they were made, will be reviewed. Chapter 14 will discuss the numismatic evidence in more detail and the problems which surround its interpretation including the problem of the copying of *denarii* and the ways in which it can be addressed, including metallurgical analyses. Chapter 15 summarises the relevant conclusions drawn from Part II and from Chapters 13–14, and then goes on to present an interpretation of the late Iron Age in Romania especially in regard to the numismatic evidence. This interpretation will also draw on the theoretical insights gained from Chapter 2.

Two criticisms of the choice of case study can be made. Firstly, Part II concentrated on Republican coinage from 150–2 BC. Such a stopping point makes no sense in the context of late Iron Age Dacia. This case study will therefore examine some evidence dating to the first century AD from Romania. Secondly, what relevance do the borders of modern Romania have for the late Iron Age? Obviously, very little. Certain aspects of the evidence are wholly contained within Romania — the Roman province of Dacia is contained within Romania. The practicalities of expanding the geographical scope, in terms of languages and academic and publication traditions, effectively preclude any such expansion here. It should always be borne in mind, however, that the patterns discussed may well continue into neighbouring regions. For the purposes of the rest of this Part, I define Dacia as the area which now constitutes Romania, the Republic of Moldova and the southern Black Sea region of the Ukraine. No ethnic, political or cultural meanings are intended or implied. Similarly, unless explicity noted the phrases 'Geto-Dacian' and 'Dacian' should be interpreted solely as conventional descriptive labels for various classes of late Iron Age material culture found in this region, and 'Geto-Dacians' and 'Dacians' as convenient labels for the late Iron Age populations of this area. In a similar fashion, certain object-names have been used in a descriptive way in order to maintain continuity with the Romanian names. For example, *fructiere* (Crişan 1969a, pp. 83–4, 126–131, 167–170) is translated as 'fruit-bowl' whereas the British ceramic tradition would probably call these vessels 'pedestal bowls'; *ceaşca dacică* (Crişan 1969a, pp. 153–160) is translated as 'Dacian cup' and refers to a distinctive type of rather coarse vessel which is almost certainly a sort of open lamp.

13.2 Romanian physical and political geography

The physical geography of Romania is dominated by the Carpathian mountains which form an almost triangular range in the centre of the country (Fig. 13.1). The largest mountains are in the southern range (*Carpaţii Meridionali*) with peaks of over 2,500m. The eastern Carpathians (*Carpaţii Orientali*) run roughly SSE–NNW running across the northern border into the Ukraine. This range has peaks up to 2,100m. There is a substantial break in the range in the NE of the country with two ranges of hills (*Dealurile Silvaniei* and *Dealurile Someşelor*). The western Carpathians (*Carpaţii Occidentali*) run southwards from these hills, connecting with the southern Carpathians in the south-west of Romania and continuing into the former Yugoslavia. The northernmost part of this range is known as the *Munţii Apuseni* with some peaks above 1,800m.

Contained within the mountains is the Transylvanian plateau (*Podişul Transilvaniei*) — a dissected zone of gently undulating hills. This area is drained by three main river systems. The river Olt drains the southernmost area, cutting a gorge through the centre of the Carpaţii Meridionali, flowing across the Danube plain and joining that river near Turnu Măgurele. The river Mureş runs westwards across central Transylvania and, along with the Tîrnava Mare and Tîrnava Mică which join it, drains a large proportion of the plateau. The Mureş crosses the Carpathians to the south of the Munţii Apuseni and flows westwards into Hungary where it joins the Tisza, itself a tributary of the Danube. The northern part of the plateau is drained by the river Someş which also flows westwards into the Tisza.

To the south of the Carpathians proper are the foothills (*Sub-Carpaţii*) and then the terraces and plain of the Danube (*Cîmpia România*). Much of the southern border of Romania is formed by the Danube which flows eastwards from the former Yugoslavia to the Black Sea. The border does cross the Danube, however, in the east where the river turns northwards before again turning west at Galaţi. As well as the Olt which crosses the plain as noted above, a number of other tributaries flow south from the Carpaţii Meridionali. The main rivers, from west to east, are the Jiu, the Olt, the Argeş, the Dîmboviţa (which flows through Bucureşti before joining the Argeş) and the Ialomiţa.

In the south-east of Romania, between the Danube and the Black Sea, is Dobrogea. This area is a dissected plateau, mainly between 100–200m., which forces the Danube to turn north before turning east into the Black Sea. The region of Dobrogea is currently divided between Romania and Bulgaria. The Danube delta, a large marshy region, lies at the north of Dobrogea.

The east and north east of Romania consists of the Moldavian plateau (*Podişul Moldovei*) which is drained by three major rivers, the Siret, the Prut and the Nistru. All three flow north-south, the first two joining the Danube, the Nistru flowing directly into the Black Sea. The area between the Prut and the Nistru, known as Bessarabia, is now in the Republic of Moldova. The whole of the this area is mainly rolling hills up to 450m. above sea level. To the south, the hills give way to the Cîmpia România.

The climate of Romania is one of extremes. The average January temperature is only above freezing on parts of the Black Sea coast. Temperatures of minus 34° have been recorded in the Danube Plain. Iaşi has had temperatures of minus 30°, and Cluj minus 32°. This contrasts with the average July temperatures of 23° in the Danube plain with maxima of 43–44°. Iaşi has had temperatures of 40° and Cluj 36°.

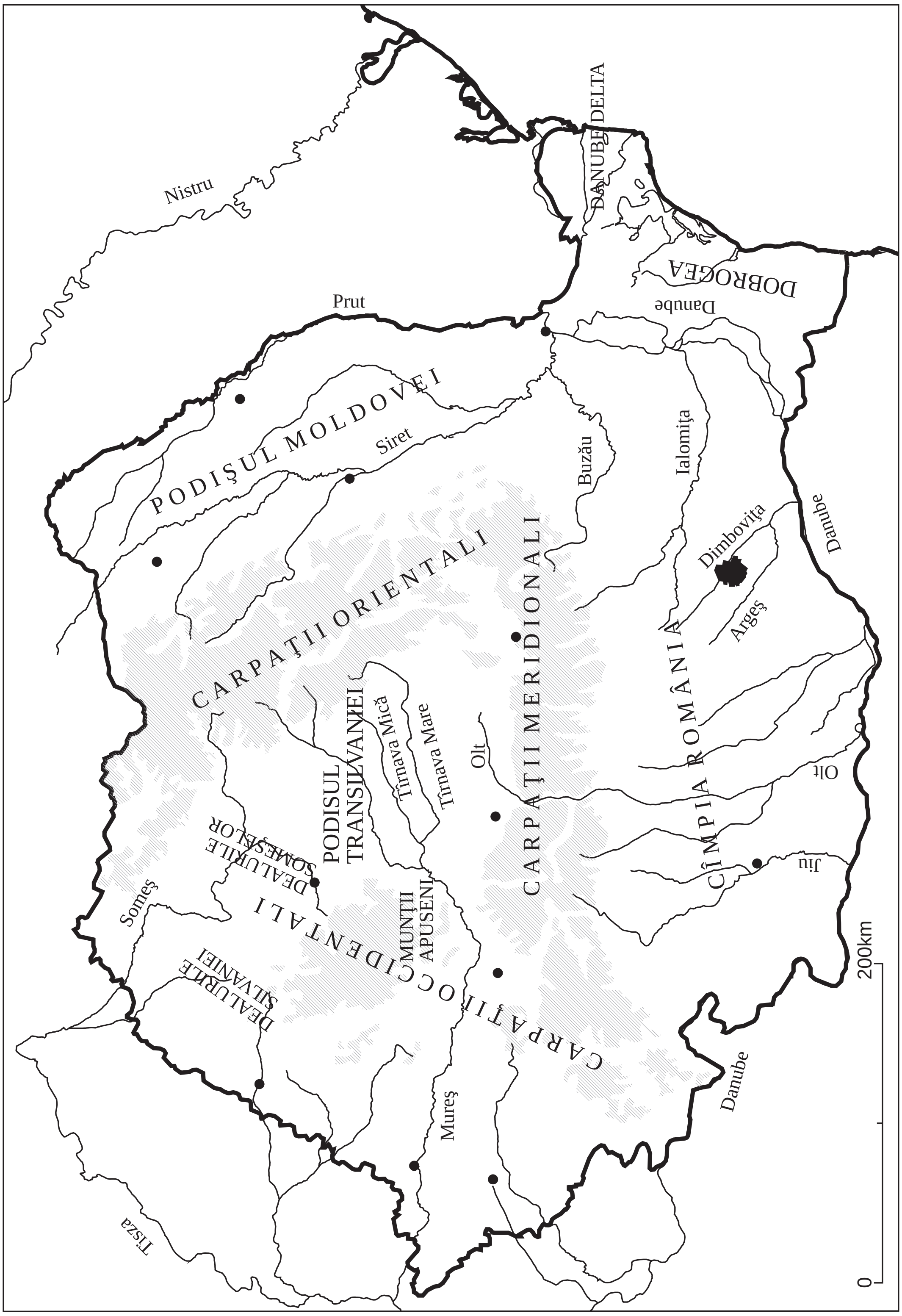


Figure 13.1: The physical geography of Romania.

The political history of Romania has been strongly influenced by the geography. The three Principalities which form modern Romania were Moldavia to the east of the Carpathians, Wallachia (or Ţara Romaneasca) to the south, and Transylvania within the Carpathian ring (Fig. 13.2). The Danube plain can be divided into Oltenia to the west and Muntenia to the east. The north of Moldavia, is known as Bucovina; the area to the far south-west forms part of the Banat which partly lies in the former Yugoslavia.

Prior to the Second World War the country was divided into a number of counties. After the war Romania lost some territory: part of Dobrogea went to Bulgaria and Moldavia east of the Prut went to the USSR. These were combined into larger regions under communist rule. However, shortly after coming to power, Ceauşescu created 39 counties and the municipality of Bucureşti. These counties are not identical to the earlier counties.

By far the largest city is Bucharest, the capital, lying in the Cîmpia România. Other important cities in south include the industrial centre of Craivoa in the west, and Galaţi, on the Danube, in the east. The capital of Moldavia, Iaşi, lies near the north-eastern border. Also in Moldavia, Suceava lies to the north in Bucovina, and Băcau is nearer to the mountains south of Iaşi. Transylvania has a number of important cities including Cluj to the north-west, Hunedoara, Sibiu and Braşov to the south. To the west of the mountains lie the cites of Timişoara, Arad and Oradea.

13.3 An outline of Romanian history

13.3.1 From the Romans to the Ottoman Empire

Pre-Roman history will be discussed below. The following, unless otherwise stated, is taken from Jelavich (1983).

The first part of the territory of modern Romania to be incorporated into the Roman Empire was Dobrogea, the area between the Danube and the Black Sea. This area has a history quite distinct from the rest of Romania being the only area subject to direct Greek colonisation in the form of city states on the coast (Radulescu & Bitoleanu 1984). The area was incorporated into the Empire by Marcus Licinius Crassus in 29–28 BC. Ovid was exiled to Tomis (modern Constanţa) from AD 9–17. The area was incorporated into the province of Moesia in AD 46.

The Dacian tribes continued to be a threat to the Roman Empire and eventually Trajan fought two wars (AD 101–2 and AD 105–6) against the Dacian tribes led by Decabulus, which led to the latter's defeat and the creation of the Dacian provinces. This province included the majority of Transylvania, the western part of the Danubian plain (Oltenia), and for an initial short period the eastern Danubian plain (Gudea 1979). Initially the area was divided between the provinces of *Moesia Inferior* and *Dacia*; then into *Dacia Superior* and *Dacia Inferior* under Hadrian (Gudea 1979, Figs. 2–3). In 167 AD the area was again reorgnaised into *Dacia Apulensis* and *Dacia Malvensis* (Gudea 1979, Fig. 4). The reasons for Trajan's invasion have been claimed to be strategic (Luttwak 1976; Gudea 1979) although whether the Empire's administration was capable of strategic planning on this scale has been disputed.

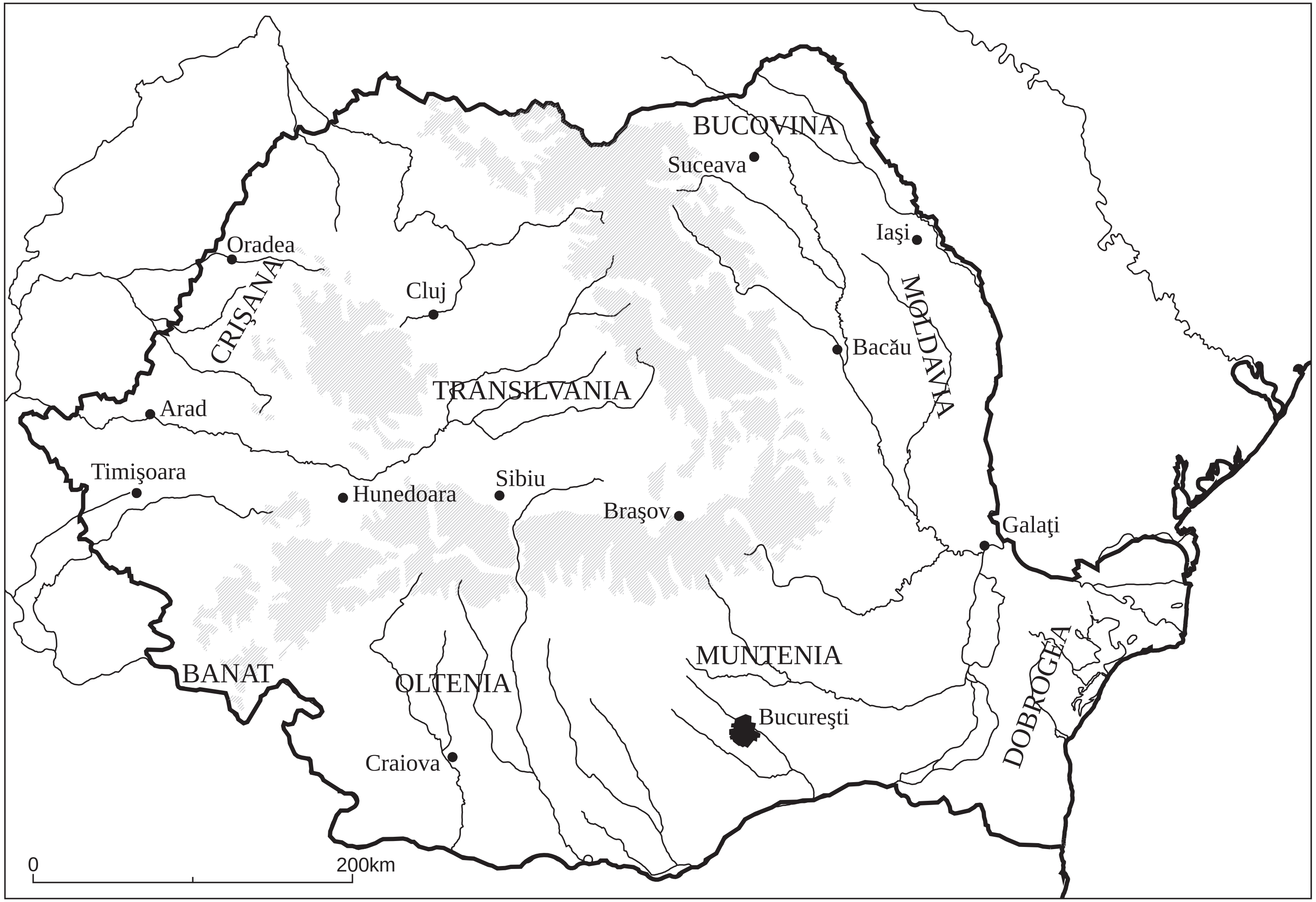


Figure 13.2: The political geography of Romania.

Dacia became a veritable fortress — Gudea lists 96 fortresses as part of Dacia's defensive system. Despite the fortifications the area was attacked on a number of occaisions. In the first few months of Hadrian's rule, Moesia (which then included Oltenia) was attacked by the Iazigii and the Roxolani; under Marcus Aurelius the area was again attacked by a coalition of tribes (Tudor 1958, p. 33). In 245 the Carpi succesfully penetrated the eastern defenses on the Danube plain and then attacked Transylvania via the valley of the Olt (Macrea & Tudor 1960). By AD 270 the situation was untenable and the provinces, apart from the Dobrogean part of Moesia, were abandoned by Aurelian.

Upon the division of the Roman Empire into East and West by Diocletian in 293, Dobrogea became the province of *Scythia Minor* (Radulescu & Bitoleanu 1984, p. 92). The province was defended by a series of large fortresses including Slava Rusa and Isaacea (Noviodunum).

The fate of the rest of the former Dacia is a matter of some controversy. The area was invaded succesively by the 'free Dacians', the Carpi, the Goths, the Huns, the Gepids, the Avars, the Slavs, and finally by the Bulgars and the Magyars (Jelavich 1983, pp. 9–13). The three invasions of possibly greatest long term significance were the Slavs, the Bulgars and the Magyars. The Slavs, having entered the Balkans in the 6th–7th centuries, settled widely especially in the area of modern Bulgaria and the former Yugoslavia. In some areas they appear to have become dominant with Slav languages becoming prevalent; in other areas, including Romania, they appear to have been assimilated and non-Slavic languages survive, *e.g.,* Romanian (p. 13–15).

The Bulgars originate from an area near the sea of Azov (p. 15). The were forced to migrate by the Khazars and originally settled near the mouth of the Danube. The Byzantine Empire failed to defeat the Bulgars and was forced to recognise this group as an independent power in AD 681 with its 'capital' at Pliska. The Bulgars ruled over a largely Slav population but by the ninth century both groups were assimilated, speaking a slavic language and adopting the Orthodox Christian faith (p. 15).

The Magyars (Hungarians) had migrated westwards along the Danube plain in the ninth century (p. 19). They were prevented from moving further westwards than the Pannonian Plain where they settled at the end of the ninth century. Their greatest ruler, Stephen, was crowned in AD 1000 and later canonised. The Hungarians were one of the few peoples in this region to adopt the Church of Rome, rather than the Orthodox faith. The future history of Hungary was closely associated with Croatia and the Romanian principalities. Hungary took possession of Transylvania in the 11th century. At the time it is probable that the population was mixed but basically Romanian (p. 20). Subsequently in the twelfth century, the Hungarians encouraged the settlement of the area by Szeklers, who were closely related to the Hungarians, and Germans (Saxons; p. 21). In areas of modern Transylvania, especially in the south, there is still a German speaking population, direct descendants of these 12th century settlers. Transylvania retained a large degree of autonomy.

For Moldavia and Wallachia we have very little historical information. Modern Romanian histories insist that there is continuity of settlement by the Daco-Roman population from 270 onwards, both in these areas and in Transylvania. It does appear that in the tenth century the population to the south and east of the Carpathians was speaking Romanian, a Romance language with a proportion of slavic words, they were Christian, used the slavonic religious service, and used the Cyrillic alphabet, as they continued to do until the 19th century (p. 21).

Romanian political development centred around two principalities, Moldavia and Wallachia (p. 21). They were both formed in the 14th century, the former under Basarab (1310–1365) who had his capital at Cîmpulung and then Argeş; the latter under Bogdan I (1359–1365). The *boyars*, the Romanian nobility, were always a problem, as were the nobles in the other Balkan states.

During the earlier part of this period (10th–13th centuries) a number of Empires were created and lost in the Balkans: the first Bulgarian Empire at its peak under Tsar Simeon (893–927), followed by a resurgence of the Byzantine Empire; Croatia under Zvonomir (1075–1089); the second Bulgarian Empire at its peak under Tsar John Asen II (1218–1241); the Serbian Empire, founded by Stephen Nemanja I (*c.* 1168–1196), was at its peak under his descendant Stephen Dušan (1331–1335) and so on. All these states suffered from the same problem: without strong and charismatic leadership they quickly disintergrated. The only state with any continuity was that of Byzantium although her fortunes waxed and waned. Byzantium, the direct descendant of the Roman Empire, was the centre of the Orthodox church. Despite attempts at reconciliation, the Church of Rome and the Orthodox church continued to disagree until in 1054 they excommunicated each other.

In 1071 Byzantium was defeated by the muslim Turks at the Battle of Manzikert. This resulted in large areas, formally Christian, coming under Islam and led to the Crusades. Although nominally fought with a religious motive, it also provided the oppotunity for western Knights to found Kingdoms in the east. During the 12th century Byzantium also came into conflict with Venice over trade. Venice managed to persuade the Fourth Crusade to attack Byzantium which fell in 1204. Her territories were divided into a number of Kingdoms, some of which lasted for a considerable time. Byzantium was reinstated in 1261 with greatly reduced territory, but was never as strong again. During the period of rule by the western Knights, the Orthodox population was often persecuted and a hatred of the ‘Franks’ became deep rooted.

This period is of importance for the whole future history of this area. Firstly, these early medieval states became the origin of the later nation states of the 19th and 20th centuries. As noted above, however, the boundaries of these early states were never fixed but fluctuated greatly, often due to intrigue within the noble classes. In defining the borders of future nation states, each has looked back to its past and their greatest extent leading, inevitably, to conflict over territory. The second major development in the early medieval is the division between the eastern and western churches, roughly along the border between the Eastern and Western Roman Empires: the Romanian principalities and Bulgaria were Orthodox, the Croats and the Hungarians Catholics. This division is reflected in many areas including architecture, literature and use of the Roman or Cyrillic scripts.

13.3.2 The region under the Ottoman Empire

From the seventh century onwards the Arabs were a threat to the area but especially to Byzantium. At the end of the 13th century a new group, the Ottoman Turks from north-western Anatolia grew in strength. They are named after their first powerful ruler Osman or Othman (1290–1326). Their expansion was rapid: they took Gallipoli in 1354. Conditions in western Europe at this time were in their favour: the Black Death, the Hundred Years War and the continuing conflict between Venice and Genoa meant that western Europe was too preoccupied to tackle the growing threat. Byzantium had never recovered from her defeat at the hands of the Fourth Crusade. The Ottoman Empire made rapid advances under a series of able sultans. Murad I (1360–1389) defeated the Serbs, Bulgars and Macedonians at the battle of the Maritsa River in 1371 and the battle of Kosovo Polje in 1389. Bayezid the Thunderbolt (1389–1402) captured the Bulgarian capital Tŭrnovo in 1393 and made Mircea the Old of Wallachia a vassal. From 1403–1413 the Ottoman state was divided by civil war but the next two sultans, Mehmed I (1413–1421) and Murad II (1421–1451) restored the situation. The next sultan, Mehmed the Conqueror (1444–6, 1451–1481) is justly famous as the captor of Constantinople in 1453 which marks the final end of the Roman Empire. He also conquered Bosnia in 1463 and Hercegovina in 1482. The Ottoman Empire reached its greatest extent under Suleiman the Magnificent (1520–1566) during which period western Europe lacked any coherant policy towards the Ottomans, *e.g.,* the French encouraged them to attack the Habsburg Empire. Suleiman captured Belgrade in 1521 and defeated the King Louis II of Hungary in 1526 at the Battle of Mohács. Much Hungarian land fell to the Ottomans including Transylvania, although the province remained part of the Habsburg Empire after the accession of Ferdinand when it gained many rights and often behaved like an independent state. Suleiman was eventually stopped at the Battle of Vienna in 1529.

Wallachia had fallen under Ottoman suzerainty at the end of the 14th century, and Moldavia had fallen at the end of the 15th, but Ottoman authority was constantly challenged. The Romanian princes who continued to rule this area had to contend not only with the Ottomans, but also with the ambitions of Poland, Hungary and her other neighbours and this led to a complex political situation. This was further complicated by the fact that the princes were elected to their posts by the nobility, the boyars, who were not adverse to co-operating with anyone for a short-term gain. In this period, Ştefan cel Mare of Moldavia (Stephen the Great, ruled 1457–1504) managed to briefly unite Wallachia and Moldavia, whilst Mihai Viteazul of Wallachia (Michael the Brave, ruled 1593–1601) managed to unite all three principalities from 1600 until he was assassinated in 1601. The territory which was to become Romania in 1919–20 had thus only been united for a single year previously.

The Ottoman Empire reached its greatest extent when it besieged Vienna in 1683, but thereafter the other European states banded together and attacted the Ottomans with some success. The watershed was the Treaty of Karlowitz (1699) which involved the Ottoman Empire, Poland, Venice and Austria, under the terms of which Austria gained Transylvania and parts of Hungary amongst other possessions.

Up until the beginning of the 18th century, the Principalities maintained a degree of autonomy with the Porte preferring the keep them as a buffer zone between themselves and the other Great Powers, primarily Russia and the Habsburgs, and as a source of revenue. The threefold division of power between the princes, the boyars and the Porte created problems. The princes often courted help from Russia, and both Constantine Brîncoveanu (1688–1714) of Moldavia and Dimitrie Cantemir (1710–1711) rebelled against the Porte and were defeated, the latter fleeing to Russia and the former being beheaded. The Porte, worried about stability in the area, then decided to sell the post of Prince to Greek Phanariots. The Phanariots, Orthodox christians who had gained much wealth through trade, occupied many important posts in the Empire but paid high prices for them, prices they attempted to recoup by exploitation of the Principalities. A strong resentment grew both amongst the boyars for their lack of access to power, and the serfs as a result of the harsh taxes from which the boyars were exempt. This burden on the serfs was increased as a result of the constant wars between the Ottomans and the other Great Powers, primarily Austria and Russia, six of which involved fighting in the Principalities in the period 1711–1812. Many serfs fled the land which led to a meeting of boyars in 1746 to address the problem. They decreed that any serfs returning to the land would be given their freedom. This led to a widespread flight from the land until, shortly after, all serfs were freed.

During the 18th century Russian influence in the area steadily grew, with the treaty of Kuchuk Kainarji in 1774 marking an important advance. Catherine the Great and Joseph II of Austria plotted the division of the Ottoman Empire and the creation of a new state of 'Dacia.' Between 1782 and 1802 Russia, the Habsburg Empire, France and England sent consuls both to Iaşi and Bucharest which became centres of European intrigue. During the Napoleanic wars Wallachia and Moldavia fell into a state of near anarchy. Under the terms of the Treaty of Bucharest (1812) Moldavia was partioned along the line of the Prut with Bessarabia going to Russia.

The situation in Transylvania was somewhat different. After the conquest of the area by the Ottomans in the 16th century, Transylvanian princes conducted an independent foreign policy. However, power was denied to the Romanian population. By the end of the 16th century there were three recognised nations (Hungarians, Szeklers and Saxons), and four religions (Calvinist, Catholic, Lutheran and Uniate) within the region. These groups had highly priviledged positions — Romanians formed less than 1% of the nobility despite forming a majority of the population. Most of the orthodox Romanians were enserfed peasants working on land belonging to other groups. In 1699 the area was ceeded to Austria. Attempts to reform and improve the situation of the serfs by the central Austrian administration under Maria Theresa and Joseph II were strongly opposed by the local nobles. This eventually led to the peasant revolt led by Horia, Cloşca and Crişan in 1784, which was forcibly suppressed but led to the abolition of serfdom in 1785. Joseph II did, however, improve the position of the Romanian population by removing the special priviledges of the Saxons, introducing greater religious freedoms, and reforming the administration. Many of his reforms were, however, revoked upon his death in 1790.

During the 18th century, however, there was a growth in the Romanian Transylvanian intelligensia. In 1791 they composed a petition, the *Supplex Libellus Valachorum*, which was sent to Leopold II. In this they restated their claim that the Romanians were of Roman origin and had equal rights with the Hungarians and Saxons until the 15th century.

During the latter 18th and 19th centuries there was a growth in 'national consciousness' and nationalism in Transylvania and the Principalities, and a large scale cultural revival (Verdery 1988). The nationalist groups had, however, very different aims. In the Principalities the prime aim was independence and self-rule; in Transylvania the aim was equality with the other 'nations' in the region.

The success or otherwise of the resistance to Ottoman rule, was often, however, dependent on the Great Powers who had a vested interest in maintaining the balance of power in the region. For example, Great Britain was very concerned not to allow the Russians to gain too much power. The Serbs were the first group to successfully obtain a semiautonomous state. In 1821, simulataneous rebellions occurred in Moldavia, Wallachia and Greece. Those in the Romanian Principalities were led by Tudor Vladimirescu, but they became primarily a peasant revolt against the boyars rather than a nationalist movement. Although defeated, the 1821 revolution did lead to the end of Phanariot rule in the region, although at the expense of greatly increased Russian influence. From the end of the revolution to 1834 the Principalities remained under Russian military rule. In this period the Organic Statutes, detailed administrative regulations, were drawn up and issued in Wallachia in 1831, and Moldavia in 1832. This statutes were wide-ranging and regularised many aspects of the administration and the law. Particularly important was the clarification of land-ownership.

In 1848 a wave of revolutions occurred in Europe starting in Paris. In the Principalities a small uprising occurred in Iaşi with little result, and a larger, more serious uprising occurred in Bucharest. The latter was put down by Russian and Ottoman forces, although the leaders escaped and were to constitute an important group in later events.

The Crimean War (1853–6), fought ostensibly over the issue of the protection of Orthodox Christians within the Ottoman Empire, led initially to the Russian occupation of the Principalities, but the Treaty of Paris led to the end of Russia's protectorate, the return of parts of Bessarabia to Moldavia, and the end of the Organic Statutes. Of more significance was the creation of new constitutions for both Moldavia and Wallachia. Nationalists had called for the unification of the provinces, but the Great Powers resisted these calls, only to find that Al. I. Cuza was elected to be prince by both provinces in the winter of 1858–9. Cuza found it difficult, however, to maintain control over two assemblies and managed to persuade the Great Powers to allow the unification of them during his lifetime. He continued to face problems with the boyar nobles who dominated the assembly until in May 1864 he solved the problem by a coup d'état.

Following this coup, his minister Mihail Kogălniceanu introduced agrarian reforms with the aim of creating a prosperous class of peasant farmers. This class did not appear as the land-holdings allotted to the peasants were too small, and the boyars obtained control of forests and pastures previously regarded as common land. The law had the opposite result to that intended with the boyars position improving. As well as agrarian reform, other reforms were put in place of which the creation of an educational system including universities was important.

Cuza was, however, unpopular and was deposed in a peaceful coup in 1866. A regency was set up which sought a foreign prince, eventually finding a willing candidate in Carol of Hohenzollern-Sigmaringen who ascended to the throne in 1866, and promptly implemented a new constitution. Carol actively sought a final separation from the Ottoman Empire, but was depressed by the continual intrigues which surrounded him. The Franco-Prussian war of 1870–1 almost led to his abdication.

Meanwhile, the position of Transylvania was closely tied to the situation within the Habsburg Empire as a whole. Attempts to centralise the administration were strongly resisted by the local nobilities, especially within the Hungarian crown-lands. Problems in Italy and Germany led to the Habsburgs needing stability in Hungary, and thus conceding to some of the demands made. The revolutions of 1848–9 strongly affected the Habsburg Empire, particularly Hungary which formed an independent administration which was only defeated when the Russian army came to the aid of the Habsburgs. Following the defeat of the Hungarians, the central administration attempted to impose centralised rule. The defeat of the Habsburgs in Italy in 1859–60, however, led to the end of the Bach regime and the issuance of the October Diploma of 1860 which reinstated the revolutionary constitution of 1848, but was quickly reversed by the February Patent of 1861. The Hungarians were not to be defeated and eventually won a major victory in the *Ausgleich* (compromise) of 1867 which led to the creation of Austria-Hungary. The Ausgliech had disasterous consequences for Romanian nationalism in Transylvania as the province was included as part of the unified Kingdom of Hungary. Despite a policy of co-operation with Vienna, the Romanians were left with very little power within the Kingdom and no separate diet. As a result, Romanian intellectuals withdrew from active political life until the 1880s.

In the mid-1870s continued crises in the Balkan peninsula eventually led to the outbreak of war involving most of the new Balkan states and the great powers. Russia entered the war against the Porte in 1877 and initially was successful but was halted at Plevden. Shortly after Russian troops had passed through Romania to fight the Ottoman Empire, Romania declared itself an independent state. Later in the year Romania went to Russia's aid and helped them take Plevden. As a result, the Porte called for an armistice in January 1878, and the Treaty of San Stefano was signed in March. This treaty was not acceptable to many of the Great Powers and the Congress of Berlin was called in June which led to the signing of the Treaty in July. Under the terms of this agreement, Romania's independence was recognised, but her Bessarabian territories were returned to Russia in exchange for the Danube delta and Dobrogea. The loss of these territories was extremely unpopular in Romania who had, after all, come to the aid of Russia in the war.

After independence Romania was declared a Kingdom and Carol was crowned in 1881. He was, however, without an heir and eventually his nephew, Prince Ferdinand, was selected to succeed him. Ferdinand was then married to Princess Marie of Edinburgh, grand-daughter of Queen Victoria, who bore several children to Ferdinand, and also to a succession of lovers.

The rest of the century was to prove relatively peaceful for Romania, although to the south the struggle for Bulgarian unification continued until 1887. Thereafter, the Great Powers were largely distracted by struggles elsewhere including the far east. Under Carol I Romania developed rapidly with a rail network and some industry including oil which was to prove an important factor in the next century.

13.3.3 The Twentieth Century

Although under the active rule of Carol I Romania had made significant advances, the majority peasant population remained empoverished. This led to the large-scale peasant revolt of 1907 which resulted in atrocities on both sides. Eventually, 120,000 troops were needed to suppress the revolt, killing in the process some 10,000 peasants. After the suppression there was, however, some attempts to improve the position of the peasants.

With the outbreak of the First World War Romania was in a difficult position. A secret treaty with Germany and Austria-Hungary and King Carol's German origins ment that he favoured joining the central powers. Conversely, the majority of Romanians would not contemplate supporting Austria-Hungary who still maintained control of Transylvania. In October 1914, however, Carol died. After two years of negotiations by Marie with both the British and the Russians, Romania entered the war on the allied side. After some intial success in Transylvania, disaster ensued. Bulgaria declared war on Romania, and caught between the Germans and the Bulgars the Romanian army was forced to retreat into Moldavia with the Royal Family fleeing to Iaşi. Worse was to come with the Russian revolution removing one of Romania's main allies. Eventually, Romania had to sue for peace in December 1917, signing a highly unfavourable treaty with Germany. Nine months later, however, the Germans were defeated by the allies.

Shortly after the end of the war, Romania moved into Transylvania which declared union with Romania on 1st December 1918. Meanwhile, a Bolshevik revolution in Hungary led by Béla Kun spread to Czechoslovakia. At Versaille, Queen Marie managed to obtain all Romania's demands made in 1916, including Transylvania, Bukovina and the Banat. Romanian armies then crushed Béla Kun's revolution. As a result, Romania grew from 53,500 square miles to 122,000 square miles, and the population rose from 8 million to 17.

Romania had many problems of integration after the war, both in infrastructure, industry and politics. The political duopoloy of the pre-war years was broken and many new parties were formed of which the Peasant Party was extremely influential although disliked by Ferdinand. A new constitution was introduced in 1923.

Ferdinand died in 1927 and his grandson succeeded to the throne with a regency council. Prince Carol had been manoeuvered out of the succession ostensibly because of his relationship with the 'Grey Lady' — Elena Lupescu. He, however, decided to reclaim his throne and after some well publicised failures arrived in Bucharest in 1930. Meanwhile, the National Peasant Party had come to power, and after a fairly won election, instigated a series of reforms. Unfortunately, these proved ineffective due to the great depression.

In the late 1920s, the charismatic Corneliu Zelea Codreanu founded the League of the Archangel Michael after a vision in prison. This fascist movement, more generally known as the Iron Guard after its youth league, attracted many followers including initially Carol II. In 1933 Jean Duca became premier and immediately cracked-down on the Guard. He was murdered three weeks later. The next premier, Gheorghe Tătărescu, who lasted until 1937, banned the Guard and the state kept a careful watch on its erstwhile leaders. By the next election in 1937 Carol was highly concerned with the Guard as it had allied itself to the Nazis. After several attempts to form an elected government, Carol suspended the constitution and formed his own. In 1938 a new constitution was introduced which created a single party state with Carol at its head. The Iron Guard was suppressed and 14 leading Guardists including Codreanu were garrotted. Relations with Germany remained good with trade and cooperation agreements being signed.

The Guardists were, however, quickly resurgent, especially after the defeat of Poland. During 1940, Carol was forced to ceed large territories to Bulgaria, Russia and Bulgaria. Eventually, Carol was forced to flee and handed power to General Antonescu and the Guards. Near anarchy ensued and in 1941 Antonescu suppressed the Guard with German approval, and then entered the war against the USSR. During this period, the communists were entirely insignificant. The Romanian army, along with the German, had large scale successes but suffered defeat at Stalingrad with the Romanians alone loosing 150,000 men. Thereafter, Antonescu dedicated his efforts to an attempt to ensure that the Soviets would not dominate the Balkans after the war, but was deposed in a Royal coup d'état on the 23rd August 1944. This coup, led by King Michael, involved the communists, primarily Lucreţiu Pătrăşcanu, in a minor rôle. They were later to claim this was a communist led event (Behr 1992). Romania promptly changed sides and fought with the Soviets against the Germans, loosing a further 111,000 men in the process.

The percentage agreements between Churchill and Stalin effectively ment that Romania was abandoned by the western powers to Soviet domination. With Soviet backing, the Communist Party in Romania gained power via a gerrymandered election in 1946, and then managed to force the abdication of the King in 1947. Romania became a Soviet puppet state from 1948. After initial power struggles Gheorghe Gheorghiu-Dej became First Secretary, a post he retained until his death in 1965. In the immediate post-war period the Soviets shamelessly exploited Romania's resources. Soviet influence in all walks of life was pervasive — Braşov was renamed Oraşul Stalin, 'social realism' in art was imposed, slavic studies were promoted, and so on.

Following Stalin's death, and the succession of Khruschev, Gheorghiu-Dej attempted to move away from the Soviet Union slightly. In 1956–8 Gheorghiu-Dej conducted a purge of anti-communist elements in Romania and was rewarded with the withdrawal of Soviet troops in 1958. Gheorghiu-Dej, along with other eastern European leaders, managed to resist Khruschev's economic specialisation plan. Thereafter, a slow process of 'derussification' occurred with greater emphasis in many areas on Romanian culture and achievement.

After Gheorghiu-Dej's death in 1965 Ceauşescu became First Secretary. He was a clever and wily politician and rapidly consolidated his power base largely through a policy of divide and rule. He also placed many members of his family in key positions. He made extensive of use of the secret police, the *Securitate*. In 1968 he firmly denounced Brezhnev's invasion of Czechoslovakia, and as a result became, in the eyes of the west, a 'good' communist. Ceauşescu did not, however, have any intention of moving away from his Stalinist principles and policies. He was widely fêted in the west, whilst maintaining a strongly centralised and planned state.

In 1971 Ceauşescu visited China, and was greatly impressed by the results of Mao's cultural revolution. Immediately upon his return, he put into place plans to create, what was called by his aides at the time, a mini-cultural revolution in Romania. This 'revolution' involved a huge increase in the state's involvement in all aspects of life, especially the newspapers, the arts and education. Western influences were, as much as possible, reduced. Having cut Romania off the the Soviets, Ceauşescu now proceeded to cut his country off from what contacts remained with the west.

Economically, Romania's isolation caused great problems, especially when the fall of the Shah of Iran in 1976 resulted in Romania having to pay hard currency for oil. Economic policies, centred around the construction of large and extremely inefficient factories, failed to improve the situation and the standard of living for most Romanians fell rapidly. Meanwhile, the Ceauşescus lived an increasingly oppulent lifestyle, eventually culminating in the never-to-be-finished 'House of the Republic' (now ironically renamed the House of the People).

Ceauşescu maintained power by extensive use of the Securitate, and by continually moving his administration around so that no one person could build-up a powerbase in one region. An atmosphere of distrust was created (Deletant 1995).

By 1989 Ceauşescu had lost touch with reality. As the rest of eastern Europe around him changed and the old order collapsed, Ceauşescu attempted to continue along the path of 'scientific socialism.' In December 1989, a demonstration in Timişoara was violently repressed. On the 21st Ceauşescu was due to speak to an organised rally from the balcony of the Central Committee building. Initially, this was just one more staged event, but it was to be the spark that lit the revolution. Ceauşescu was jeered off the balcony, and eventually had to flee the building by helicopter. Meanwhile, a battle between the Securitate and the revolutionaries ensued. Initially, the army supported the regime but quickly changed sides. After a dramatic flight, Ceauşescu and his wife Elena were arrested. On Christmas day 1989 they were quickly tried, and shot. After his death, the Securitate forces who had continued to fight finally surrendered.

13.3.4 History and the Iron Age

Obviously, Roman and later history cannot have had any affect on the preceeding period in the region, but it has had a strong affect on the *writing* of the history and archaeology of the late Iron Age, as well as all other periods. The first histories of Romania were, for example, written as part of a process of self-definition:

> As historians attached to one or another boyar faction in the courts of the Moldavian or Wallachian princes these writers [*cronicarii*] initiated what was to be a permanent feature of the nationalist discourse: its defining Romanian identity in terms of the past.
>
> … For east Europeans, however, struggling not only to create a new society but to define the very entity upon which it was to be based — the "nation", an entity subjugated and divided by various neighbouring states for many centuries — it was precisely in the past that antecedants worthy of modern nationhood might be found: in the grandeur of modern Poland, in Hungary's splendid Renaissance courts, in the Serbian Empire…
>
> The grounds upon which these scholars [Romanian chroniclers] would seek an earlier national greatness were not, however, the medieval splendor of other East European regions but the question of the origins of the Romanians as a people. An almost entirely speculative question, this matter has been disputed and revised continually for centuries… (Verdery 1988, p. 29)

Verdery goes on to show how the three main schools of thought on this matter, those emphasising Roman origins, those emphasising Dacian origins, and those emphasising that Romanians are a mixture of Roman, Dacian and later peoples, were largely influenced by the contemporary political situation. This situation continued into the 20th century — there is a Romanian joke that they are the only people born of two men, Decebalus and Trajan.

The influence of modern history on the study of the Iron Age centres around the need for a period at which the whole of the Dacian (for which read 'Romanian') peoples were united. The Roman province was mainly based in Transylvania and Oltenia, there was no medieval Empire, and the single year of unification under Mihai Viteazul was more an illustration of the lack of unity within the boyars than a possible justification for the unity of Romania. The Iron Age is also the only period at which the Romanian ('Dacian') people could credibly claim that they were all genuinely independent prior to 1877.

As will be discussed in section 13.5 below, some of the work of one of the greatest Romanian archaeologists, Vasile Pârvan (Condurachi 1964, pp. 9–48), can be seen as a process of justification for the unification of Transylvania with Romania after the first world war (Lockyear forthcoming). Romanian emphasis on excavation of the Dacian fortress sites in Transylvania could be seen not only as a reflection of their undoubted archaeological importance, but also as part of the need to emphasise Romanian origins in the region. Also, by concentrating on the Dacians, and claiming that the Romanian people are a result of the interaction of Dacians and Romans, an origin was established which substantially predated the Hungarian, Szekler, German and Slavic populations both within Romania and surrounding it.

Under the communists, there was an initial period when the identification of slavic elements in language, archaeology, history and culture was emphasised as a result of strong Soviet influence. Adherence to the form of Marxist history favoured by Stalin can be seen. With the break away from the Soviets, slavic studies were quickly dropped in favour of indigenist interpretations, and some deviation from the strict Marxist historical schema was allowed so long as it illustrated the greatness of Romania. Just as the Iron Age had proved a suitable period for Romanian nationalism, so it became a vehicle for communist propaganda, and this will be discussed in more detail below.

The use of history and archaeology for nationalist aims is not unique to Romania, but to understand the interpretations presented of the prehistory of the region, particularly the late Iron Age, some knowledge of the history of the region which forms the background to those interpretations is a necessity. One needs to understand not only the contemporary situation within which the historian or archaeologist is writing, but also the background to that situation, and the possibilities offered by that background for the promotion of whichever cause is being championed.

13.4 The evidence for the late Iron Age in Romania

13.4.1 Introduction

This section will give a short overview of some of the archaeological and historical evidence for the late Iron Age in Dacia. These take the form of a small number of historical sources and the archaeological evidence. More detailed consideration of the coinage evidence will be given in the next chapter.

The archaeological data for the period from the whole of Romania is obviously large and I therefore concentrated on examining the evidence from the three counties of Alba, Hunedoara and Sibiu (Figure 13.3). This area was chosen as it contains the series of Dacian fortresses which dominate the literature on this period, and because this area forms one of the three main concentrations of coin finds from Romania (Figure 14.2).

13.4.2 Written sources

Unsurprisingly, there are very few written sources for the period and region. The three most influential have been Strabo's *Geography*, the Akornion inscription, and Jordanes' *Getica*. Given their undoubted influence it is worth juxtaposing extracts from these three texts here.

Book seven of Strabo's Geography discusses the region in some detail and provides various historical episodes. There are further mentions, especially in book 16. Strabo (*c.* 64–3 BC–AD

23–26) was contemporary with the period with which we are interested and his book, which was probably published sometime after AD 14, is therefore a valuable source (Matei 1991, p. 214). For example, Burebista is mentioned in connection with military campaigns in the west, having a great 'Empire', and the banning of wine.

The following are a series of extracts from the Loeb translation (Jones 1954). Some important names and words are also given in the Greek, again in the form shown in the Loeb edition.

> **[7.3.2]** … For at the present time these tribes, as well as the Bastarnian tribes, are mingled with the Thracians (more indeed with those outside the Ister, but also with those inside). And mingled with them also the Celtic tribes — the Boii, the Scordisci, and the Taurisci. However, the Scordisci are by some called "Scordistae"; and the Taurisci are called also "Ligurisci" and "Tauristae".
>
> **[7.3.4]** … "All the Thracians, and most of all we Getae (for I too boast that I am of this stock) we are not very continent"; and a little below he sets down the proofs of their incontinence in their relations with women: "For every man of us marries ten or eleven women, and some, twelve or more; but if anyone meets death before he has married more than four or five, he is lamented among the people there as a wretch without bride and nuptial song."…
>
> **[7.3.4.]** … So, then, the interpretation that the wifeless men of the Getae are in a special way reverential towards the gods is clearly contrary to reason, whereas the interpretation that zeal for religion is strong in this tribe, and that because of their reverence for the gods the people abstain from eating any living thing, is one which, both from what Poseidonius and from what the histories tell us, should not be believed.
>
> **[7.3.5]** In fact, it is said that a certain man of the Getae, Zamolxis by name, had been a slave to Pythagoras,… and at last he persuaded the King to take him as a partner in the government, on the ground that he was competent to report the will of the gods; and although at the outset he was only made a priest of the god who was most honoured in their country, yet afterwards he was even addressed as god, and having taken possession of a certain cavernous place that was inaccessible to anyone else he spent his life there, only rarely meeting with any people outside except the king and his own attendants; and the king cooperated with him, because he saw that the people paid much more attention to himself than before, in the belief that the decrees which he promulgated were in accordance with the counsel of the gods. This custom persisted even down to our own time, because some man of that character was always to be found, who, though in fact only a counsellor to the king, was called god among the Getae. And the people took up the notion that the mountain was sacred and they so call it, but its name is Cogaeonum, like that of the river which flows past it. So, too, at the time when Byrebistas [Βυρεβίστας], against whom already the Deified Caesar had prepared to make an expedition, was reigning over the Getae, the office in question was held by Decaeneus, and somehow or other the Pythagorean doctrine of abstention from eating any living thing still survived as taught by Zamolxis.
>
> **[7.3.8]** … For when Alexander, the son of Philip, on his expedition against the Thracians beyond the Haemus,[1] invaded the country of the Triballians and saw that it extended as far as the Ister and the island of Peuce in the Ister, and that the parts on the far side were held by the Getae, he went as far as that, it is said, but could not disembark upon the island because of the scarcity of boats;… he did, however, cross over to the country of the Getae, took their city, and returned with all speed to his home-land, after receiving gifts from the tribes in question and from Syrmus… And the following are signs of the straightforwardness of the barbarians: first, the fact that Syrmus refused to consent to the debarkation upon the island and yet sent gifts and made a compact of friendship;…
>
> **[7.3.10]** … Aelius Catus transplanted from the country on the far side of the Ister into Thrace fifthy thousand persons among the Getae, a tribe with the same tongue as the Thracians…
>
> **[7.3.11]** As for the Getae, then, their early history must be left untold, but that which pertains to our own times is about as follows: Boerebistas [Βοιρεβίστας] a Getan, on setting

[1] The Balkans

himself in authority over the tribe, restored the people, who had been reduced to an evil plight by numerous wars, and raised them to such a height through training, sobriety, and obedience to his commands that within only a few years he had established a great empire [ἀρχήν] and subordinated to the Getae most of the neighbouring peoples. And he began to be formidable even to the Romans, because he would cross the Ister with impunity and plunder Thrace as far as Macedonia and the Illyrian country; and he not only laid waste the country of the Celti who were intermingled with the Thracians and the Illyrians but actually caused the complete disapperance of the Boii who were under the rule of Critasirus, and also of the Taurisci. To help him secure the complete obedience of his tribe he had as his coadjutor Decaeneus... The following is an indication of their complete obedience: they were persuaded to cut down their vines and to live without wine. However, certain men rose up against Boerebistas and he was deposed before the Romans sent an expedition against him; and those who succeeded him divided the empire into several parts. In fact only recently, when Augustus Caesar sent an expedition against them, the number of parts into which the empire had been divided was five, though at the time of the insurrection it had only been four. Such divisions, to be sure, are only temporary and vary with the times.

[7.3.12] But there is also another division of the country which has endured from early times, for some of the people are called Daci, whereas others are called Getae — Getae, those who incline towards the Pontus and the east, and Daci, those incline in the opposite direction towards Germany and the sources of the Ister... But though the tribe was raised to such a height by Boerebistas [Βοεριβίστα], but has been completely humbled by its own seditions and by the Romans; nevertheless, they are capable, even to-day, of sending forth an army of forty thousand men.

[7.3.13] ... although the Getae and the Daci once attained to very great power, so that they actually could send forth an expedition of two hundred thousand men, they now find themselves reduced to as few as forty thousand, and they have come close to the point of yielding obedience to the Romans, though as yet they are not absolutely submissive, because of the hopes which they base on the Germans, who are enemies to the Romans.

[7.5.2] A part of this country was laid waste by the Dacians when they subdued the Boii and the Taurisci, Celtic tribes under the rule of Critasirus. They alledged that the country was theirs, although it was separated from theirs by the River Parisus[2] [Παρίσου], which flows from the mountains to the Ister near the country of the Scordisci who are called Galatae, for these too lived intermingled with the Illyrian and the Thracian tribes...

[16.2.39] ... Such, also, were Amphiaräus, Trophonius, Orpheus, Musaeus, and the god among the Getae, who in ancient times was Zamolxis, a Pythagoreian, and in my time was Decaeneus, the diviner of Byrebistas [Βυρεβίστᾳ]...

One text which appears to provide much detailed information about the area and period is Jordanes' *The Origin and Deeds of the Goths* — usually known by Mommsen's abbreviation *Getica*. This work was written in AD 551 by Jordanes, a Goth who was serving as a *notarius* to a noble Gothic family. It is a précis of the Gothic History of Cassiodorus which was in twelve books, and Jordanes claims it was written from memory (probably in Constantinople), sometime after having borrowed the history from Cassiodorus' steward (*dispensator*) in Bruttium for three days (Mierow 1915, pp. 1–12). There are, however, large sections lifted from other works, *e.g.*, his introduction is borrowed from Rufinus of Aquileia, a fourth–fifth century author (Mierow 1915, p. 14). Most of the other sources Jordanes cites are probably lifted second-hand from Cassiodorus. Cassiodorus was secretary to Theodoric the Great, and to Athalaric, his grandson and successor. Cassodorus' history was written as an attempt to reconcile the Romans to Gothic rule by glorifying the Goths, and Theodoric's ancestors in particular (Mierow 1915, pp. 15–16). In attempting to trace the Goths

[2]The 'Parisus' is otherwise not known, and should probably be amended to 'Pathissus,' or the River Tisza.

back to remote history Cassiodorus identifies, wrongly, the Goths with the Getae. Mierow states (p. 16):

> Though he may have done this in good faith, these are mistaken identifications, and accordingly we must reject as evidence for true history the chapters that deal with these peoples.

Jordanes purpose in writing this abridgement of Cassiodorus, appears to be political in that he saw the future of the Goths as resting as much upon the Romans as themselves.

Given all this, how much credence can be given to Jordanes for the 'history' of the Getae is difficult to assess. The *Getica* has been, however, widely used and cited in studies of the late Iron Age in Romania, and Pârvan even called his great work *Getica*. This is not the place to enter upon a detailed historical critique of Jordanes, and thus what follows are simple extracts from Mierow's translation. It would be fair to say, however, that I am extremely sceptical as to how much faith should be placed in the Getica for the elucidation of any aspect of late Iron Age societies in this region.

> **[V.39]** To return, then, to my subject. The aforesaid race of which I speak is known to have had Filimer as king while they remained in their first home in Scythia near Maeotis. In their second home, that is the countries of Dacia, Thrace and Moesia, Zalmoxes reigned, whom many writers of annals mention as a man of remarkable learning in philosophy. . .
>
> **[V.40]** . . . Wherefore the Goths have ever been wiser than other barbarians. . . [and] wrote their history and annals with a Greek pen. He [Dio] says that those of noble birth among them, from whom their kings and priests were appointed, were called first Tarobostesei and then Pilleati. . .
>
> **[X.65]** Then Philip, the father of Alexander the Great, made an alliance with the Goths, and took to wife Medopa, the daughter of King Gudila, so that he might render the kingdom of Macedon more secure by the help of this marriage. It was at this time, as the historian Dio relates, that Philip, suffering from the need of money, determined to lead out his forces and sack Odessus, a city of Moesia, which was then subject to the Goths by reason of the neighbouring city of Tomi [Tomis, modern Constanţa. He was unsuccesful.]. . .
>
> **[X.66]** After a long time Sitalces, a famous leader of the Goths, remembering this treacherous attempt, gathered a hundred and fifty thousand men and made war upon the Athenians. . . [and] overran Greece and laid waste the whole of Macedonia.
>
> **[XI.67]** Then when Buruista [Burebista] was king of the Goths, Dicineus came to Gothia at the time when Sulla ruled the Romans. Buruista received Dicineus and gave him almost royal power. It was by his advice the Goths ravaged the land of the Germans, which the Franks now possess. [XI.68] Then came Caesar, the first of all the Romans to assume imperial power and to subdue almost the whole world. . . and yet was unable to prevail against the Goths, despite his frequent attempts. Soon Gaius Tiberius ruled as third emperor of the Romans, and yet the Goths continued in their kingdom unharmed. **[XI.69]** Their safety, their advantage, their one hope lay in this, that whatever their counsellor Dicineus advised should by all means be done;. . .
>
> **[XI.71]** . . . He gave the name of Pilleati to the priests he ordained, I suppose because they offered sacrifice having their heads covered with *tiaras*, which we otherwise call *pillei*. **[XI.72]** But he bade them call the rest of their race Capillati. This name the Goths accepted and prized highly, and they retain it to this day in their songs.
>
> After the death of Dicineus, they held Comosicus in almost equal honour, becuase he was not inferior in knowledge. By reason of his wisdom he was accounted their priest and king. and he judged the people with greatest uprightness.
>
> **[XII]** When he too had departed from human affairs, Coryllus ascended the throne as king of the Goths and for forty years ruled his people in Dacia, which the race of the Gepidae now possesses. **[XII.74]** This country lies across the Danube within sight of Moesia, and is surrounded by a crown of mountains. It has only two ways of access, one by way of Boutae

and the other by Tapae. This Gothia, which our ancestors called Dacia and now, as I have said, is called Gepidia. . .

[XIII.76] Now after a long time, in the reign of the Emperor Domitian, [AD 81–96] the Goths, through fear of his avarice, broke the truce they had long observed under the other emperors. They laid waste the bank of the Danube, so long held by the Roman Empire, and slew the soldiers and their generals. Oppius Sabinus was then governor of that province, after Agrippa, while Dorpaneus held command over the Goths. Thereupon the Goths made war and conquered the Romans, cut off the head of Oppius Sabinus and invaded. . . **[XIII.77]** Domitian hastened with all his might to Illyricum, bringing with him the troops of almost the entire empire. He sent Fuscus before him. . . **[XIII.78]** But the Goths were on the alert. They took up arms and presently overwhelmed the Romans. . .

[The history now skips to the reign of Severus]

We can see from the above that there are certain elements in common with the account of Strabo, but Jordanes has also introduced a number of further elements, particularly the account of the social structure of the Dacians. Following Mierow, I would doubt the usefulness of the extra passages. They have, however, become widely used and quoted (*e.g.,* Gostar & Lica 1984).

The most important inscription is the so-called Akornion inscription (Dittenberger 1917, No. 762) from Dionysopolis, modern Balčik (Bulgaria), on the Black Sea Coast. It is worth citing in full. The following translation is taken from Sherk (1984, No. 78). In the following, square brackets [] enclose letters or words that no longer stand in the text as it survives but have been restored by modern scholars, text in parentheses () is an explanatory addition to the text, and *italics* indicates that only part of the original word is extant. Notes to the inscription are also from Sherk.

[– –
– –] he took up [– –
– –] Theodoros and Epi[– –
– –] at their own expense [–
– –] fellow travelers *he departed* [–
– –] to Argedauon[3] to [his(?)] father[4]
[– –] *having arrived* and met with (him) at once [– –
– –] from him he won (him) over completely [and]
released his People from the (?) [– –;] and having become priest
[– of the] *Great* [God] the processions and sacrifices he [per
formed magnificently] and with the citizens he shared [the
meat (of the sacrifices),] and having been chosen priest of [Sar]apis by lot, in like manner at his own *expen
se* [he conducted himself] well and as one who loves goodness, and when the eponymous (god)
[of the city, Dion]ysos, did not have a priest for many years,
[he was called upon] by the citizens and he devoted himself (to the priesthood), *and* [through
out the] wintering-over of [Gaius] Antonius[5] he assumed
[the (priest's) crown] of the god and the processions and sacrifices [he per
formed well] and sumptuously and with the citizens [he sha
red the] *meat* lavishly, and, in regard to the gods in Samothrace,
having assumed for life their (priest's) [crown,] their processions [and
sacrifices] he performed on behalf of the *mystai* and the *ci
ty*; and when recently King Burebista had *become* first and [great

[3]A variant for Argedava mentioned by Ptolemaeus (3.8.4).

[4]Not his own father, but the father of the person to whom 'he' has gone as envoy.

[5]C. Antonius M.f. Hibrida, consul for 63 BC with Cicero and the proconsul of Macedonia in the following year. His campaign against the Thracians of the north-east ended in disaster not far from Histria.

est] of the kings in Thrace and over all
[the (land)] *across* the river (Danube) and the (land) on the near side had gained possessio
n, also to him he became first and *great*
est friend and procured the greatest advantages for our city by spe
eches and advice of the best kind; and the goodwill of the *ki*
ng with respect to the safety of his city he urge
d, and in all other ways of himself unsparingly
did he give; the city's embassies with their dangers he under
took without hesitation to win in all respects
the advantage for his native city, and to Gnaeus Pompeius, Gnaeus' so
n, Roman imperator,[6] he was sent by King Burabe[i
s]ta as an envoy, and meeting with him in the area of Macedonia
around [Her]aklea-in-Lynkos not only the negotiations on behalf of the *ki*
ng did he conduct, bringing about the goodwill of the Romans
for the king, but also concerning his native city most fruitful
negotiations did he conduct; and in general throughout every situation of cri
sis he applied himself body and soul, expenses
being paid from his own means of livelihood; and, some of the material things of the city subsi
dizing by himself, he has exhibited the greatest zeal for the
safety of his native city: in order therefore that the People also might be seen honouring
fine and good men and those who benefit them (i.e. the People), *it is de*
creed by [the] Boule and the People for these services to praise Akornion
(son) of Dion[y]sios and to present to him at the Games of Dionysos a gold
crown and a bronze statue, and to crown him also in the *fu*
ture each year at the games of Dionysos with a gold *cro*
wn, and for the erection of the statue to *give* him a pla
ce, the most conspicuous, in the agora. *vv*

There are a number of other sources for the period, especially Ptolomy's *Geography* which gives the name of Dacian settlements. The remaining sources are relatively minor for the period under consideration.

From the historical sources we can see that we have, in reality, very little reliable evidence for the reconstruction of either the social structure of Dacian society — if we can even justify discussing a single Dacian society — or for the creation of a pseudo-history of Burebista. We can be confident that Burebista was a powerful ruler for a period, that he was a threat to the Greek city states, and roamed as far as the Tisza in the west. We cannot use this as evidence for the existence of a state, nor can it be evidence for the size and location of that state. It would appear that religious leaders were powerful within Dacian society, and there are references to a mountain-top site of religious significance, although we must be wary of retroprojection of contemporary information into the past. These passages, although informative, are a weak base upon which to found a 'history' of the Dacians.

13.4.3 Archaeology

This section reviews the archaeological evidence for the 'classical Dacian period' in Romania (1st century BC–1st century AD). Detailed descriptions of individual sites are contained in Appendix D and site numbers refer to that appendix. References are also contained in the appendix unless a

[6]Pompey was called imperator after the battle against Caesar at Dyrrachium in 49 BC; Caesar *Civil Wars* 3.71.3.

specific point is being discussed. The discussion starts by examining various general aspects of the archaeology of the period in Romania. It then proceeds to concentrate on the evidence for the three counties of Alba, Sibiu and Hunedoara (Fig. 13.3), for which an extensive literature review has been undertaken, and on a few specific types of site and evidence, primarily defences and religious sites.

Material culture

The material culture of the Dacian period is extremely rich and includes indigenous products, imports, primarily from the Greco-Roman world, and copies of those imports.

The commonest archaeologically recovered find is, of course, pottery. Crişan's (1969a) *Ceramica Daco-Getică cu specială privire la Transilvania* remains the primary work of reference for this material. Crişan divides the ceramic evidence into four phases dated to VI–V, V–VI, III–II, and 100 BC–AD 100, of which the last is of primary interest here. Unfortunately, the quantification of pottery has made no headway in Romania and I know of no excavation report which presents this type of data. Glodariu (1981b) makes an attempt to refine the chronology of the ceramics at this period on the basis of forms within closed complexes (*i.e.,* pits *etc.*) but data from only two Transylvanian sites, Slimnic (site no. 88, page 531) and Arpasu de Sus (site no. 76, page 526), were available and his results must be viewed as a preliminary, if extremely welcome, step in the right direction. Thus, the majority of sites, especially smaller excavations and findspots, cannot be dated more securely than to 100 BC–AD 106. Given the rapid changes and important developments in this period, this is a severe hindrance.

The ceramics at this time were both hand and wheel made. A number of characteristic 'Dacian' forms continued to be made and developed. Of these, the *ceaşca dacică* (Dacian cup) is common and distinctive, looking like a crudely made tea-cup, usually with a rim-diameter of 12–20cm. These vessels appear to have been a form of open lamp. Another common form of coarse-ware vessel is the *vas borcan* (vase in the form of a jar). These vessels often have a decorative band and/or lugs. Of the fine-wares, *fructiere* (literally, fruit-bowls) are distinctive and fairly common. These vessels have a tall pedestal base and a wide, relatively shallow bowl. Occasionally, vessels of this form are painted as at Bîtca Doamnei (Crişan 1969a, fig. 83). A unusually large example comes from the 'princely' burial at Cugir (site no. 11, page 500). Strainers (*vase strecurători*) with a hemispherical or conical base and a single handle are also relatively common, along with a variety of single and two handled jugs, storage vessels *etc*. Amongst the rarer forms are copies of Greek forms although these seem to be more common in Moldavia, particularly from the site of Poiana (site no. 112, page 541).

Of particular importance, however, are the painted vessels (Crişan 1969a, pp. 197–202). These vessels come in two forms: painted with geometric designs and painted with plant and zoomorphic motifs. The motifs are usually painted on a slip similar to contemporary vessels such as those found at Manching (Berciu & Moga 1974, p. 73). The geometric motifs have been found at a number of sites across Romania; the vegetable and zoomorphic designs were only found in the complex of settlements in the Orăştie mountains. This type of vessel appears to have had some significance. For example, at the mountain-top site of Piatra Craivii (site no. 21, page 503) vessels with geometric motifs were found but only on the terrace on which the earlier rectangular sanctuary was found.

Figure 13.3: Location of the counties of Alba, Hunedoara and Sibiu.

There is some dispute as to whether these vessels are partly imports and partly imitations (*e.g.*, Glodariu 1974–5b, p. 18), or solely local products (Berciu & Moga 1974, p. 74).

One unique vessel deserves note. From one of the terraces in the civil settlement at Sarmizegetusa Regia (see below), fragments of a large conical vase were recovered. This vase has a reconstructed rim diameter of 125cm., a height of 70cm. but a base diameter of 9cm. (Crişan 1969a, pp. 189–190). Equidistant around the rim are holes, presumably for suspending the vessel. Finally, stamped below the rim in two cartouches are the words DECEBALVS PER SCORILO. The meaning of these words is not clear (Protase 1986), but the reference to Decebalus is extremely suggestive if not definitive.

Other ceramic products included the usual range of spindle whorls, burnishers, and tile along with special artefacts such as the zoomorphic figurines from Cîrlomăneşti (site no. 109, page 539).

The 'classic' Dacian period is also notable for its rapid increase in production of iron artefacts conveniently summarised in Glodariu & Iaroslavschi (1979). A very wide range of tools and weapons were produced including locks, hinges, armour, agricultural tools, crampons, metal and wood-working tools. A large proportion of the iron work recovered, and of the evidence for iron-working, comes from Sarmizegetusa Regia (*e.g.*, Glodariu 1975). On a terrace near the Sacred Precinct (see below and site no. 50), a group of furnaces were discovered and over one ton of iron blooms. The concentration of iron working at Sarmizegetusa Regia is rather unusual in that the ore was not immediately available but had to be brought to the site.

Evidence for the working of copper and bronze can also be found at Sarmizegetusa Regia. Bronze was used to make broaches and other items of personal ornament, as well as copies of imported bronze vessels.

There is also a high incidence of silver hoards in Romania. Mărghitan (1976) lists some 120 hoards of silver work from Romania, a large proportion of which occur within the Carpathian arc (see Fig. 14.4). These hoards often contain silver jewelry such as broaches, arm-rings, pendents, rings *etc.*, and/or silver vessels such as two-handled cups, or hemispherical-based handleless cups. The famous Herăstrău hoard (Mărghitan 1976, pls. 5–9), from the park of the same name in Bucureşti, contained fibulae, bracelets, and a *vas tronconic* (hemispherical cup). Within these hoards there are often imports such as the Megaren bowls from Sîncrăieni (Popescu 1960), although there is some dispute over some items.

There would appear to be much to be gained in a more formal analysis of this material, especially in conjunction with the coinage evidence. What is very curious about the precious metal discoveries in Romania is the lack of gold. There is very little in the way of gold, either as jewelry or as coinage, from Dacia. This stands in sharp contrast to the sources which claim that Trajan received five million pounds of gold and ten million pounds of silver as a result of the Dacian wars. This problem has been discussed by Makkay (1995). The Dacian preference for silver can be observed into the Imperial period (Guest 1994).

The last important material culture item, coinage, will be discussed in the next chapter.

Settlement evidence

The settlement pattern of the three counties, if not of Dacia as a whole, is dominated by a series of 'fortresses' which cluster along the edges of the Carpathian mountains. The largest of these, Gradiştea Muncelului, also known as Sarmizegetusa Regia, is a huge site with a fortified central enclosure, a series of 'sanctuaries', and a civil settlement spread several kilometres along a mountain ridge (site no. 50, page 515). Other sites in this category include Costeşti (site no. 46, page 512) and Blidariu (site no. 38, page 509), both of which lie just to the north of Sarmizegetusa Regia near the start of the valley which leads to it, Piatra Roşie (site no. 60, page 521) which lies to the west, and Baniţa (site no. 37, page 509) which lies on the southern side of the Carpathians. To the east of Costeşti and Blidariu lies the sites of Căpîlna (site no. 5, page 497), Tilişca (site no. 91, page 533) and Cugir (site no. 11, page 500). The final site in this category is the extraordinary site of Piatra Craivii (site no. 21, page 503) which lies 20km. to the north of Alba Iulia on the east side of the Munţii Apuseni.

These sites all have a number of features in common. Firstly, they all occupy hill- or mountain-top locations. Piatra Craivii is at 1083m., Baniţa at 1000m., Căpîlna at 610m. and so on. Secondly, all the sites are built on a series of man-made or man-enhanced terraces. In the case of Sarmizegetusa Regia, the scale and number of terraces cut into the micaschist bedrock is breath-taking. Thirdly, with the exception of Cugir, all these sites have evidence of a particular type of construction technique known as *murus dacicus* (Daicoviciu 1972, pp. 129–131). Fourthly, many of these sites are associated with particular structures thought to be sanctuaries. Fifthly, many of the sites have an associated 'civil settlement', and lastly, they all have very rich finds assemblages often including many imported, or possibly imported pieces.

The *murus dacicus* building technique is thought to be an adaptation of a Greek one. It consists of a dry stone wall made of large ashlar blocks, usually limestone. In most cases there are two faces of ashlar, and an earth and rubble core. The two faces of the wall are held together by timber beams fitted into slots cut into the top of some of the blocks. These slots are flared at the external end, and presumably the lacing timbers were similarly flared at both ends. Some of the walls had only a single face with the timbers being inserted into the slope of the hill, *e.g.*, Căpîlna. At Piatra Craivii, the courses of ashlar blocks were divided by large well-fashioned rectangular blocks. On some sites, *e.g.,* Blidariu, the blocks have Greek letters carved on their surface.

The extent of the constructions in this technique vary greatly from site to site. At Sarmizegetusa Regia, the long precinct wall is of *murus dacicus*, as are walls supporting the terraces upon which the various sanctuaries are built, and a selection of "dwelling" and "watch" towers. Similarly, Blidariu, Costeşti, and Piatra Roşie make extensive use of walls built like this. All have square towers with foundations of *murus dacicus*, and an enclosure surrounded by walls of this type. To the east, however, the huge settlement of Tilişca only has two towers of this construction on its summit; Piatra Craivii has no towers but a length of circuit wall.

The presence of these walls is not limited to the fortresses. On the east slope of the *Valea Albă*, overlooking Sarmizegetusa Regia, the site of Feţele Albe also has *murus dacicus* walls of at least two phases (site no. 49, page 514). This site, with a circular sanctuary and a round building, is built on a series of terraces and the *murus dacicus* walls support the lower edges of these terraces. In the area cointaining the main concentration of these sites, the Munţii Orăstie, there are a huge number of findspots and casual finds which suggest the presence of isolated 'dwelling-towers' or look-out posts which use this construction technique (see especially maps in Daicoviciu *et al.* 1989). There are also a small number of sites such as Deva (site no. 48, page 514) which may have had similar sites but have been largely destroyed by later developments such as the medieval castle. The structures built of *murus dacicus* are discussed in detail in *Arhitectura Dacilor* (Glodariu 1983). Equally important is the fact that this technique is missing from other large settlements of the same period, *e.g.*, Cîrlomăneşti, Bîtca Doamnei, Popeşti or Poiana.

The next linking theme between these sites is the presence of 'sanctuaries.' These structures come in two basic forms: rectangular and circular. The former consist of lines of stone discs, similar in form to column-drums. These discs vary in material, size and the care in which they were cut. Sarmizegetusa Regia has eight of these sanctuaries, although they are not all contemporary. Some of the sanctuaries at Sarmizegetusa Regia were made of limestone, and some of andesite, neither of which is found at the site which is built on a micaschist ridge. These sanctuaries were originally reconstructed as open air buildings (*e.g.*, Daicoviciu 1972, Fig. 27), but more recently as roofed structures (Strîmbu & Glodariu 1981). Neither reconstruction appears wholly convincing. Rectangular sanctuaries have been found at other sites such as Baniţa, Costeşti, Piatra Craivii and Piatra Roşie. They have been inferred at Căpîlna from discs reused in the outer walls, and at Blidariu there is a sanctuary at the near-by site of Pietroasa lui Solomon. The important site of Tilişca does not have a rectangular sanctuary, and neither does Cugir. Outside of the three counties, very few other sites have evidence for this type of sanctuary, Bîtca Doamnei, a hill-top settlement/fort in Moldavia, being one example. This type of structure is therefore extremely rare outside of the concentration of sites in the Orăştie mountains (see section D.4.1).

The second type of sanctuary is circular (see section D.4.2). As with the rectangular sanctuaries, they were reconstructed as open sites, but have recently been reconstructed as covered circular buildings (Antonescu 1980). There are, however, three categories: those constructed with an outer circle of stone, those with an outer circle of wood, and those which have intermittent stone in their foundations. Of the first category, only three are known, two at Sarmizegetusa Regia, and one at Feţele Albe. The second category consists of timber structures thought to be of the same or similar function to the first class. These include structures such as those found at Dolinean in the Ukraine (site no. 110, page 540), Brad in Moldavia (site no. 108, page 537), and Pecica in jud. Arad. These sites are generally accepted as sanctuaries. The identification is partly due to the rarity of circular constructions outside the Orăştie mountains. The last category come from a small series of sites in the Orăştie mountains where opinion is divided as to their sacred significance, namely Pustiosu (site no. 62, page 523), Rudele (site no. 64, page 524) and Meleia (site no. 55, page 520). The first is regarded by some authors as a circular dwelling, the latter two as upland sheep-folds. Others (*e.g.*, Sanie 1995) have regarded these structures also as sanctuaries. The similarity in form between these sites and the Great Circular Sanctuary at Sarmizegetusa Regia has been commented on at various times (*e.g.*, Nandris 1981).

The sanctuaries of the first category have a continuous external circle made of stone blocks of two sizes, wide and low, and narrow and tall. These are usually arranged in some form of regular pattern. The Great Sanctuary at Sarmizegetusa Regia then has post-hole evidence for a second inner circle of wood, with four 'threshold' stones set equidistant around the circumference. Within this is a second set of posts in a D formation with two threshold stones set opposite eachother. The other two sanctuaries of this type had less evidence for internal structures. Attempts to identify the Great Circular Sanctuary as a calendar suffer from a lack of certainty regarding the number of posts in the inner circles.

One interesting aspect of the sanctuaries associated with the fortresses is that they occur *outside* the defensive circuit. This is true even of sites such as Costeşti which would have had sufficient room for the constructions to take place inside the circuit. It is also interesting to note that, in parallel to the *murus dacicus* wall, many large and important sites outside the Orăştie mountains do *not* have sanctuaries, *e.g.*, Poiana and Popeşti. Lastly, Sanie (1995) includes attributes a sacred function to a number of other building forms, such as the apsidal building at Piatra Roşie, but these identifications are less generally accepted, and anyway the structures are quite rare.

The civil settlement at Sarmizegetusa Regia is the largest and best developed of all of these sites. Mainly spreading several kilometers along a mountain ridge below the enclosure and sacred precinct, the settlement consists of a large number of terraces cut into the micaschist. Every terrace which has been excavated has revealed evidence for structures. These often use blocks of stone as foundations. The buildings can be rectangular, poligonal, or circular. Some of these sites are workshops with a large quantity of evidence for metal working (Glodariu 1975). In fact, the majority of the evidence for iron working at this period in Romania comes from this one site (Glodariu & Iaroslavschi 1979). Some structures were probably granaries, and some probably had a special function such as that within which the DECEBALVS PER SCORILO vessel was discovered (Glodariu *et al.* 1988, pp. 95–6).

Civil settlement at other fortresses varied greatly. Blidariu appears to have been a strictly military site, whereas Costeşti is much larger, and has some evidence for a 'civilian settlement.' Tilişca, somewhat to the east, is a large site with much evidence for a sizeable community. Căpîlna, smaller than Tilişca, strikes one more as a fortified residence, rather than a military fortification or a large urban centre. Perhaps most striking is the site of Piatra Craivii. From the literature one gets the impression that a large population occupied an urban or proto-urban site (*cf.* (Collis 1972)). On visiting the site, however, this impression is shown to be false as the site is difficult of access, has a relatively small area of useable land, and is more suitable for the sort of mountain-top refuge that occupied the site in the middle ages. The finds assemblage, however, is extremely rich with imported goods, coins, iron and silver work *etc.* The presence of, for example, plough shares on this site, should occasion comment, although their association with the rectangular sanctuaries cannot necessarily have significance as 95% of *all* finds were found on the terrace with the sanctuary. The function of this site should be open for further debate.

The finds assemblages from these sites all tend to be extremely rich and varied. This is partly due to the scale of both the sites, and the excavations which have investigated them. The finds often include imports such as the carpenters plane which is stamped HERENNI and comes from a workshop at Aquileia (Daicoviciu 1972, pp. 194–5), and many bronze vessels, handles, statuettes *etc.* (Glodariu 1968). Additionally, there is a rich assemblage of Dacian artefacts including a wide variety of ceramic forms, iron-work of all descriptions, jewelry in silver, bronze and iron, and so on. At two of the sites (Sarmizegetusa Regia and Tilişca), coin-dies have been found (see Chapter 14). Many of the high-status sites in this area have painted pottery with vegetable and zoomorphic designs — painted pottery with geometric designs is not as rare as this type and is more widely found (Berciu & Moga 1974).

As well as these features which many of the fortress sites have in common, there are a number of other interesting aspects. For example, many of the sites, including Sarmizegetusa Regia, Feţele Albe and Blidariu have evidence for sophisticated water management with stone conduits and/or ceramic pipes. The Sacred Precinct at Sarmizegetusa Regia, as well as the eight rectangular sanctuaries and the two circular ones, has a large 'solar disk', an andesite disc made of a smaller central disc and a series of radial wedges, under one edge of which runs a water or drainage conduit. There is also a paved road, and on the terrace just above the precinct (the *terasa cu grîu*) a thick layer of carbonised grain which has been interpreted as evidence for a granary destroyed by the Romans when they captured this area.

We have, therefore, in the Orăştie Mountains, a series of 'fortresses' (Sarmizegetusa Regia, Blidariu, Costeşti and Piatra Roşie) with many similarities, and outside this immediate area, but still in the SW of Transylvania, more sites with the same common features (Căpîlna, Tilişca and Piatra Craivii). The only site sharing these features not in Transylvania is Baniţa which lies on the south side of the mountains, although not all that far from Sarmizegetusa Regia as the crow flies. Unenclosed sites in the same area share similar features, the best known of which is Feţele Albe. A very large number of sites are known in the same area which may form similar settlements to those described (Daicoviciu & Ferenczi 1951; Daicoviciu 1964; Daicoviciu *et al.* 1989).

Before moving to other classes of site outside this small area, two other groups of sites need to be discussed. The first is the upland sites of Meleia (site no. 55, page 520), Rudele (site no. 64, page 524) and Pustiosu (site no. 62, page 523), and the second is the odd site of Ponorici (site no. 61, page 522). The three sites in the first category are to be found in the mountains above Sarmizegetusa Regia— Meleia is at 1,419m. and Rudele at 1,366m. These three sites are important as their function is disputed. There are two schools of thought. The first is that Rudele and Meleia are *stîne*, or upland sheep folds, and Pustiosu is a dwelling, if a rather up-market one (*e.g.*, Daicoviciu 1972). The second school of thought, championed by Sanie (1995), is that they are circular sanctuaries. Either explanation leads to interesting possibilities in that the plan of these structures, and that of the Great Circular Sanctuary, are very similar (Nandris 1981). If they are *stîne*, we could postulate a link between agriculture, specifically sheep-rearing, and religion. The form of the sanctuary could be deliberately reflecting the form of the sheep-folds and we could suggest an agricultural trait in Dacian religion, a trait which can be seen in many attested religions. Conversely, if these upland structures are religious, why are they at such great heights where they are only accesible for certain parts of the year? Again, if we make the large assumption that the upland pastures were exploited for animal husbandry in this period, which is not unreasonable, we may yet see a link between these structures, religion and agriculture.

The second group of sites is the odd set of features at Ponorici (site no. 61, page 522). These consist of a series of earthern banks which are poorly dated. A single coin of Domitian was found in the earlier part of this century, and most authors regard these works as Dacian, probably of the time of Decebalus. There is also a Roman marching camp at the site which uses one of the banks for one of its defenses. The main feature is a bank some 1.5km. long which cuts right across the valley at this point. This bank has, however, a large series of shorter banks at right angles to the main bank, and also a series of “bastions”. To the south-west of this feature are three more complexes of banks — firstly, a simple oval enclosing the top of Dealul Feţei; secondly, a more complicated quadrilateral enclosure some 300m. to the north of the first enclosure, and finally a complicated enclosure and bank system about 300m. to the west.

This system of defenses is usually seen as being created specifically to protect Sarmizegetusa Regia from attack across the mountains along this upland pass. It is often thought of as being part of an elaborate system of ‘defence in depth.’ This system of defenses does not appear from the plan, however, to represent a single planned episode, and further research is needed. For example, it is difficult to see the intended function of the relatively short (70m.) banks at right angles to the main vallum.

The settlements in this small area of Romania have been subject to an immense quantity of detailed research which is still continuing. They are usually discussed as being part of a system, and their similarities emphasised. The dating of the sites is extremely problematic, partly due to the lack of refinement in the pottery chronology, partly due to the general lack of coinage with the additional problem of copies (see next chapter), and partly due to a need for up-date excavation techniques which have fallen behind because of the isolation imposed by the communist regime. One of the few attempts to assess the problem of the relative dating of these sites was that of Daicoviciu & Glodariu (1976). The end of the major sites in this region is usually attributed to the Roman invasion. Given the nature of the sites, and the fact that many of them end with a major conflagration, this seems an not unreasonable supposition. It is also an explanation which is in keeping with the numismatic evidence such as it is (see next chapter). The attribution of many rebuilding episodes to the period between the two Dacian wars is less easy to sustain, and much more difficult is the attribution of the start of these sites to the period of Burebista, who is also credited with forming this defensive ‘system’. It would be immensely helpful if more detailed distribution plans were available, or the data to undertake a GIS analysis. Unfortunately, until maps of a suitable scale cease to be military secrets, this will continue to be impossible.

So far, we have discussed a small set of rather extraordinary sites within the three counties. There are, however, a small number of other sites in these counties which have been subject to extensive excavation, and a larger number of sites which have had small scale sondages, surface collection, or chance finds.

Of these other types of site, there appear to be two main classes, defended and undefended small settlements. The former include sites such as Arpasu de Sus (site no. 76, page 526). This site is situated on a small promentory between two rivers and is defended by a single ditch and bank. The site contained a series of small sunken, or partially sunken floored buildings and pits. The finds were largely domestic, with no coins, only one possible import, and limited silverwork. This site is a classic Iron Age defended site for which no special explanation is needed. Certainly, to suggest that it represented a garrison site protecting the eastern flank of the Orăştie complex (Glodariu 1974–5a) is almost certainly to embue it with an importance it never had.

This site is one of many similar sites both within and without the three counties, *e.g.,* Şeica Mică (site no. 87, page 531). Outside the three counties, some other sites of this type have been published including Sprîncenata (Preda 1986) which has the added interest that a small hoard of 18 *denarii* was discovered during the excavation (hoard SPR).

The second type of site is the undefended rural settlement of which Slimnic (site no. 88, page 531) and Şura Mică (site no. 89, page 532) represent two good examples. These sites consisted of a series of sunken-floored or semisunken-floored buildings (*bordei* or *semibordei*). The finds from these sites are plentiful, but much more 'ordinary' than the fortress sites discussed earlier. A few *fibulae* were found, but the majority of the finds were pottery. Both sites are claimed to show continuity from the late Iron Age into the period of the Roman occupation, and Şura Mică is said to continue into the post-Roman period. The building forms do not change substantially after the invasion, the main differences being in the ceramic assemblages which show Roman influences.

Appendix D has attempted to list as much of the publically available evidence for settlement *outside* the Orăştie mountains as an attempt to balance the picture. Although the density of sites in the Orăştie mountains is exceptional, the pattern has been distorted by the pattern of archaeological research, a problem by no means unique to Romania. We can see from the Appendix that small rural settlements such as Arpasu de Sus and Slimnic are almost certainly the norm for the late Iron Age of this region; the fortresses are exceptional, as is the whole of the region within which they lie. Outside of this region there exist other large and important sites, for example Poiana in Moldavia (site no. 112, page 541). In the case of this site, its dominant position on the river system enabled it to control trade from the Greek cities on the Black Sea coast. As a result, the quantity of coins and other imports is greater here than anywhere else in Moldavia. The settlements in the hinterland of Poiana are smaller, and have lower quantities of imports; the archaeological picture is immediately intelligible.

Several questions arise from the above discussions. Firstly, should the fortresses be associated with any historical figure? It would seem reasonable to suppose that in their final phases they were contemporary with Decebalus, although if he ruled them all as part of his Kingdom is unknown. We have no evidence to suggest a link with Burebista. To suggest that the use of *murus dacicus* dates to Burebista as he had conquered the Greek cities on the Black Sea is tenuous. Secondly, should the fortresses be seen as part of a unified system? I think not, despite their obvious similarities, although they may have come together to function in co-operation during a period such as the Dacian wars. The reason for this claim is that as well as similarities there are distinct differences. The most striking contrast being between Costeşti and Blidariu although they are widely acknowledged to start at different periods. These sites could be seen as an expression of élite competition rather than solely an expression of the centralised power of a state.

Of particular interest is the concentration of the fortresses and sanctuaries in a small area of Dacia. Surely this argues against the oft-proposed cultural and political unity of the Geto-Dacian peoples (*e.g.,* Babeş 1979)?

It would seem, therefore, that explanations of these sites and buildings somewhat different from those usually proposed at present are possible, and I shall return to this in Chapter 15.

13.5 Past and Present — interpretations of the evidence from Pârvan to the present

> Istoriografia noastră este astăzi cvasi-unanimă în aprecia că, în perioada sa clasică, lumea geto-dacică era împărţită în clase şi organizată într-un stat unitar, al cărui fondator a fost marele rege Burebista.
>
> Ursulescu (1992, p. 42)[7]

The interpretations of the late Iron Age archaeological and historical evidence offered by Romanian archaeologists during the last 70 years have been strongly influenced by contemporary politics, and the post-Iron Age history of the area. As Ursulescu noted, there is a remarkable conformity in many aspects of these interpretations, although there have also been some important differences. The study of the inter-relationship between some of these various versions of the past and contemporary politics will form a separate study (Lockyear forthcoming) and will only be outlined here.

Vasile Pârvan is seen by many as the founder of modern archaeology in Romania (Zub 1974). He was born in 1882, a University professor by 1909, director of the National Museum in 1910, academician by 1911, founded the journals *Dacia* and *Ephemeris Dacoromana*, and died at the age of 44 in 1926. Two of his publications are of prime interest here: *Getica* (Pârvan 1926) and *Dacia* (Pârvan 1928). *Getica* is a detailed synthesis of the archaeology of Romania until the Roman invasion, *Dacia* is a posthumously published volume in English based on a series of lectures given in Cambridge in 1926, and can be seen as a summary of the monumental *Getica* which was published in that year.

The chapter titles of *Dacia* instantly reveal Pârvan's conception: Carpatho-Danubians *and* the Villanovans, Carpatho-Danubians *and* the Greeks, Carpatho-Danubians *and* the Romans. The cultural unity of the 'Carpatho-Danubians' is taken as fact, and their relationship with other peoples is of interest. This work was written, of course, only a few years after the unification of Transylvania with Romania as one result of the First World War. The need to legitimise this union may have been a factor in the perspective taken. Pârvan concludes *Getica* by stating that to understand the 'birth, development and persistence' of Danubian 'romanism', one needs to understand the protohistory of the region in the first millenium BC (p. 723).[8] It is to be inferred, of course, that this 'romanism' is to be seen in contrast to the Slavs and Hungarians.

Burebista is seen, in the work of Pârvan, as the founder of the 'great Danubian state' (Pârvan 1926, p. 80). This state bought peace and prosperity:

> … for it was not until the days of Burebista that the whole Black Sea coast, from Olbia to Apollonia, acknowledged the sway of the Getae… Even after the death of Burebista himself, when the Dacian state was divided up into several kingdoms, these favourable conditions did not disappear entirely. Pârvan (1928, pp. 106–7)

[7]Our historians today are quasi-unanimous in the appreciation that in the classic period, the Geto-Dacian world was divided into classes organised in a unified state, which was founded by the great King Burebista.

[8]Pentru a înţelege naşterea, dezvoltarea şi persistenţa romanismului danubian, trebuie să cunoaştem înainte de orice protoistoria Europei centrale şi carpato-balcanice în mileniul întîi î.e.n.

This theme of the great 'State' of Burebista re-occurs throughout the next 70 years. Pârvan sees the fortresses in southern Transylvania as "the castles of the Dacian princes of Transylvania" (Pârvan 1928, p. 107–8) which were "admirable centres for the accumulation of booty by warlike chieftains" (p. 120). Pârvan goes on to state:

> When we remember that the limestone and the slabs with which the castle at Gradiştea Muncelului was built and decorated had all to be brought from a great distance and raised up to the summit of a mountain some 4000 feet in height, in the face of very great labour and unheard of dangers, it will be clear that the name of the Getic King Burebista should stand out above all others. (p. 121)

It is noticeable that the fortresses are associated with Burebista, rather than the later king, Decabulus. In *Dacia*, Decabulus is only mentioned twice (p. 134–5 & p. 159), and even in one of those in reference to Burebista. In talking about supplies of gold and silver Pârvan states:

> An equally helpful suggestion is given us by the ancient authors who wrote of the treasures of Decabulus which fell into the hands of Trajan. So much gold... could hardly have been obtained solely as a result of the invasions and foreign wars of Burebista and his successors. (Pârvan 1928, pp. 135–6)

This emphasis on the acheivements of Burebista, rather than Decabulus, is another recurring theme in works dealing with this period. This may be a reflection of the fact that Decabulus lost the war against Trajan and is thus less suitable as a national hero than Burebista, the "first and greatest of the Kings of Thrace."

In 1960 the first volume of the *Istoria Romîniei* was published (Daicoviciu 1960b). This work, published in five volumes from 1960–5, reached "a high level of scholarship" in Romanian history and archaeology (Stahl 1992, p. 124). By this date, as we have seen, the country was firmly under communist rule, and very strongly under Russian influence. For example, the first volume of *Studii şi Cercetări de Istorie Veche*, one of Romania's foremost archaeological journals, had as a frontispiece a photograph of Stalin, and its first paper was about his contribution to the study of archaeology. Russian influence resulted in a concentration on 'Slavic' studies in the 1950s and early 1960s with journals such as 'Romanoslavica' being founded, the first issue of which, published in 1958 in Bucureşti, was entirely in French and Russian.

The first volume of the *Istoria* dealt with the period from the palaeolithic until the transition to feudalism, and contains an important summary of the late Iron Age evidence by Daicoviciu (1960a). By this time there had been extensive excavation on many of the Transylvanian sites such as Gradiştea Muncelului, Costeşti, Piatra Roşie and Blidariu (*e.g.*, Daicoviciu & Ferenczi 1951; Daicoviciu 1954, see Daicoviciu *et al.* 1989 for summary and overview) which had revealed a wealth of new information. This data was again interpreted in terms of the State of the great king Burebista, but now the state was seen as an evolutionary stage in the development of Romania. The classic Dacian period was seen as having reached the stage of an incipient slave-based state which was formed of 'antagonistic classes' (Daicoviciu 1960a, p. 255). Changes at the period are explained by an increase in the 'forces of production.' The fortresses in southern Transylvania formed one of the main pieces of evidence for this development (pp. 278–282).

The evolutionary schema within which the whole of the *Istoria* is cast, although ultimately derived from Engels' *The Origin of the Family, Private Property and the State,* was best-known in Romania at the time from Stalin's *Materialism dialectic şi materialism istoric* (Stahl 1992, p. 126) from which five evolutionary stages were proposed: primitive communism, slavery, feudalism, capitalism and socialism. The *Istoria* was constrained to identify these stages in the archaeological evidence. Stahl (1992) notes that the *Istoria* was written by historians trained in the pre-war non-marxist tradition and as such the work suffers from a lack of theoretical depth.

Within the comparatively short space of 12 years, however, a significant change in the interpretation of Burebista's state occurred. *Dacia de la Burebista la cucerirea romană* (Daicoviciu 1972) still maintained the existence of a Dacian state: "the history of Dacia from Burebista until the Roman Invasion is, above all, the history of the Dacian state" (p. 7)[9]; but no longer was this seen as a 'slave-based' state (Bodor 1981). This change from the strict schema proposed by Stalin could be attributed to the fact that by this time Ceauşescu, whilst maintaining a strictly Marxist state, had broken ranks with the Russians during the Prague spring of 1968. The need now was not to conform to Russian influences, but to show the origins of the benign Romanian state as far back as the late Iron Age.

Perhaps more important than the book itself was a review by Babeş (1974). Babeş is, to my knowledge, the only scholar at this time to openly question the existence of a Dacian state under Burebista. He argued cogently that too much emphasis was placed on the translation of the Greek word ἀρχή as 'state.' (Indeed, the translation of Strabo presented above uses the word 'Empire'). Babeş correctly notes that Strabo's choice of words cannot have had any regard to modern typological niceties. He also condemned the uncritical use of Jordanes *Getica*.

Babeş's review, often quoted, did not significantly change the direction of future publications. *Burebista and his time* (Crişan 1978a) presents a detailed discussion of the life and times of Burebista, including, of course, the formation of his state. Crişan concludes:

> Burebista was by far the most brilliant figure in the history of Dacia exceeding the limits of his people's history. The Daco-Getae gave ancient Europe Burebista, one of the most conspicuous politicians of the Barbarian world of the 1st century BC. Just as Rome gave Caesar. (p. 249)

The map of Burebista's kingdom (p. 139) shows it stretching from Olbia to Apollonia and from Bratislava to the Black Sea, *i.e.,* the greatest extent of Romania between the two Great Wars, plus a little more in the west.

By this period, Ceauşescu saw himself as a latter-day Burebista and the communist party propaganda machine used this period as one weapon in its unceasing campaign. In 1980 the Romanian state celebrated the 2050th aniversary of the foundation of the free, independent and centralised State of the Dacians under Burebista. The occasion was marked by a spate of publications, and most journals carried a heavy emphasis on the late Iron Age (*e.g.,* Crişan 1979; Glodariu 1980; Floca 1981). The number '2050' was planted in shrubs and plants on the side of the hill on which Costeşti stands (Miclea & Florescu 1980, photograph on dust-jacket); there were plans to rebuild

[9] Istoria Daciei de la Burebista la cucerirea romană este, înainte de toate, istoria statului dac.

the walls of Bîtca Doamnei until excavation showed that they were not defensive but supported terraces (Mihăilescu-Bîrliba 1994b). Such emphasis on this period by the communist state inevitably constrained interpretation. Gostar & Lica (1984, pp. 156–157), for example, could only suggest that the Dacian state was somewhere "between Hellenistic monarchy and the small celtic states."

Papers and books published after the Romanian 'revolution' of December 1989 have not, generally, taken the opportunity to reshape the received interpretations. Ursulescu (1992), in an admittedly short volume, does not challenge the 'cvasi-unanimă' opinions of his colleages. Crişan's last book (1993), published shortly before his death, does little to revise his earlier opinions. Two reasons can be adduced for the lack of revisionism. Firstly, the younger generation of archaeologists who studied during the last years of Ceauşescu's rule generally prefer not to study this period. Secondly, communist propaganda can be just as effective as nationalist propaganda. For example, Crişan (1992) has claimed that the borders of Burebista's kingdom could be shown to stretch as far as Bratislava on the basis of some finds of Dacian cups, and a difference in the settlement form as originally suggested by Collis (1972). Some scholars are, however, starting to ask more searching questions of the evidence (*e.g.,* Mihăilescu-Bîrliba 1990).

The question arises as to why the propaganda machine used this period? The answer lies in the long-term history of Romania. As we have seen, unlike Bulgaria, Serbia, Hungary or any of the other Balkan states, Romania never existed as a unified Empire except for one year under Mihai Viteazul. The late Iron Age, and the 'greatest of all the Kings of Thrace', provided an ideal opportunity. Obviously, the inter-war period when Romania was at its largest territorial extent, was not suitable as at this time the Romanian proletariat was supposedly struggling against its capitalist oppressors.

There has, however, been a unexpected and useful consequence of this situation. Presumably because many archaeologists prefered not to write blatant propaganda, there is a strong tradition for the collection and publication of *corpora* of data such as Chiţescu's (1981) corpus of Roman Republican coin hoards and Glodariu's (1976) corpus of Greek and Roman imports to Dacia. By making a distinction between elements of reportage and explanation in the published accounts, I will present one alternative version of the late Iron Age in Dacia (see Chapter 15).

13.6 Republican Coinage in Dacia

A detailed discussion of the monetary evidence for this period will be given in the next chapter. Here I wish to note how, until recently, the presence of these coins has been interpreted.

There are basically two schools of thought: that of the Romanians and that of Michael Crawford. The Romanian school as exemplified by Mitrea (1945, 1958) and Chiţescu (1981) is that the Republican coins represent the development of of trade and commercial links between the Roman Empire and the Dacians, particularly the state of Burebista. Chiţescu sees the development of copies as an attempt by Burebista to create a national coinage based on the most readily available and acceptable coinage of the time, the *denarius*. The dating of these copies, and thus their interpretation is now being questioned (Mihăilescu-Bîrliba 1990).

Crawford (1977b, 1985) sees the presence of these coins as primarily the result of the slave trade with this region after the supression of piracy in 67 BC. The rôle of these coins was simply as a rough and ready method for measuring value, and for the distribution of gifts. Although not denying the existence of some trade between the Dacia and the Graeco-Roman world, he does not believe it sufficient to account for the phenomenon observed.

Both these explanations leave many questions unanswered and I will return to these problems in Chapter 15.

13.7 Summary

In this chapter we have reviewed a diverse selection of pieces of information. Whilst not proposing an environmentally deterministic explanation of the Dacian Iron Age, the physical characteristics of the region have had a powerful effect on the history of the region. Similarly, the post-Iron Age history of the region has had a profound affect on how the Iron Age has been investigated and portrayed from the 19th century onwards. The explanations offered are the outcome from a complex interaction of the evidence, the surviving historical sources, the contemporary situation of the authors both within Romania and within the international archaeological community. Within this complex situation the coinage evidence has been examined and interpreted and it is to that eivdence we turn in the next chapter. In the final chapter I will return to the broader issues and attempt to present an alternative explanation of the evidence.

Chapter 14

Coinage in Dacia

14.1 Introduction

This chapter firstly reviews the evidence for non-Roman coinage in Dacia,[1] and then proceeds to discuss the Roman Republican material in both hoards and site finds in more depth including the problem of copies.

14.2 Non-Roman coinage

Distributed primarily around the Black Sea coast, and associated with early Greek settlement in the region, the earliest objects which appear to have some form of monetary function are a series of small 'arrowheads' (*vîrfurile de săgeţi*) made of copper or bronze (Mihăilescu-Bîrliba 1990, pp. 36–38 & p. 181). They appear to be in two classes: the first is willow-leaf shaped and weighs 4.5–6.5g.; the second has three sides, a truncated point, a central tube filled with lead, and weighs 5–9g. (Preda & Nubar 1973, p. 17 & plate 1). A second group of objects, 'dolphins' (*delfinaşii*), consist of small fish or dolphins made of bronze and are again concentrated on the Black Sea coast mainly near the Greek city of Olbia, in the Ukraine (Simmel 1990, pp. 144–5). Current thinking dates the *vîrfurile de săgeţi* to the earlier part of the 6th century BC, and the *delfinaşii* to the latter part (Mihăilescu-Bîrliba 1990, p. 38).

The earliest coins in the area are a scatter of Greek issues, including some quite early pieces, although these are generally confined to the Black Sea coastal region (Mihăilescu-Bîrliba 1990, p. 40). They include finds from Cyzicus and rare finds from Olbia (Mihăilescu-Bîrliba 1990, pp. 40–43, 52–54; Mitrea 1945, pp. 23–27; Winkler 1955, p. 22). Histria, a Greek foundation on the Black Sea coast of Dobrogea, struck coinage of its own (Mihăilescu-Bîrliba 1990, pp. 43–51; Preda & Nubar 1973) which is most common in its immediate hinterland, but is also found in small quantities in the rest of Dacia, especially southern Moldavia; Glodariu (1976, pp. 216–222) lists 35 finds of Histrian coins from outside Dobrogea.

[1] As was noted in the previous chapter, I here use the term 'Dacia' simply to refer the area which now forms Romania and the Republic of Moldova. No ethnic, political or cultural meanings are implied or intended.

Finds of the issues noted above are relatively rare, especially away from the Black Sea. In contrast, issues of Macedonia struck from the middle of the fourth century BC are relatively common, starting with issues of Philip II (Mihăilescu-Bîrliba 1990, pp. 55–56; Mitrea 1945, pp. 27–45; Winkler 1955, pp. 24–26 & Table I) and particularly issues in the name of Alexander the Great (Mihăilescu-Bîrliba 1990, pp. 56–64; Mitrea 1945, pp. 46–58; Winkler 1955, pp. 26–27 & Table II). These issues are extremely complicated because many were struck in his name after his death; the complication is magnified by the copying of them by the local population. One of Alexander's generals, Lysimachos, took control of Thrace and coins were minted in his name which are also found in Dacia (Winkler 1955, Table III). In 1540 a hoard of 40,000 gold staters of Lysimachos was found near the river Strei (Mitrea 1945, p. 49) very near the concentration of fortresses discussed above (page 369). Winkler (1972a) argues that this hoard was actually found at Sarmizegetusa Regia. This find is also said to have contained issues of ΚΟΣΩΝ (see below). Just as with Philip II and Alexander, coins in the name of Lysimachos were struck posthumuously, and are even thought by some to continue to be struck until the first third of the 1st century BC (Mihăilescu-Bîrliba 1990, p. 59).

The native populations of this region also struck imitations of coins of Philip II (Preda 1973, pp. 27–47) and then went on to to strike their own issues of coinage (Preda 1973, pp. 49 f.). The majority of these issues are derivatives of the coinage of Philip with a bearded head on the obverse and a horse on the reverse. These designs, however, become increasingly stylised, *e.g.,* the Vîrteju-Bucureşti type (Mihăilescu-Bîrliba 1990, pp. 77–79; Preda 1973, pp. 215–248). The distribution of each coin type is often quite restricted: the relatively common Vîrteju-Bucureşti issues cluster primarily around Bucureşti and in Muntenia with a few finds to the west in Oltenia and some in southern Moldavia. Very few coins of this type are found within the Carpathian ring. Smaller issues can have even more restricted distributions, *e.g.,* the Janiform head type (Preda 1973, pp. 142–149). As well as these types, the local populations also struck imitations of issues of Alexander the Great and Philip III (Preda 1973, pp. 325–343); these issues have a wide distribution.

The Geto-Dacian issues probably started in the late third century BC and continued in circulation until the early first century BC. Mixed hoards of Roman Republican and Dacian issues are very rare — there are only two hoards in the CHRR database which include Geto-Dacian issues: Buzău and Baziaş (BUZ & BAZ). Crawford (1985, p. 228, n. 24) asserts that Geto-Dacian coins were not struck in the first century BC, *contra* Preda (1973), but provides no evidence or arguments in support of this statement.

From the middle of the second century BC a number of other coinages are found in Dacia. These include tetradrachms of Macedonia Prima and Thasos, and drachms of Apollonia and Dyracchium. The tetradrachms of Macedonia Prima are mainly found in Transylvania and the central area of the Danube plain (Winkler 1955, map 6); there is only a single find from the east of Dacia (Mihăilescu-Bîrliba 1990, p. 83). Coins of Thasos are more common than those of Macedonia Prima — Glodariu (1976, p. 47) lists 450 tetradrachms of Macedonia Prima and 2,900 tetradrachms of Thasos. Coins of Macedonia Prima are rarely found with Roman Republican issues — the only hoard in the CHRR database that contains both is Nicolae Bălcescu (NB1), and even in this case the coin is a barbarous imitation.[2] Coins of Macedonia Prima are also rarely found with Geto-Dacian coins; Winkler (1955, Table VI) only lists two finds, the hoards from Cojasca and Petelea.

Coins of Thasos, as well as being more common, are more often found associated with Roman Republican coins; the most important finds being the Stăncuţa and Bobaia hoards (STN & BOB). These coins are also often imitated — the Topolovo hoard from Bulgaria (TOP) contained forty imitations of tetradrachms of Thasos and the Sfinţeşti hoard (SFI) contained thirteen.

There is, however, a problem with these tetradrachms. Crawford (1985, pp. 131–2) noted that if one looks at the distribution of finds of these coins as a whole, there is a large concentration in Bulgaria and Romania. From an inspection of some of these finds, Crawford has "no doubt" that "virtually all the Macedonian and Thasian issues in these hoards are local imitations" (p. 132). This view has not met with universal acceptence (Poenaru Bordea *pers. comm.*) and is in contrast to the debate surrounding the Roman Republican series which will be discussed below. It is unfortunately beyond the scope of the present work to investigate this problem, but does have a bearing on the discussion.

As well as these coins, a large number of *drachmae* from the cities of Apollonia and Dyrrachium are found on the territory of Dacia (Glodariu 1976, pp. 48–9, 233–241; Mitrea 1945, chapter 10; Winkler 1955, pp. 40–42, Tables VII–VIII, maps VII–VIII). These coins were struck from the end of the third century BC until *c.* 50 BC (Crawford 1985, pp. 224–5). Coins of Dyrrachium are more common than those of Apollonia — Winkler (1955, p. 40–1) gives a figure of 1,841 *drachmae* of Dyrrachium compared to 293 of Apollonia. Winkler also shows that the vast majority of these issues are found in the intra-Carpathian area (p. 42) but issues a caution that the picture may be biased due to regional publication traditions (p. 43). The earliest catalogues of archaeological and numismatic material concentrated on Transylvania (Carl Gooss) and the Banat (Berckeszi Istvan) as noted by Chiţescu (1981, pp. 3–4), and this influenced the pattern as observed and interpreted by later scholars (*e.g.*, Pârvan 1926). By 1976 the number of finds from Dacia of coins struck in these two cities had risen to 11,900 (Glodariu 1976, p. 48), but the main concentration remained within the Carpathians and in the west of the country, in the Banat and Crişana, although some finds have been made in Oltenia, Muntenia and Moldavia. The distribution of these finds in Transylvania and towards the west of Dacia is much more marked than the finds of Thasos and Macedonia Prima. These *drachmae* were also imitated by the local population as finds such as the Bobaia hoard (BOB) attests.

There are rare finds of other coin types including 'Celtic' (Winkler 1955, p. 44 & Table IX), 'Scythian' (Mihăilescu-Bîrliba 1990, pp. 89–90) and 'Thracian' (Mihăilescu-Bîrliba 1990, p. 91). It is, however, the gold ΚΟΣΩΝ issues which have attracted most attention (Glodariu 1976, pp. 51, 267–8; Mihăilescu-Bîrliba 1990, pp. 91–2; Mitrea 1945, chapter 12; Winkler 1955, pp. 44–6 & Table X; Winkler 1972b). This issue of gold staters imitates *denarii* of M. Brutus (RRC 433/1)

[2] Glodariu (1976, n. 225) also lists Boiu Mare (few details and entirely lost; Chiţescu 1981, No. 21), Conţeşti (a hoard of tetradrachms of Macedonia Prima, plus assorted stray finds which includes Roman *denarii*), Hunedoara III (41 Republican *denarii*, one intrusive imperial *denarius* of Vespasian and one tetradrachm of Macedonia Prima; Winkler 1958, pp. 403–4; Chiţescu 1981, No. 99) and Vărmaga (unknown conditions of discovery, tetradrachms of Thasos and Macedonia Prima and one *denarius*; Chiţescu 1981, No. 211).

giving us a *terminus post quem* using Crawford's chronology of 54 BC. Crawford (1985, p. 238) is dismissive:

> Showy and useless, it [the ΚΟΣΩΝ issue] was probably produced in the area of modern Transylvania in the second half of the first century [BC.]

The finds of these coins appear to concentrate in the Hunedoara area, although records are vague. The first recorded find which may have included coins of ΚΟΣΩΝ was that made in 1540 when a tree fell over revealing a hoard of 40,000 gold coins, which supposedly were of Lysimachos and ΚΟΣΩΝ (Daicoviciu *et al.* 1989, p. 121). The area became known for 'treasure' and during the 18th and 19th centuries many 'excavations' took place. It was during one such treasure-hunt in 1787 that the circular sanctuary at Sarmizegtusa Regia was found (Daicoviciu *et al.* 1989, p. 124). Relatively few specimens of the ΚΟΣΩΝ coinage have survived to the present day.

By the time that Roman Republican *denarii* started to arrive in Dacia, the area already had a long tradition of coin-use and manufacture. These coins are found in hoards and as isolated finds, but also on excavated sites (see Table 14.4). In terms of sheer quantity, however, they are insignificant compared to the Roman Republican coins to which we shall now turn.

14.3 Roman Republican coins in Dacia

14.3.1 Introduction

As previously noted, one of the greatest anomalies in the distribution of Roman Republican coinage is the huge quantity of finds from Dacia. This has been estimated at some 25,000 pieces (Glodariu 1981a, p. 51). These finds have been subject to a series of studies and catalogues (Chiţescu 1981; Glodariu 1976; Mitrea 1945; Winkler 1955; Winkler 1967), but despite these there are still many areas of controversy and disagreement. The second remarkable aspect of these coins is the exceptional evidence for the copying of *denarii* at this time in Dacia. Following Chiţescu (1971b) I make the distinction between *imitations* of *denarii* which are coins of roughly the same weight as genuine *denarii* and use Roman designs but are clearly not products of the central mint and probably were not made with intent to decieve, and *copies* which are all but identical to genuine *denarii* and are thus extremely difficult to detect. Additionally, there are also plated *denarii*; these coins are found across the Roman world (Crawford 1968) and examples from Romania could have arrived with the genuine coins.

In the rest of this chapter these problems will be discussed, both in relation to the results of the analyses presented in Part II and in the light of further analyses to be presented. The questions raised by these coins can be divided into two groups. The first set of questions can be considered fundamental and are amenable to empirical investigation:

1. How does the structure of the hoards compare to contemporary material from elsewhere, especially Italy?

2. What is their spatial distribution, especially in relation to other classes of evidence?

3. When did the supply of these coins start?

4. What was the pattern of supply? Was it constant or erratic?
5. What was the relationship between these coins and the other coins found in Dacia?
6. How many of these coins are locally made copies?
7. When did copying start? When did it end?

Although fundamental, in the sense that the answers to these questions are essential before further interpretation can take place, they are not all straightforward to investigate. Some of these answers can be considered as *reportage*, and the rest are still so dependent on the data as to be considered as low-level explanation. The rest of this chapter will look at these questions. The second set of questions are the more interesting, but are firmly in the realm of explanation:

1. Why did the Romans export so many *denarii* to this region?
2. Why did the local population desire to possess these coins?
3. What was the function of these coins in Geto-Dacian society?
4. Why were the copies made? Why were these copies so precise?
5. What rôle, if any, did these coins play in the changes observed in the late Iron Age of this region?

Obviously, the answers to the fundamental questions will influence the explanations offered in answer to these social and historical questions which will be tackled in Chapter 15.

14.3.2 Supply, structure and distribution

The question of the pattern of supply of *denarii* to the region has been addressed by a number of Romanian scholars and by Crawford, and a number of competing hypotheses exist.

Mitrea, in a large study of the evidence for Muntenia, equates the presence of *denarii* with trade between the Geto-Dacians and the Roman state, and the quantity of *denarii* of particular dates, with the level of trade at those dates Mitrea (1958, p. 177 f.). Thus, trade connections start at the end of the second century BC as shown by the fact that 13.5% of the coins from Muntenia are of that date (p. 180 and Table 1).[3] There then follows a rapid rise in the number of *denarii* dating to the first three decades of the first century (102–73 BC, 68%), followed by a reduction in the number of exchanges (72–44 BC, 13%), and then this “criza” reaches its maximum in 43–3 BC which only accounts for 5% of the coinage in Muntenian hoards. This interpretation followed that of earlier scholars (*e.g.,* Macrea 1933–5, p. 163). This view was slightly modified later (Mitrea 1970b, pp. 434–438), primarily due to the publication of a new catalogue for the Roman Republic (Sydenham 1952). He states that the penetration of *denarii* started before the end of the 2nd century BC, and the period of maximum import was the first two decades of the 1st century BC (Mitrea 1970b, p. 436). Noting that 43% of the Gura Padinii hoard and 58% of the Mihai Bravu hoard dates to before 100 BC, he

[3] Mitrea is using Greuber’s (1910) chronology.

states that it is very probable that most of these coins were introduced into Dacia before or around 100 BC (p. 436).[4]

A number of authors have concurred with this view. Chiţescu (1971a, pp. 162–164) notes that the three periods/decades with most coins in Moldavian hoards were pre-100 BC, 90–81 BC, and 50–41 BC. She argues that lack of coins in the 70s was due to the third Mithradatic war, and the lack in the 60s was because of the turmoil caused by the foundation of the new state by Burebista. She believes that the lack of new imported coinage resulted in the start of the copying of Roman Republican *denarii*. She later re-affirmed this view based on an analysis of 10 hoards from outside Moldavia (Chiţescu & Anghelescu 1972, pp. 310–1).

During the 1970s three new hypotheses were proposed. Preda (1971, p. 75) dates the penetration of *denarii* to the start of the second quarter of the first century BC, or 'even towards the middle of the century', on the basis that Roman Republican *denarii* and Dacian coins of the Vîrteju–Bucureşti type are never found together. This hypothesis was expanded by Preda & Beda (1975) where they allow that there may have been occasional imports of *denarii* at the beginning of the first century (p. 43–4), but that most arrived after the second decade (p. 45).

The second hypothesis was inspired by excavated evidence. Associated with the final phases of the Geto-Dacian settlement of Cîrlomăneşti were a number of coins, primarily a hoard of Vîrteju-Bucureşti issues, but also one coin of the Inoteşti-Răcoasa type, one coin of Philip III Arrhidaeus, one tetradrachm of Thasos and one drachm of Dyrrachium (Babeş 1975, pp. 129–35); no Republican coins were found. Given the abundance of *denarii* in Dacia this led Babeş to conclude that the site must have been abandoned prior to the arrival of Roman *denarii* in Dacia, and thus to investigate the date of that arrival. Firstly, Babeş presented a table, reproduced here as Table 14.1, showing associations within Dacian hoards. This clearly showed that Roman *denarii* are very rarely found with Geto-Dacian issues or coins of Macedonia Prima, but are often found with coins of Thasos, Dyrrachium and Apollonia. Coins of Illyrian cities are usually found together, but not always with Roman *denarii*. Babeş noted that most of these drachms were probably struck 125–75 BC, and because there exist hoards of drachms without *denarii*, that the latter must start to arrive in Dacia later than the drachms. He proposed two phases of coin use (p. 132):

1. An 'ancient' phase with Geto-Dacian coins, tetradrachms of Macedonia Prima and Thasos, and the earliest drachms of Apollonia and Dyrrachium.

2. A 'recent' phase dating from the arrival of Roman Republican coinage which circulated with coins of Apollonia, Dyrrachium and Thasos.

Babeş then referred to Poenaru Bordea's (1974, pp. 232–3) observation that the great majority of hoards closing in the early first century BC were incomplete, and argued that the traditional interpretation of the pattern of supply was difficult to sustain (p. 133). Babeş then moved on to argue that coinage would take some time to arrive in Dacia after minting and that it is unlikely that much coinage arrived before 50 BC. He therefore dated the end of the ancient phase and the start of the recent phase to *c*. 50 BC.

[4]"Este foarte probabil că o bună parte din aceste monede [those from before 100 BC] să fi fost introduse în Dacia încă înainte sau imediat în jurul anului 100 î.e.n."

	Geto-dacian	Macedonia Prima	Thasos	Dyrrachium	Apollonia	Roman Republican
Macedonia Prima	2					
Thasos	8	17				
Dyrrachium	1	1	8			
Apollonia	1	1	4	33		
Roman Republican	2	3	18	20	13	
silver jewelry	1	—	4	6	4	15

Table 14.1: Association of coin series in hoards from Dacia, 2nd century BC– 1st century AD. From Babeş 1975, Fig. 6.

The third hypothesis is that of Crawford (1977b).[5] He correctly noted that those periods claimed by Mitrea and others to be periods of high import were periods of high coin production, and thus the quantity of coins of those dates in Romania need have no bearing on the date of import (Crawford 1977b, p. 119, n. 17). He also stated:

> On balance, therefore, the beginning of the massive penetration of Republican denarii may be regarded as contemporary with the closing date of the earliest hoards of Republican denarii from the Danube basin… For it is implausible to suppose, in view of the large number of hoards of non-Roman coins of earlier centuries, that Republican denarii circulated for very long in the Danube basin without being hoarded. (Crawford 1977b, p. 119)

He presented two tables of data, for Romania and Bulgaria (pp. 123–4), which clearly showed the earliest hoards (with in excess of six *denarii*) dating to 80–76 BC (*cf.* Fig. 14.1 below). Crawford went on to argue that because few of the hoards were known in their entirety, and because there may have been a time lap between the striking date of a coin issue and its arrival in Dacia, the closing dates of the hoards are even less likely than usual to reflect the hoard's date of deposition (pp. 120–1). He therefore argued that the massive penetration of *denarii* to Dacia started in the mid-60s BC onwards. This date fitted well with his hypothesis that this penetration was due to an increase in the slave trade after the suppression of piracy by Cn. Pompeius in 67 BC.

By 1980, therefore, there were four competing hypotheses: the 'traditional' Romanian view (penetration starts around 100 BC), Preda–Poenaru (starts 80–70 BC), Crawford (65 BC onwards) and Babeş (50 BC onwards). The traditional view can be seen to be manifestly wrong — the striking date of a coin only provides a *terminus post quem* for the import and deposition of a coin. The hoard evidence clearly contradicts the view that these coins arrived in any quantity prior to 100 BC. Preda's and Babeş' hypotheses take this point, but are both reliant on more poorly dated issues such as the Geto-Dacian tetradrachms and the drachms of Apollonia and Dyrrachium. Crawford's date would seem preferable as it was based on the more securely dated Republican series, and from a intimate knowledge of Republican hoards from across Europe. He did not, however, discuss the possible implications of his observation that "Most Dacian hoards consist of a run of issues followed by a

[5] Here I only review Crawford's views in regard to the date of the import of issues. His views concerning the reasons for these issues with be discussed in Chapter 15.

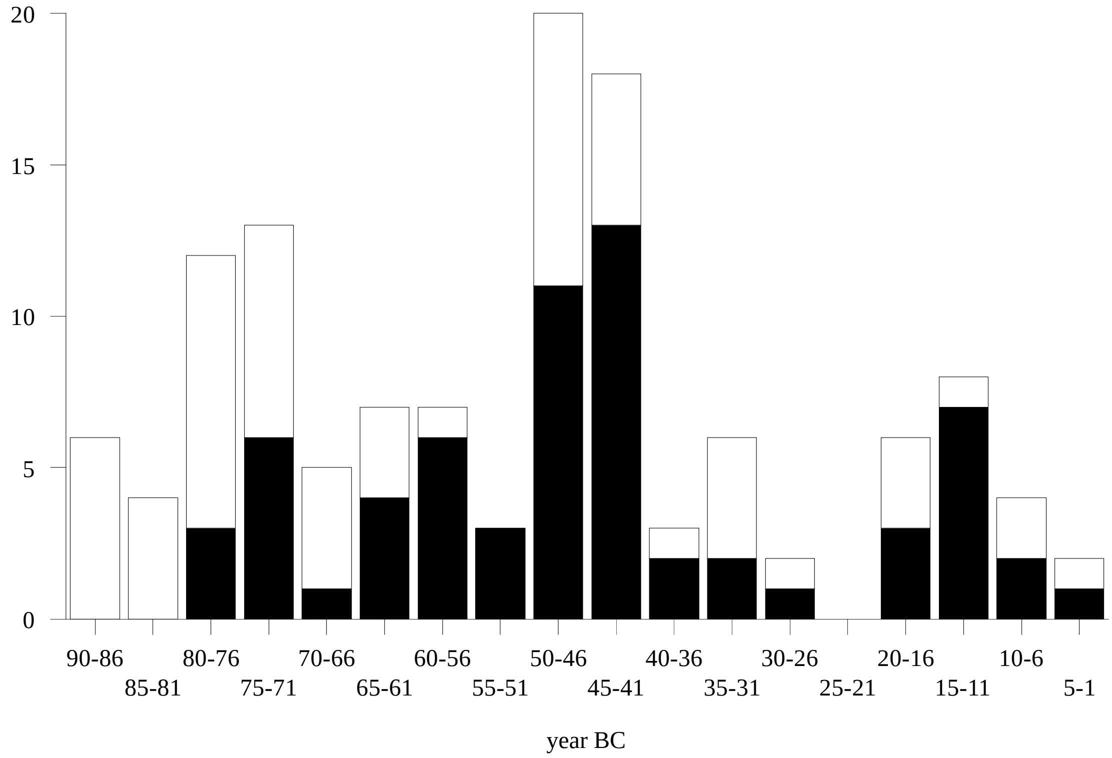


Figure 14.1: Number of hoards by date from Romania. Solid bars represent hoards with ⩾30 'good' *denarii*; open bars hoards <30. Hoards Olteni and Bugiuleşti with `end_date`'s prior to 100 BC omitted as they contain only 3 well-identified *denarii* between them. The pattern after 31 BC is possibly unrepresentative.

few pieces separated by several years from each other and from the hoard as a whole" (Crawford 1977b, p. 119).

In her catalogue of the Republican coinage from Romania, Chiţescu presented a series of tables showing the closing dates of hoards from various regions of Romania (Chiţescu 1981, pp. 11–13), which clearly showed the earliest hoards dating to after 80 BC (Sydenham's chronology). She then presented an overview of the various suggestions for the pattern of supply of *denarii* to Dacia (pp. 14–16), before proceeding to fly in the face of her own data and concur with the views of Mitrea and others because they "correspond entirely to the historical reality" (p. 16), and argued that:

> We can ascertain that, during the last decade of the 2nd century B.C., Roman Republican coins are coming into Dacia more than sporadically, while, by the year 100 B.C., this type of coin starts to impose itself as the only coinage throughout the whole Geto-Dacian world. (p. 16)

The last contribution to this debate was that of Poenaru Bordea & Cojocărescu (1984) which has been briefly reviewed in section 3.14, page 104. This remarkable paper used Crawford's die-estimates to provide the background pattern, which all previous Romanian analyses had lacked, an idea originally proposed in the Romanian literature by Ocheşeanu (1981). They proposed that the hoard structure of the five Transylvanian hoards analysed suggested that the main period of supply of coinage to Dacia was 75–65 BC, but that after this period the supply decreased dramatically. This decrease in supply is *not* simply a reflection of the low level of coinage production in the 60s and 50s BC, as the quantity of *denarii* in Romania was below the production levels suggested by Crawford in RRC. The main problem with this technique is its reliance on Crawford's controversial die estimates which were investigated in Chapter 11.

To answer this question we need to examine the closing dates of the Romanian hoards, and to examine the structure of Romanian hoards in comparison to the Italian baseline. Fig. 14.1 shows that although there are a number of hoards closing prior to 80 BC, all contain very few *denarii*. The first hoard with any significant number of *denarii* is Bobaia (BOB) closing in 79 BC. This hoard is a mixed deposit containing *denarii*, drachms of Apollonia and Dyracchium, and tetradrachms of Thasos. In structure, this hoard is rather archaic compared to Italian material (section 8.3.7, page 188). The next two hoards of any size, Inuri and Alexandria (INU & ALX), both close in 75 BC and are similar to contemporary Italian material (section 8.3.8). A similar pattern is observed with other Romanian hoards dating to the 70s and early 60s (sections 8.3.9–8.3.10). From this we can conclude that the supply of *denarii* to this region may have begun slightly before 80 BC, but is unlikely to have reached any significant level until the middle of the 70s BC.

In comparison to the level of hoarding elsewhere, and the pattern of striking, there are a surprising number of hoards closing 65–50 BC from this region. This could be seen as support for Crawford's dating, but the fact that hoard structure in this period becomes increasingly archaic raises further complications. The cluster analysis (Chapter 10) showed that a majority of the Romanian hoards examined were most similar in structure to Italian hoards closing in the 70s BC (Class 1 hoards) and a minority being similar to later Italian hoards from 55–29 BC (Class 2). This was in agreement with the correspondence analyses (section 8.3). A global CA (not presented) of the Romanian data showed that the majority of the hoards were very similar to each other.

We can conclude that not only was there a massive penetration of *denarii* to this area starting *c.* 75 BC, but that a overwhelming proportion of the Republican *denarii* hoarded in Dacia probably arrived in the period *c.* 75 BC– *c.* 65 BC. Thereafter, the supply of *denarii* became more erratic, although there is a likely to have been an increase in supply in the 40s BC. This is *not* simply a reflection of the increased levels of production in that decade. The statistical analyses therefore confirm the pattern proposed by Poenaru Bordea & Cojocărescu (1984).

This explanation of the evidence raises a further question: if the majority of the coinage enters the area in *c.* 75–65 BC, why is the number of hoards dating to 65–50 BC so high, especially in comparison to the relative frequency of Italian hoards of that date, and the relative rarity of coins of that date? This question will be addressed in Chapter 15.

The distribution of hoards across the country is obviously of interest. Fig. 14.2 shows all the hoards containing Roman Republican coins found in Romania up until 1981. As can be seen, there are three main concentrations of hoards: southern Moldavia, the central part of the Danube (Wallachian) plain, and Transylvania, although there are a scatter of hoards in most parts of Romania. The separation between Transylvania and the other two groups is due to the Carpathians. The lack of hoards in eastern Muntenia is, however, quite marked. This point distribution is, however, slightly misleading. For example, the majority of the coins in Moldavia, as opposed to the find-spots, occur in the settlement at Poiana; the finds to the north tend to be much smaller. This is also reflected in other classes of finds (Teodor 1983–1984).

Formal spatial analysis of the hoard material was beyond the scope of this project but will be the subject of future work. One fruitful line of enquiry would be to compare the results of the statistical analyses with the spatial distribution of hoards. An informal investigation along these

Figure 14.2: Distribution map of Roman Republican hoards in Romania. From Chiţescu (1981).

code	hoard	country	‘end date’	‘good total’
Class 1 hoards closing after 55 BC				
CLN	Călineşti	Romania	54	92
CUC	Cuceu	Romania	48	484
FA2	Fărcaşele	Romania	42	113
GUR	Gura Padinii	Romania	32	232
ISA	Işalniţa	Romania	41	134
ISL	Islaz	Romania	42	124
JEG	Jegălia	Romania	43	453
LOC	Locusteni	Romania	48	88
OBI	Obislav (Dîmboviţa)	Romania	32	50
ODS	Orbeasca de Sus	Romania	48	137
ROA	Roata de Jos	Romania	49	35
SAT	Satu Nou	Romania	49	125
SDS	Sălaşul de Sus	Romania	54	103
STP	Stupini	Romania	41	226
VAS	Văşad	Romania	46	53
Class 2				
BPT	Bran Poartă	Romania	42	59
BUZ	Buzău	Romania	54	48
ILI	Ilieni	Romania	46	108
NAG	Nagykágya	Romania	42	131
NB2	Nicolae Bălcescu	Romania	42	43
PRE	Prejmer	Romania	42	149
PRS	Poroschia	Romania	39	541
RAC	Răcătău de Jos II	Romania	39	53
SEI	Şeica Mică	Romania	29	348
SIN	Sînvăsii	Romania	46	43
SPR	Sprîncenata	Romania	46	110
TI2	Tîrnava	Romania	46	148
VIS	Vişina	Romania	41	139

Table 14.2: Class 1 hoards closing after 55 BC, and all Class 2 hoards plotted in Fig. 14.3. Class 2 hoard ‘Transylvania’ (TRN) omitted as no exact findspot known.

lines was performed by plotting groups and classes of hoards derived from the cluster analysis. A map of all the hoards analysed did not appear to show any particular patterning but a second map was drawn which plotted the Class 2 hoards, those with a more modern structure, and the Class One hoards which closed after 55 BC, *i.e.*, hoards with an archaic 70s structure (Table 14.2, Fig. 14.3). This map does appear to show patterning in the evidence with Class 2 hoards mainly occuring in Moldavia and south-eastern Transylvania, with a small cluster in south central Wallachia. This evidence is suggestive, but a detailed exploration of its validity is outside the scope of this study. One may posit, however, that Republican coinage entering the area in the 50s–30s BC did so largely from the east. A second interesting facet of the data is the concentration of Class 2 hoards in south-central Wallachia which includes the hoard from Poroschia (PRS). The Poroschia hoard is extremely important as it has excellent evidence for the copying of *denarii*, and will be discussed below in some detail. The existence of a relatively coherent group of hoards, in spatial and structural terms, is again suggestive.

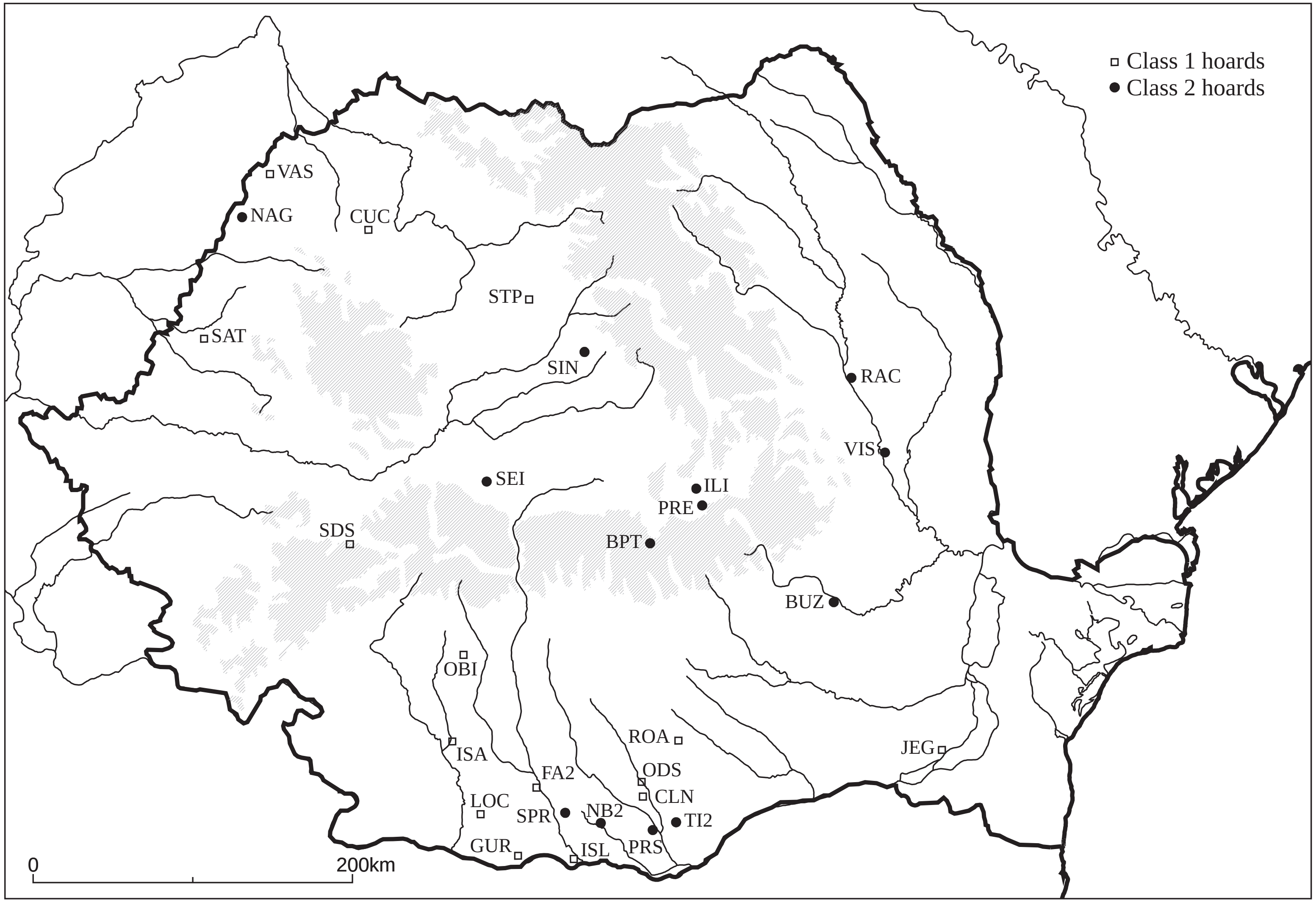


Figure 14.3: Distribution map of Class 1 and Class 2 hoards in Romania closing after 55 BC— see Table 14.2 for details.

14.3.3 *Denarii* and the pre-Roman coinages

The relationship between the pre-*denarii* coinage and *denarii* is not easy to investigate. The hoard evidence must be used with caution because even in areas where the different coin denominations form part of an integrated system, we often find only one type or denomination hoarded together. The Republican hoards in Italy, for example, mainly consisted of *denarii*, or sometimes *denarii* and *quinarii*— rarely were bronze denominations hoarded along with the silver. We can compare this to the evidence from Pompeii where we have the contents of the purses of those who died (Breglia 1950). Here we find, for example, one skeleton with a purse which contained 1 *aureus*, 101 *denarii*, 5 *sestertii* and 1 *as*, and another skeleton with a small box which contained 24 *denarii*, 16 *sestertii* and 21 *asses* (Breglia 1950, Table B, nos. 55–56). Conversely, a vase in the *recinto di Vestorio Prisco* contained 29 *denarii* and no other denominations (Table B, no. 54), and a *dolia* in a shop in the first region contained only bronze (374 *asses* and 1237 *quadranti*; Table B, no. 59).

The use of site evidence is equally problematic. Unless good stratigraphic evidence is available, site lists are the cumulative loss of coins over the life of the site and thus provide little evidence as to which issues were circulating simultaneously.

In Dacia, however, we do have some mixed hoards. Table 14.3 lists all hoards from Romania which are currently in the CHRR database; 25% are mixed deposits. As can be seen, hoards containing Roman Republican coins rarely contain coins of Alexander the Great, Histria, Macedonia Prima or Geto-Dacian issues, as was observed by Preda (1973) and Babeş (1975). They do, however, frequently contain coins of Apollonia, Dyracchium and Thasos. The hoards are listed in Table 14.3 in order of closing-date. From this we can see that of the 163 tetradrachms of Thasos, 73% are in hoards closing before 60 BC. Of the 667 drachms of Apollonia and Dyrrachium, 78% are in hoards closing before 60 BC; of the remainder, 144 (21.6%) are in the Deva (DV3) hoard. We can gain an impression, therefore, that during the period of massive penetration of *denarii* to Romania, the earlier coinages and *denarii* ‘circulated’, or at least were occasionally hoarded, together. By the mid-50s BC, however, these earlier coinages seem to have largely disappeared from circulation. Why tetradrachms of Thasos and its copies remained in circulation for considerably longer than the tetradrachms of Macedonia Prima remains a paradox.

14.3.4 The site find evidence

The site find evidence has been conveniently summarised by Mihăilescu-Bîrliba (1990, Table 6) and is presented here in Table 14.4. The sites have been divided into 3 regions: Moldavia, Oltenia and Muntenia, and Transylvania and Crişana. From Table 14.4d there appear to be marked differences between the the regions. Moldavia, for example, is dominated by Roman Republican issues (90%), Muntenia and Oltenia is dominated by Geto-Dacian issues (62%) and Transylvania and Crişana is dominated by Roman Republican issues (68%) and coins of Histria (14%). These totals are misleading. A closer examination of Table 14.4a shows that the majority of the Roman Republican issues come from two sites: Poiana and Răcătău. These totals are largely the result of the six hoards from Poiana, and two hoards from Răcătău. Similarly, 133 of the Geto-Dacian coins from Muntenia and Oltenia come from Cîrlomăneşti, mainly from a dispersed hoard (Table 14.4b; Babeş 1975).

Table 14.3: Hoards from Romania in the CHRR database. Totals given include copies.

code	hoard	date	Alex.	Histria	Geto-Dac.	Mac.I	Thasos	App. & Dyr.	Roman	other	total
OLT	Olteni	194	·	·	·	·	·	·	2	·	2
BUG	Bugiuleşti	112	·	·	·	·	·	·	2	·	2
TMR	Tîrgu Mureş	90	·	·	·	·	·	·	3	·	3
HIL	Hilib	89	·	·	·	·	21	79	1	·	101
ZIM	Zimnicea	88	·	·	·	·	·	·	3	·	3
CRM	Cremenari	87	·	2	·	·	·	·	2	·	4
FUN	Fundeni	87	·	·	·	·	·	1	9	·	10
ORA	Oradea	86	·	·	·	·	·	·	4	·	4
DRG	Drăgeşti	85	·	·	·	·	·	133	3	·	136
ICL	Iclănzel	84	·	·	·	·	2	·	18	·	20
ADJ	Amărăştii de Jos	84	·	·	·	·	·	·	4	·	4
DV1	Deva I	83	·	·	·	·	·	1	8	·	9
LUD	Luduş	82	·	·	·	·	·	·	2	·	2
NED	Nedeia	79	·	·	·	·	·	·	19	·	19
BOB	Bobaia	79	·	·	·	·	25	185	41	·	251
MSI	Moisei	79	·	·	·	·	·	·	5	·	5
GDJ	Gliganul de Jos (Rociu)	79	·	·	·	·	·	·	11	·	11
SU1	Suhaia I	79	·	·	·	·	·	10	27	·	37
SA1	Sălasuri I	79	·	·	·	·	·	·	4	·	4
NUS	Nuşfalău	79	·	·	·	·	·	·	18	·	18
BAL	Bălăneşti	78	·	·	·	·	·	·	10	·	10
ALX	Alexandria	77	·	·	·	·	4	·	32	·	36
INU	Inuri	77	·	·	·	·	·	·	37	·	37
MIE	Mierea	77	·	·	·	·	·	·	3	·	3
SOM	Şomoşcheş	76	·	·	·	·	·	·	10	·	10
COR	Cornetu	75	·	·	·	·	·	1	128	·	129
ZAT	Zătreni	75	·	·	·	·	·	·	41	·	41
MBR	Mihai Bravu	75	·	·	·	·	·	·	57	·	57
JDI	Jdioara	74	·	·	·	·	·	·	69	·	69
HN4	Hunedoara	74	·	·	·	·	·	32	42	·	74
HOT	Hotărani	74	·	·	·	·	·	·	25	·	25
NAS	Năsăud	74	·	·	·	·	·	·	8	·	8
MHA	Mihăeşti	74	·	·	·	·	·	·	14	·	14
LNC	Lunca	74	·	·	·	·	·	·	12	·	12
TAL	Talpe	71	·	·	·	·	·	64	21	·	85
SFI	Sfinţeşti	71	·	·	·	·	13	·	93	·	106
HTR	Hotăroaia	71	·	·	·	·	·	·	9	·	9
BNC	Bancu	71	·	·	·	·	·	·	3	·	3
MTN	Mărtiniş	70	·	·	·	·	1	·	15	·	16
TIN	Tincova	69	·	·	·	·	·	·	147	·	147
NB1	Nicolae Bălcescu	69	·	·	·	1	·	·	13	·	14
GRD	Gradiştea	67	·	·	·	·	1	·	21	·	22
PTS	Pietrosale	67	·	·	·	·	·	·	3	·	3
CUR	Curtea de Argeş	64	·	·	·	·	·	·	10	·	10
BAZ	Baziaş	63	·	·	1	·	·	13	38	·	52
STN	Stăncuţa	63	·	·	·	·	53	·	34	·	87
GAR	Gărvan	63	·	·	·	·	·	·	29	·	29
LCR	Licuriciu	62	·	·	·	·	·	·	63	·	63
BON	Bonţeşti	62	·	·	·	·	·	·	37	·	37
SOP	Şopotu	62	·	·	·	·	·	·	32	·	32
ALN	Alungeni	59	·	·	·	·	·	·	33	·	33
CHT	Chiţorani	57	·	·	·	·	·	2	7	·	9
FND	Frauendorf	56	·	·	·	·	·	·	563	·	563

Table 14.3 continued from previous page…

code	hoard	date	Alex.	Histria	Geto-Dac.	Mac.I	Thasos	App. & Dyr.	Roman	other	total
SMC	Somesul Cald	56	·	·	·	·	·	·	117	·	117
AMN	Amnaş	56	·	·	·	·	·	·	157	·	157
ICN	Icland	56	·	·	·	·	2	·	34	·	36
DUN	Dunăreni	56	·	·	·	·	·	·	128	·	128
CLN	Călineşti	54	·	·	·	·	3	·	98	·	101
BUZ	Buzău	54	·	·	1	·	·	·	48	·	49
SDS	Sălaşul de Sus	54	·	·	·	·	·	·	111	·	111
ROA	Roata de Jos	49	·	·	·	·	·	·	35	·	35
SAT	Satu Nou	49	·	·	·	·	1	·	129	·	130
BRN	Brîncoveanu	49	·	·	·	·	·	·	14	·	14
ALS	Albeşti	49	·	·	·	·	·	·	10	·	10
CUC	Cuceu	48	·	·	·	·	33	·	488	2	523
PLO	Ploieşti	48	·	·	·	·	·	·	6	·	6
TI1	Tîrnava	48	·	1	·	·	·	·	20	·	21
BUC	Bucureşti	48	·	·	·	·	1	·	6	·	7
LOC	Locusteni	48	·	·	·	·	·	·	89	·	89
ODS	Orbeasca de Sus	48	·	·	·	·	·	·	143	·	143
TRN	Transylvania	47	·	·	·	·	·	·	43	·	43
BIR	Bîrsa	47	·	·	·	·	·	·	29	·	29
VAS	Văşad	46	·	·	·	·	·	1	53	·	54
TI2	Tîrnava	46	·	·	·	·	·	·	148	·	148
ILI	Ilieni	46	·	·	·	·	·	·	111	·	111
SIN	Sînvăsii	46	·	·	·	·	·	·	44	·	44
VLA	Vlădeni	46	·	·	·	·	·	·	14	·	14
SPR	Sprîncenata	46	·	·	·	·	·	·	110	·	110
GOR	Goranu	46	·	·	·	·	·	·	5	·	5
ROE	Roeşti	46	·	·	·	·	·	·	21	·	21
JEG	Jegălia	43	·	·	·	·	2	·	482	·	484
SU2	Suhaia II	43	·	·	·	·	·	·	10	·	10
PIA	Piatra Roşie	43	·	·	·	·	·	·	277	·	277
NAG	Nagykágya	42	·	·	·	·	·	·	154	·	154
PRE	Prejmer	42	·	·	·	·	·	·	158	·	158
MUR	Murighiol	42	·	·	·	·	·	·	9	·	9
MR1	Moroda I	42	·	·	·	·	·	·	10	·	10
ISL	Islaz	42	·	·	·	·	·	·	160	·	160
FA2	Fărcaşele	42	·	·	·	·	·	·	120	·	120
LIP	Lipov	42	·	·	·	·	·	·	7	·	7
NB2	Nicolae Bălcescu	42	·	·	·	·	·	·	45	·	45
CDJ	Cernatu de Jos	42	·	·	·	·	·	1	4	·	5
BPT	Bran Poartă	42	·	·	·	·	·	·	63	·	63
FA1	Fărcaşele	42	·	·	·	·	·	·	84	·	84
ISA	Işalniţa	41	·	·	·	·	·	·	134	·	134
VIS	Vişina	41	·	·	·	·	·	·	146	·	146
STP	Stupini	41	·	·	·	·	·	·	231	·	231
SD2	Sadova II	41	·	·	·	·	·	·	30	·	30
PRS	Poroschia	39	·	·	·	·	·	·	552	·	552
RAC	Răcătău de Jos	39	·	·	·	·	·	·	55	·	55
DOB	Dobrogea	38	·	·	·	·	·	·	17	·	17
ROS	Roşiori de Vede	32	·	·	·	·	·	·	6	·	6
GUR	Gura Padini	32	1	·	·	·	1	·	232	·	234
OBI	Obislav	32	·	·	·	·	·	·	53	·	53
CTN	Costineşti	32	·	·	·	·	·	·	17	·	17
BRS	Breasta	32	·	·	·	·	·	·	11	·	11
DV3	Deva	32	·	·	·	·	·	144	2	·	146
VLM	Valachia Mică	29	·	·	·	·	·	·	17	·	17
SEI	Şeica Mică	29	·	·	·	·	·	·	348	·	348

Table 14.3 continued from previous page...

code	hoard	date	Alex.	Histria	Geto-Dac.	Mac.I	Thasos	App. & Dyr.	Roman	other	total
CAP	Căpîlna	19	·	·	·	·	·	·	28	·	28
DAE	Dăeşti	19	·	·	·	·	·	·	4	·	4
PLP	Plopşor	19	·	·	·	·	·	·	52	·	52
CRN	Cornii de Sus	18	·	·	·	·	·	·	113	·	113
SCU	Scurta	17	·	·	·	·	·	·	14	·	14
BRD	Bordeşti	16	·	·	·	·	·	·	44	·	44
CNT	Conţeşti	15	·	·	·	·	·	·	145	·	145
1PO	Poiana	15	·	·	·	·	·	·	152	·	152
PIR	Pîrgăreşti	15	·	·	·	·	·	·	6	·	6
SPG	Şpring	15	·	·	·	·	·	·	50	·	50
CET	Cetăţeni	13	·	·	·	·	·	·	127	·	127
SG1	Sfîntu Gheorghe	13	·	·	·	·	·	·	61	·	61
CIU	Ciuperceni	12	·	·	·	·	·	·	161	·	161
STB	Strîmba	11	·	·	·	·	·	·	215	·	215
RDJ	Răcătău de Jos	8	·	·	·	·	·	·	70	1	71
BRZ	Breaza	8	·	·	·	·	·	·	132	·	132
VII	Viile	2	·	·	·	·	·	·	51	·	51
Total			1	3	2	1	163	667	8915	3	9751

The presence of large quantities of coins of Histria at Costeşti (Macrea 1933–5) is the cause of the large proportion of these coins in Transylvania (Table 14.4c). A final source of bias in these tables is the omission of sites which have no coin evidence. For example, the well-excavated site of Arpasu de Sus (Macrea & Glodariu 1976) in SE Transylvania had no coin finds. It would be useful to know what porportion of the settlements excavated had any coin finds, although even this would be biased as until now excavation has largely concentrated on the major, richer, settlements.

We can, however, remove some of these biasses by using presence absence data. For example, in Muntenia and Oltenia 7 of 8 (87.5%) sites have Geto-Dacian coins, compared to 1/13 (7.7%) of sites listed in Transylvania/Crişana and 4/8 (50%) of sites listed for Moldavia, thus reinforcing the picture given by the percentage totals. For coins of Histria, however, the distribution is more even than the total percentages suggest.[6] Although only in Moldavia do all the sites have some Republican issues, the very low percentage for Muntenia and Oltenia can be seen to be a false impression created by the hoard of Geto-Dacian coins at Cîrlomăneşti — the picture is in fact more even.[7]

We should also note that *all* the Trajanic issues are found on Transylvanian sites, none have been found on Moldavian, Muntenian or Oltenian sites. Imperial period coin hoards continue to occur in the areas outside the Roman provinces (see maps in Guest 1993; Mihăilescu-Bîrliba & Butnariu 1993), and the lack of later coins on these sites remains a problem. For example, based on coin finds alone, we might suggest that there was a major dislocation in the settlement pattern in Transylvania in the period Nero–Vespasian because all four major excavated sites have coin lists which stop at this time.

The disruption of the settlement pattern in Transylvania during the reign of Trajan, especially the fortified mountain sites such as Căpîlna, Costeşti and Grădiştea Muncelului, should occasion

[6] Moldavia: 3/8 (37.5%); Muntenia & Oltenia: 3/8 (37.5%); Transylvania & Crişana 3/13 (23%).
[7] Moldavia: 8/8 (100%); Muntenia & Oltenia: 6/8 (75%); Transylvania & Crişana 9/13 (69%).

Coin series	Brad	Buneşti	Galaţi-Barboşi	Moineşti	Bîtca-Doamnei	Poiana	Poiana-Dulceşti	Răcătău	Total		%
									No.	%	of all
Macedonian	1 AR	1 AR	·	·	·	1 AR (imitation)	·	·	3	0.33	0.22
Geto-Dacian	4 AR	16 AR	·	·	·	2 AE + 11 AR	·	5 AR	+38	4.16	2.84
Celtic	·	·	·	·	·	·	·	·	0	·	0
Macedonia Prima	·	·	·	·	·	·	·	·	0	·	0
Thasos	·	·	·	·	·	1 AR (imitation)	·	·	1	0.11	0.07
Dyrrachium	·	·	·	·	1 AR	1 AR	·	·	2	0.22	0.15
Apollonia	·	·	·	·	·	1 AR	·	·	1	0.11	0.07
Histria	·	1 AR	+ AE	·	·	5 AR	·	·	+6	0.66	0.45
Tomis	·	·	+ AE	·	·	·	·	·	+	·	0
Callatis	·	·	·	·	·	35 AE	·	·	35	3.83	2.61
Other Greek coins	·	·	+ AE	·	·	·	·	2 AE	+2	0.22	0.15
Roman Republican	11 AR	1 AR	3 AR	2 AR	2 AR	644 AR + 8 AE	1 AR	150 AR + 1 AE	+823	90.04	61.46
Augustus	2 AR	·	+	·	·	+	·	+	+2	0.22	0.15
Tiberius	·	·	+	·	·	+	·	+	+	·	+
Caligula	·	·	+	·	·	+	·	+	+	·	+
Claudius	·	·	+	·	·	+	·	+	+	·	+
Nero–Vitellius	1 AE	·	+	·	·	+	·	+	+1	0.11	0.07
Vespasian	·	·	+	·	·	+	·	·	+	·	+
Titus	·	·	·	·	·	·	·	·	0	·	0
Domitian	·	·	·	·	·	·	·	·	0	·	0
Nerva	·	·	·	·	·	·	·	·	0	·	0
Trajan	·	·	·	·	·	·	·	·	0	·	0
total	19	19	+3	2	3	709	1	158	914		
total (%)	2.08	2.08	0.33	0.22	0.33	77.57	0.11	17.29			
overall total (%)	1.42	1.42	0.22	0.15	0.22	52.95	0.07	11.8			68.26

(a) Area A — Moldavia

Table 14.4: Coin finds from Dacian settlements. After Mihăilescu-Bîrliba 1990, Table 6.

Coin series	Buridava	Cetăţeni	Cîrlomăneşti	Pietrosale	Piscu Crăsani	Popeşti	Sprîncenata	Tinosul	Total		%
									No.	%	of all
Macedonian	·	·	1 AR	·	1 AV	·	·	+1 AE	+3	1.11	0.22
Geto-Dacian	1 AR	+	133 AR	2 AR	8 AR	·	1 AR	23 AR	+168	62.22	12.55
Celtic	·	·	·	·	·	·	·	·	0	·	0
Macedonia Prima	·	·	·	·	2 AR	·	·	·	2	0.74	0.15
Thasos	·	·	1 AR	·	·	·	·	·	1	0.37	0.07
Dyrrachium	4 AR (1 imitation)	·	1 AR	·	·	·	·	·	5	1.85	0.37
Apollonia	·	·	·	·	·	·	·	·	0	·	0
Histria	·	·	·	1 AR	1 AR	·	1 AR	·	3	1.11	0.22
Tomis	·	·	·	·	·	·	·	·	0	·	0
Callatis	·	·	·	·	·	+AE	·	·	+	·	+
Other Greek coins	·	1 AE	·	·	·	1 AR	·	·	2	0.74	0.15
Roman Republican	37 AR (1 imitation)	+ AR	·	3 AR	3 AR	+	19 AR	·	62	22.96	4.63
Augustus	8 AR +1 AE	·	·	·	·	1	·	·	10	3.7	0.75
Tiberius	3 AE	·	·	·	·	·	·	·	3	1.11	0.22
Caligula	1	·	·	·	·	·	·	·	1	0.37	0.07
Claudius	3 AR	·	·	·	·	·	1 AE?	1	5	1.85	0.37
Nero–Vitellius	·	·	·	·	·	·	·	·	0	·	0
Vespasian	3 AR	·	·	·	·	·	·	·	3	1.11	0.22
Titus	1 AR	·	·	·	·	·	·	·	1	0.37	0.07
Domitian	1 AR	·	·	·	·	·	·	·	1	0.37	0.07
Nerva	·	·	·	·	·	·	·	·	0	·	0
Trajan	·	·	·	·	·	·	·	·	0	·	0
total	63	+1	136	6	15	+2	22	+25	270		
total (%)	23.33	0.37	50.37	2.22	5.55	0.74	8.15	9.26			
overall total (%)	4.71	0.07	10.16	0.45	1.12	0.15	1.64	1.87			20.16

(b) Area B — Muntenia and Oltenia

Table 14.4: Coin finds from Dacian settlements (continued). After Mihăilescu-Bîrliba 1990, Table 6.

Coin series	Blidariu	Căpîlna	Cernatul	Cîmpuri	Costeşti	Cuciulata	Grădiştea	Piatra	Sălaşuri	Sf.	Sf. Gheorghe	Sîncrăieni	Ziridava	Total (C)		%
	·	·	de Sus	Surduc	·	·	Muncelului	Roşie	·	Gheorghe	Bedeháza	·	·	Nr.	%	of all
Macedonian	·	·	·	·	·	·	·	·	·	·	·	·	·	0	·	0
Geto-Dacian	·	·	2 AR	·	·	·	·	·	·	·	·	·	·	2	1.29	0.15
Celtic	·	·	·	·	1 AR	·	·	·	·	·	·	·	·	1	0.65	0.07
Macedonia Prima	·	·	·	·	·	·	·	·	·	·	·	·	·	0	·	0
Thasos	·	·	·	·	·	·	3	1 AR imitation	·	·	·	·	·	4	2.58	0.3
Dyrrachium	·	·	·	1 AR	1 AR imitation	·	6	·	·	·	·	·	·	8	5.16	0.6
Apollonia	·	·	·	1 AR	·	·	·	·	·	·	·	·	·	1	0.65	0.07
Histria	·	·	·	·	19 AE	·	1	1 AR + 1 AE	·	·	·	·	·	22	14.19	1.64
Tomis	·	·	·	·	·	·	·	·	·	·	·	·	·	0	·	0
Callatis	·	·	·	·	·	·	·	·	·	·	·	·	·	0	·	0
Other Greek coins	·	·	·	·	1 AE	·	·	·	·	·	·	·	·	1	0.65	0.07
Roman Republican	·	28 AR	·	·	2 AR imitations	·	4 AR	4 AR (1 imitation)	2 AR	61 AR	1 AR	1 AR	2 AR	105	67.74	7.84
Augustus	·	1 AR	·	·	·	1 AR	·	·	·	·	·	·	·	2	1.29	0.15
Tiberius	·	·	·	·	·	·	·	·	·	·	·	·	·	0	·	0
Caligula	·	·	·	·	·	·	·	·	·	·	·	·	·	0	·	0
Claudius	·	·	·	·	1 AE	·	1 AE	·	·	·	·	·	·	2	1.29	0.15
Nero–Vitellius	·	·	·	·	·	·	·	·	·	·	·	·	·	0	·	0
Vespasian	·	·	·	·	·	·	·	·	1 AR	·	·	·	·	1	0.65	0.07
Titus	·	·	·	·	·	·	·	·	·	·	·	·	·	0	·	0
Domitian	·	·	·	·	·	·	·	·	·	·	·	·	·	0	·	0
Nerva	·	·	·	·	·	·	·	·	1 AR	·	·	·	·	1	0.65	0.07
Trajan	1 AE†	·	·	·	1 AE‡	·	+2§	·	·	·	·	·	1 AR¶	5	3.23	0.37
total	1	29	2	2	26	1	+17	7	4	61	1	1	3	155		
total %	0.65	18.71	1.29	1.29	16.77	0.65	10.97	4.52	2.58	39.35	0.65	0.65	1.94			
overall total	0.07	2.17	0.15	0.15	1.94	0.07	1.27	0.52	0.3	4.56	0.07	0.07	0.22			11.58

(c) Area C — Transylvania and Crişana. † AD 101–102; ‡ AD 103–111; § 1 AR without *Dacicus*, +1 AE AD 101–2; ¶ AD 108–110.

Table 14.4: Coin finds from Dacian settlements (continued). After Mihăilescu-Bîrliba 1990, Table 6.

	Area A			Area B			Area C			Grand totals	
Coin series	Nr.	%	% of all	Nr.	%	% of all	Nr.	%	% of all	Nr.	%
Macedonian	3	0.33	0.22	+3	1.11	0.22	·	·	·	6	0.45
Geto-Dacian	+38	4.16	2.84	+168	62.22	12.55	2	1.29	0.15	208	15.53
Celtic	·	·	·	·	·	·	1	0.65	0.07	1	0.07
Macedonia Prima	·	·	·	2	0.74	0.15	·	·	·	2	0.15
Thasos	1	0.11	0.07	1	0.37	0.07	4	2.58	0.3	6	0.45
Dyrrachium	2	0.22	0.15	5	1.85	0.37	8	5.16	0.6	15	1.12
Apollonia	1	0.11	0.07	·	·	·	1	0.65	0.07	2	0.15
Histria	+6	0.66	0.45	3	1.11	0.22	22	14.19	1.64	31	2.32
Tomis	+	·	+	·	·	·	·	·	·	+	+
Callatis	35	3.83	2.61	+	·	+	·	·	·	35	2.61
Other Greek coins	+2	0.22	0.15	2	0.74	0.15	1	0.65	0.07	5	0.37
Roman Republican	+823	90.04	61.46	62	22.96	4.63	105	67.74	7.84	990	73.94
Augustus	+2	0.22	0.15	10	3.7	0.75	2	1.29	0.15	14	1.05
Tiberius	+	?	?	3	1.11	0.22	·	·	·	3	0.22
Caligula	+	?	?	1	0.37	0.07	·	·	·	1	0.07
Claudius	+	?	?	5	1.85	0.37	2	1.29	0.15	7	0.52
Nero–Vitellius	+1	0.11	0.07	·	·	·	·	·	·	1	0.07
Vespasian	+	?	?	3	1.11	0.22	1	0.65	0.07	4	0.3
Titus	·	·	·	1	0.37	0.07	·	·	·	1	0.07
Domitian	·	·	·	1	0.37	0.07	·	·	·	1	0.07
Nerva	·	·	·	·	·	·	1	0.65	0.07	1	0.07
Trajan	·	·	·	·	·	·	5	3.23	0.37	5	0.37
Totals	914	100	68.26	270	100	20.16	155	100	11.58	1,339	100

(d) Totals for all three regions

Table 14.4: Coin finds from Dacian settlements (continued). After Mihăilescu-Bîrliba 1990, Table 6.

no surprise. What is more notable, however, is the low level of coin finds from these sites. Given the exceptional nature of the other evidence from many of the sites, especially those in the counties of Hunedoara, Alba and Sibiu, this lack of coins is particularly noteworthy. Conversely, there is no lack of hoards from the region (Glodariu 1976; Chiţescu 1981) and some of the sites have produced evidence for the copying of coins (see page 403).[8] If one removes, however, all hoards from the evidence, the pattern again becomes more even.

14.3.5 Coin finds and silverware

In addition to the numerous hoards of coins known from Romania, there are a number of hoards of late Iron Age silverware (Crişan 1969b; Horedt 1973; 1974; Mărghitan 1971; 1976; Popescu 1960; 1971, 1972; Zirra & Spânu 1992). An examination of the distribution map shows that these hoards tend to be more concentrated in Transylvania and the west of Dacia (Fig. 14.4). A number of coins hoards are associated with silverware such as Şeica Mică (SEI).

It is unfortuantely beyond the scope of the current project to undertake an analysis of the composition of these hoards of silverware although this would be a profitable line of research. Horedt (1973) has provided us with an analysis of the hoard evidence which shows that there does appear to be some regional patterning in the distribution of certain artefact classes; *e.g., Knotenfibeln* are found only within Transylvania and Crişana. There is evidence for the working of silver on the late Dacian sites such as Piatra Craivii (Popa 1971; Moga 1979). Silver jewelry has also been found on quite modest settlements such as Arpasu de Sus (Macrea & Glodariu 1976).

It has also been suggested that the Stăncuţa hoard also provides evidence of the manufacture of jewelry (Preda 1957, 1958b). This hoard contained a mixture of Roman Republican *denarii*, tetradrachms of Thasos and two silver bars. There is, however, no evidence that the silver was being used for the manufacture of *jewelry* and the possibility remains that it could be evidence for the manufacture of coins. This possibility led to the examination of this hoard as part of the archaeometallurgical project presented below. Objects sampled are illustrated on Plates X–XII, nos. 57–65.

14.4 Copies of Roman Republican *denarii*

14.4.1 The evidence

As I have mentioned above, one of the greatest problems facing the study of the coinage evidence for late Iron Age Dacia is the copying of Republican *denarii*. There are two main schools of thought on this topic. The first, as represented primarily by Chiţescu and Preda, is that a large proportion of the Republican *denarii* found in Romania are locally produced copies which form a class of coinage called 'Geto-Dacian coins of the Roman Republican type' (Preda 1973, pp. 345–352). The second school of thought is that of Crawford (1980) who, whilst acknowledging that there is remarkable

[8] The Tilişca monograph appeared too late for the coin finds to be included in Mihăilescu-Bîrliba (1990). The site produced 4 Republican *denarii*, two imitations of *denarii*, and one badly damaged coin, possibly of Apollonia or Dyrrachium.

Figure 14.4: Hoards of late Iron Age silver-work from Romania. From Mărghitan 1976.

evidence for the copying of *denarii*, has no doubt that the majority of them are genuine. This view is based on his personal examination of some of the coins. He believes that if a large proportion of the coins are copies, there should be a higher proportion of hybrid coins, as the Geto-Dacians would not be concerned to match obverses and reverses. Before proceeding to attempt to estimate the proportion of copies in the Dacian hoards, I shall review the evidence for the copying of *denarii*.

Coin dies

The first category of evidence are coin dies for the striking of Roman Republican issues. Prior to 1961, four coin dies were known, one each from Poiana (Galaţi), Braşov, Ludeşti (near Costeşti) and Pecica (Chiţescu 1981, p. 316; Preda 1973, p. 347; Stoicovici & Winkler 1971). It is impossible to identify which issues were struck with the Poiana and Pecica dies; the Ludeşti die is for the reverse of C. Marius C.f. Capito (Stoicovici & Winkler 1971, pp. 78–9) and the Braşov die for “Caesar” (Chiţescu 1981, p. 316). The Ludeşti example is ‘die-linked’ to a coin in Paris (A12480; Crawford 1980, n. 5).

During excavations on the large hill-top settlement of Tilişca in the summer of 1961, a further set of fourteen dies were discovered (Lupu 1967; 1989). These dies were found in an earthernware vessel along with three mounts. The dies were made of copper alloy (bronze?), the mounts were made of iron. Ten of these dies had clear designs and would have struck coins identical to Republican issues dating from 148–74 BC (see Plate I). The remaining four dies had no visible design. These dies appear to have been made by some form of hubbing process. Die 9, the reverse of a coin of C. Naevius Balbus (RRC 382/1a, 79 BC), shows a clear impression of serrations around the edge of the design (Plate I). The serrations on some issues of *denarii* would have been applied to the flan of the coin by the Roman mint, not to the die surface. Crawford (1980, n. 4) also notes a ‘die-link’ between the design on Plate I, die 7, an obverse of the same issue, and a coin from the Maccarese hoard (see also RRC plate LXV). We can assume, therefore, that these dies were made by some mechanical process from original coins.[9]

In 1988 during excavation and conservation work at Sarmizegtusa Regia a further three dies were found (Mihăilescu-Bîrliba 1990, p. 98; Glodariu *et al.* 1992). The designs on these dies date to issues from 126 BC (RRC 266/1), 68 BC (RRC 407/2) and to Tiberius (AD 14–37). The dies were found in a context beneath two layers of Roman date and the excavators suggest that they date to immediately prior to the second Dacian war (AD 105–6).

We have, therefore, the possibility that 2nd century BC issues could have been struck at the very beginning of the second century AD. This possibility has obvious implications for the dating of sites based on coin evidence, and even for the date of deposition of coin hoards.

One further observation can be made: all the dies where the design can be identified as Roman have been found in Transylvania, and the best preserved dies have all been found in the south-central

[9]Justine Bailey has kindly informed me that it would be impossible to create a bronze die by using a silver coin as a punch even if the bronze was hot and the silver cold. We must assume, therefore, that either some form of casting process was used, which seems unlikely as the resultant die would be brittle, or that an intermediate punch was made, in which case why do we have dies representing seven different issues? The problem requires further, perhaps experimental, investigation.

	obverse		reverse	
find-spot	ref.	date	ref.	date
Berzovia, Caraş Severin	*cf.* 219/1a	146	*cf.* 279/1	121
Braşov	374/1	81	337/1b	91
Nagykágya (NAG)	*cf.* 349/1	87	?	?
Ruzicka collection	316/1	105	384/1	79
Calineşti (CLN)	380/1	80	238/1	136
Breasta (BRS)	408/1a–b	67	352/1a	85
Tîrgu Ocna	433/1	54	392/1a	75
Barboşi–Gherghina	412/1	64	237/1a	136
Murighiol (MUR)	449/1a	48	409/1	67
Beclean	432/1	55	487/1	43
Conţeşti (CNT)	533/2	38	494/42a	42
Augustin	401/1	71	RIC $1^{(2)}$ 307	19
Cetăţeni (CET)	RIC $1^{(2)}$ 367	16	RIC $1^{(2)}$ 287	19

Table 14.5: Hybrid coins from Romania. Data from Chiţescu 1981.

or south-west of the region. The dies from Poiana and Pecica could have been used to strike one of many possible issues, not only Republican. This is in contrast to the other evidence to which we shall now turn.

Hybrids

There are a number of coins from Romania where the obverse and reverse are incorrectly paired (Crawford 1980). Chiţescu (1981, pp. 318–9) lists 13 examples of hybrid coins which are listed in Table 14.5. Crawford (1980) sees the existence of hyrids as evidence that "*a priori*… a Dacian mint would not be concerned with ensuring that obverse and reverse were correctly paired" (p. 52), and therefore, because there are only 13 known, the proportion of copies overall is low.

The Breaza hoard

The Breaza hoard was found in 1967 after a storm. It is currently in two lots: one of 10 coins in Sibiu (Lupu 1969) and second of 122 coins in the Severeanu Museum, Bucureşti (Poenaru Bordea & Ştirbu 1971). Differences between the reports accompanying the acquistion of these two lots make it unsure whether they represent one or two hoards (Poenaru Bordea & Ştirbu 1971, p. 265). The two lots were analysed as one hoard in Part II (BRZ; see section 8.3.23, page 240), and did not appear unusual; it was most similar to other Romanian hoards of the period (*e.g.*, Răcătău de Jos, RDJ), although the pattern within these late coin hoards is complicated.

Within the Bucureşti lot of coins there are some coins which are identical to each other — not only is the type identical, as might be explained by the use of the same dies, but the shape of the flan, the position of the design and the position of countermarks are also identical (see Plate I, 26–7, 50–1, Plates IX–X, nos. 38–42 for some examples). There is only one possible explanation: these coins must have been cast, almost certainly using an original coin to make the moulds. Five separate issues were cast with a total of 11 coins being identified. The dates of the issues copied range from

85–41 BC (Crawford's chronology).

This piece of evidence has major implications: these cast coins can only be identified when there are two or more cast from the same coin in a hoard, and one also has to be aware that the possibility of cast copies exsists, which was not the case prior to 1971.

The Poroschia hoard

The Poroschia hoard, found in 1964, forms the last major piece of evidence for the copying of *denarii*. In her original interim publication, Chiţescu (1965) published a photograph of a *denarius* of L. Satvrn which she believed was an imitation of a *denarius*; Crawford (1969c, p. 124), on the basis of the photograph, stated "the piece illustrated is not an imitation." Subsequently, Chiţescu developed her classification of imitations and copies (Chiţescu 1971b), and in the full publication of the Poroschia hoard (Chiţescu 1980)[10] indentified 55 of the 552 coins as copies of *denarii*, and 9 as imitations.[11]

On what evidence did Chiţescu base the classification of copies? A number of criteria were presented and explained. These were:

1. coin weights
2. diameter
3. style
4. errors in the design and/or legend
5. errors in serration
6. lack of cuts on the coins
7. metallurgy

As regards weight, Chiţescu discusses the weight distribution of coins in hoards from Italy, such as Morrovalle (MOR) in comparison to Romanian hoards including Poroschia, Gura Padinii and others (pp. 54–58, 60–63). She concludes that there is a larger proportion of light-weight coins (*c*. 3.4–3.6g.) in Romanian hoards than in Italian, and that this is one indicator that these coins are copies.

The second criterion, diameter, is hard to assess. Chiţescu states that the diameter of Republican *denarii* is 20–22mm., whereas the coins identified by her as copies are only 17.5–19mm. (p. 60). Unfortunately, comparative data from outside Romania is lacking.

Style is a difficult criterion to examine as it relies upon the expert knowledge of a numismatist who has handled large numbers of coins. In the context of the copies in the Poroschia hoard Chiţescu states:

[10] An English translation by H. Bartlett Wells of this important article is on file in the Department of Coins and Medals, The British Musuem.

[11] Chiţescu classifies the 3 brockages in the Poroschia hoard as being non-Roman; brockages are not uncommon amongst official products of the Rome mint and thus cannot be classified as copies without other reason.

> The 55 silver coins which total 7 types are sharply detached from the other coins in the hoard and even from the types of coins issued by the same moneyer magistrates that appear in the hoard. All the specimens are distinguished from the originals in style and execution. There are elements — such as the rendering of the figures, the hair, the horses, the flames — that are not identical with those on the original coins. The effigy of Roma on the coin of L. Appuleius Saturninus, for example, is closer to an eastern rendering than to a hellenistic one; the pelt on the held of Juno on this coin seems more like a head of hair with ringlets; the torch flames on the coins of P. Clodius are spirals; the effigy of Apollo on the coins of C. Piso L.f. L.n. Frugi is in flattened relief, not modelled as on the original coins. These are only a few of the distinct elements that patently separate the copied coins from the original Roman coins found in all the catalogs of the speciality field. (Chiţescu 1980, p. 60; H. Bartlett Wells translation, p. 24)

Chiţescu also believed that errors in the legend on the coins may be an indication that they were copies (p. 60). This criterion will vary between issues as some, *e.g.,* the issue of M. SCAVR (RRC 422/1a–b, 58 BC) has many blundered legends, whereas other issues, such as those of MVSA (RRC 410/1–10b, 66 BC) appear to have been more carefully struck. One group of coins in the Poroschia hoard, that of L. Procilius (397/2), has the legend PROCII I instead of PROCILI; it appears that the bottom bar of the L has somehow been accidently omitted although the space has been preserved (*e.g.,* Plate III, no. 402).

For a small number of coins, the incomplete serration, or serration of an issue not normally serrated, also led Chiţescu to suggest they were copies. She also makes the extremely interesting observation that only 1 of the 55 coins she identified as copies has any form of cut or countermark on the surface. Many Republican *denarii* are 'cut', usually with a punch, presumably by money-changers or possibly even the state, to test whether the coin is solid silver or a plated coin (Crawford 1968). It is difficult to assess the usefulness of Chiţescu's observation without collecting comparative data. The final criterion, metallurgical analysis, was unavailable to her, although she did note that two coins of M. Fourius Philus and C. Cassius 'appear to be alloyed with much bronze' (p. 60).

We have, therefore, a series of criteria and observations that led Chiţescu to believe that at least 55 of the Poroschia coins were copies. Each of these observations by themselves would not be enough to identify with absolute confidence that these coins were copies. Chiţescu did, however, either fail to mention, or did not notice, one further aspect of these coins which in my view confirms the attribution of many of them as copies.

During a short visit to Alexandria in 1992 to take samples for the metallurgical analyses discussed below, I observed a high number of die-links in the issues of C. Piso Frugi. I was able to return briefly in 1993 and carefully examined and photographed all the putative copies. Initially, I examined the 24 coins of L. Procilius (RRC 379/2). Chiţescu believed that 23 of the coins were copies, and only one genuine (no. 401), which appeared to be die-linked to an example in Naples (Chiţescu 1980, p. 59). To my great astonishment, I found that 21 of the 24 coins had complete die-links, that is both the obverse and reverse die in each case was identical (Plates II–III, nos. 397, 399–400, 402–419).[12] This is extremely unusual (Crawford 1980, p. 52) although high levels of

[12] The identification of the obverse die-link was made easier by virtue of a small fault on the die surface just below the legend SC. Coin numbers 398, 401 and 420 were struck with different dies from each other and the 21 other coins.

die-linking can sometimes be seen between copies in later hoards in Roman Britain (R. Bland, *pers. comm.*). The die-linked coins varied in weight from 3.04–4.26g. with a mean of 3.51g. and a median of 3.51g. The remaining three coins had weights of 3.79g., 3.82g. and 3.91g. I believe that these 21 coins can be confidently identified as copies.

Following this I then examined the 17 coins of C. Piso Frugi (RRC 408/1a–b). Of these 17 coins, Chiţescu had identified 12 as copies (Plates IV–V, nos. 476, 482–492). All 12 had complete obverse and reverse die links. Similarly, she had identified 4 of 8 anonymous coins (RRC 350A/2), 6 of 10 coins of L. Saturnius (RRC 317/3b), and 8 of 8 coins of P. Clodius (RRC 494/23) as copies: all were completly die linked (Plates II–V). The remaining two coins she identified as copies were on the basis that they were serrate, whereas the originals were not. The mean weight of most these groups of die-linked coins was low (3.4–3.52g.) with the exception of the anonymous issue 350A/2 (3.84g.). All the coins from these five issues are shown in Plates II–V. As a result, I believe that we can safely accept that at least 53 of the 55 coins identified by Chiţescu are copies. An important point, also noted by Chiţescu, is that *all these coins are copies made by striking*.

The style of the copied coins did not appear to me as substantially different from the genuine coins, although I lack extensive experience in handling this material. A large selection of coins from Romania, and some from UK Museums, are presented in the Plates. I suspect, but cannot prove, that the Poroschia coins were struck from dies made in a mechanical way from original coins (*cf.* the Tilişca and Ludeşti dies) and thus the style criterion is a red herring.[13]

Another important consequence of the Poroschia data is that we can no longer "suppose *a priori*" that a Dacian mint would not be concerned to match obverse and reverse, *contra* Crawford (1980).

Summary

We have, therefore, evidence for the manufacture of copies both by striking and by casting. Only in two hoards, Breaza and Poroschia, can we securely identify at least 9% of each hoard as copies. Chiţescu (1981, pp. 316–8) identifies issues in other hoards as copies but these have not been subject to independant verification. Table 14.6 summarises all the evidence for copies except hybrid coins which were listed in Table 14.5.

It was decided to attempt to examine this problem in more detail and to attempt to derive an estimate of the quantity of copies in the Romanian material. Of the methods listed above, diameter and surface cut marks/counter-marks lacked comparative data from which any analysis might proceed. Style is not easily amenable to analysis. An extremely limited examination of possible die-link information was undertaken (section 14.4.2). The main method used, however, was metallurgical analysis (section 14.4.3), and finally, a comparative analysis of coin weights will be briefly outlined (section 14.4.7). A short comparison of the results of the analysis in Part II will be given (section 14.4.8) followed by a summary of this chapter.

[13] It is curious to note that of the die-linked issues of C. Piso Frugi, some have been catalogued as 408/1a and some as 408/1b on page 68 of the report, but all have been catalogued as 408/1b on page 59.

origin	evidence	RRC	date of original
Tilişca	coin dies (obv. & rev.)	216/1	148 BC
Tilişca	coin die	245/1	134 BC
Tilişca	coin die	256/1	130 BC
Sarmizegetusa	coin die	266/1	126 BC
Poroschia	die-linked struck coins (6 ex.)	317/3b	104 BC
Tilişca	coin die	324/1	101 BC
Tilişca	coin die	350A/2/1	86 BC
Poroschia	die-linked struck coins (4 ex.)	350A/2	86 BC
Breaza	cast coin (2 ex.)	353/1	85 BC
Ludeşti	coin die	378/1a	81 BC
Poroschia	die-linked struck coins (21 ex.)	379/2	80 BC
Tilişca	coin die	382/1a	79 BC
Tilişca	coin dies (obv. & rev.)	382/1b	79 BC
Breaza	cast coin (2 ex.)	390/2	76 BC
Tilişca	coin die	396/1a	74 BC
Sarmizegetusa	coin die	407/2	68 BC
Poroschia	die-linked struck coins (21 ex.)	408/1a-b	67 BC
Breaza	cast coin (2 ex.)	433/1	54 BC
Breaza	cast coin (2 ex.)	452/2	48–47 BC
Braşov	coin die	‘Caesar’	before 44 BC
Poroschia	die-linked struck coins (8 ex.)	494/23	42 BC
Breaza	cast coin (3 ex.)	517/5	41 BC
Sarmizegetusa	coin die	Tiberius, RIC $1^{(2)}$ pp. 93–95	AD 14–37

Table 14.6: Evidence for copies of coins from Romania. The rows are in order of date of the original issue.

14.4.2 Identifying copies — die-links

Following the discovery of the die-linked coins in the Poroschia hoard I examined all the issues of L. Procilius and C. Piso Frugi in the Nicolae Bălcescu II hoard (NB2) which was also available in the museum at Alexandria. No die-links were found either within that hoard, or between that hoard and the Poroschia hoard (Plate VI). Subsequently, I was able to examine all 12 coins of C. Piso Frugi and 4 coins of L. Procilius in the Coin Cabinet of the Institutul de Arheologie “Vasile Pârvan”, Bucureşti (Plate VI). Again, no die-links were found either between coins at the Institute, or with the Poroschia hoard.

This result is not surprising: no coins struck by the Tilişca dies have been identified in Dacia, and Crawford was not able to find further cast copies in the collection of 42 *denarii* of Mn. Fonteius C.f. at the Institutul de Arheologie (Crawford 1980).

This approach could be a fruitful way of examining the problem of copies, but would be extremely time-consuming, and was beyond the scope of the current project.

14.4.3 Identifying copies — metallurgical analyses

Metallurgical analysis of coins has usually been employed to determine the fineness or composition of issues in order to plot the pattern of debasements or changes in composition (*e.g.,* Walker 1976). In this case, we hoped to be able to distinguish between genuine *denarii* and copied *denarii* on the basis of their metallurgical composition. To do this, *denarii* from Romanian hoards, along with some imitations, some tetradrachms and the Stăncuţa silver bars, were sampled and analysed, and

type	no.	sample nos.
barbarous imitations	10	29, (30), 31, 32, (33), 34, 66, 70, 71, 72, 73, 186
tetradrachms of Thasos	5	35, 36, (37), 63, 64, 65
cast copies (Breaza)	5	38, 39, 40, 41, 42
struck copies (Poroschia)	6	81, 82, 98, 99, 111, 122
silver bars (Stăncuţa)	2	61, 62
British Museum and Ashmolean	24	179–185, 187–190, (191), 192–203
other *denarii* from Romania	165	all others

Table 14.7: Objects sampled for metallurgical analysis.

compared to coins from the British Museum and the Ashmolean Museum, Oxford. Table 14.7 provides a summary.

A large range of techniques for metallurgical analysis have been employed previously, including wet chemical methods (Reece 1964) and XRF (*e.g.,* Walker 1980). Wet chemical techniques involve the destruction of a large proportion of the coin and are thus of limited use. Ponting (1994) has shown that surface techniques such as XRF can give seriously misleading results because of the alteration of the surface composition of coins, either deliberately as in the 4th century AD material, or by the coins' burial environment. The technique chosen for this analysis was, therefore, atomic absorption spectometry on samples taken from the core of the coins by drilling (Plate VII).

It was decided to obtain samples from 10% of coins in a number of Romanian hoards. This proportion was chosen because we estimated that we would be able to sample 150 coins in the time available, and the hoards we originally wished to examine contained approximately 1,500 coins. The analyst, Dr. Matt Ponting, and I attempted to sample, and photographed 178 coins and objects during May 1992 (Plates VIII–XVII).[14] The hoards examined varied from those originally chosen due to non-archaeological factors. Subsequently during 1994 further samples were taken from museum specimens in Britain (Plates XVII–XVIII).

The hoards analysed were chosen on numismatic and pragmatic grounds; details are given in Table 14.8. A formal method of random selection was not possible as the requirements for drilling precluded this — each flan had to be thick enough in least one area, it had to be reasonably flat, and could not be too brittle. Instead, the most suitable coin nearest to every tenth coin was selected, where the order of the coins was that in which they were stored or catalogued. Additionally, four cast coins were deliberately chosen from the Breaza hoard to ensure that some comparative data from known copies were available, and some deliberate imitations both unprovenanced and from hoards were examined. At this time, the die-linking of the Poroschia coins had not been observed and therefore no deliberate selection of them was undertaken. Some of these coins were, however, selected by the process described above and thus provide more comparative data.

The samples were taken from the cylindrical edge of the coins using a high-speed twist drill and a 0.6 or 0.8mm. drill-bit (Plate VII). The initial surface material was discarded, and then the remaining drillings stored in small sample tubes until analysis. The details of the analytical process

[14]In this project, selection of samples was undertaken by the author, sampling and metallurgical analysis was undertaken by Dr. Ponting, statistical analysis and interpretation was undertaken by the author. Our many debts of gratitude are duly noted in the acknowledgements, see page 21.

hoard	no.	sampled	reference	reason
Zătreni	41	6	ZAT; Chiţescu 1981, no. 215	early hoard in Muntenia
Poiana	152	20	1PO; Chiţescu 1981, no. 148	hoard from major settlement in Moldavia
imitations	—	6	Chiţescu 1981, nos. 11, 28, 84, 67, 165, 239	unprovenanced, for comparison to hoard material
Popeşti	?	3	in preparation	3 tetradrachms of Thasos, by request of Poenaru Bordea
Breaza	122†	19	BRZ; Poenaru Bordea & Ştirbu 1971; Chiţescu 1981, no. 29	contains cast copies
Stăncuţa	34	9	STN;Preda 1958b; Chiţescu 1981, no. 188	mixed hoard of tetradrachms, *denarii* and silver bars
Voineşti‡	94	3	VOI; Ştirbu 1978, p. 90, no. 4;	by request of C. Ştirbu
Poroschia	552	66	PRS; Chiţescu 1980; Chiţescu 1981, no. 154	contained possible copies
Şeica Mică	348	44	SEI; Floca 1956a; Chiţescu 1981, no. 193	hoard from Transylvania, used by Crawford in RRC

Table 14.8: Romanian hoards sampled May 1992. † Bucureşti lot. ‡ Not published in detail and thus not uploaded to CHRR database.

will be discussed in detail elsewhere (Lockyear *et al.* forthcoming). The samples were analysed in batches: the first 30 were analysed in late 1992 (Lockyear & Ponting 1993), the remainder, including comparative material from British museums, was analysed in the summer of 1994. The first batch of coins was analysed using a single solution method where the sample was partially dissolved in concentrated nitric acid to digest the silver and most of the other elements. Concentrated hydrochloric acid was then added to form aqua regia which should dissolve any tin and gold remaining (Lockyear & Ponting 1993, p. 9). This highly acidic solution was then diluted to 25ml (48% acid) for analysis by AAS.

The results from these first analyses were highly encouraging. However, there were some problems and the analyst changed technique slightly for batches 2–9. The second method required the use of two solutions: nitric acid for most elements, and a ‘high acid’ solution (aqua regia) for tin and gold. Smaller quantities of sample were used for the high acid analyses than the nitric acid analyses. The results, mainly for the quantity of silver contained in these coins, are believed to be more reliable. Some samples from the first batch using a single solution were re-analysed using the two solution method to provide a comparison. There are nitric and high acid results for copper for batches 8–9; the nitric acid results were used in the analyses to be consistent with batches 2–7.

In the first batch twelve elements were measured: silver (Ag), copper (Cu), lead (Pb), gold (Au), zinc (Zn), antimony (Sb), cobalt (Co), bismuth (Bi), arsenic (As), nickle (Ni), tin (Sn) and iron (Fe). The last three elements (Ni, Fe and Sn) were consistently below the detection limit. In batches 2–9, arsenic was dropped as the analyst believed the results to be unreliable.

The results of AAS are readings in parts per million (PPM). These readings are converted into a percentage using the following formula:

$$x = \left(\frac{\left(\frac{av}{10}\right)}{w} \right)$$

where a is the parts per million reading from the AAS, v is the volume of the solution, and w is the sample weight. For the single solution method v is always 25ml.; for the two solution method the nitric acid volume is 25ml., the high acid solution is 10ml.

In any metallurgical technique, each element will have a detection limit below which concentration the measurement will be unreliable. This can create problems at the statistical stage of the analysis. A common technique for the analysis of this sort of data, for example, is PCA of log-transformed data, or PCA of data using Aitchison's transformation (Aitchison 1986). If the low readings are input as 0, this will cause an error in both methods as log 0 is impossible. It is usual, therefore, to input a substitute value. One common method is to calculate the percentage using the formula above, but replacing a with the detection limit, and then dividing the results by two (Ponting, *pers. comm*.). A second method is to replace the value of the element with half the lowest value obtained from the other samples.

Both of these options work well if the sample weight w is relatively constant. Due to factors beyond our control, this was not the case with the samples taken in Romania and some were very small. As an illustration we can compare the cobalt results for samples 3 and 29 (Table 14.11). For sample 3 which had a good sample weight and the reading was above the limit we get:

$$x = \left(\frac{\left(\frac{av}{10}\right)}{w}\right) = \left(\frac{\left(\frac{0.112\times 25}{10}\right)}{4.26}\right) = 0.066\%$$

We can compare this with sample 29 which was a small sample and was below the detection limit. The PPM value a is replaced with the half the detection limit $d/2$:

$$x = \left(\frac{\left(\frac{d/2\times v}{10}\right)}{w}\right) = \left(\frac{\left(\frac{0.5/2\times 25}{10}\right)}{1.15}\right) = 0.543\%$$

In this case sample 29 has a higher estimated value than the measured value for sample 3, and a higher value than most other coins, but by adopting the second strategy and using half the lowest measured value, the sample would then have a very low value. In both cases the use of this value would be misleading as the fact that this element is below the detection limit is probably only due to the small sample size. I know of no studies which attempt to study the effect of these procedures on the analysis of metallurgical data. The simplest solution here would be to omit all samples with a sample weight below a certain limit. I felt, however, that the loss of perfectly good data for the other elements was not desirable.

I therefore decided to investigate the suitability of a dual-mode system where the estimated readings would be the median value of measured readings for small sample sizes, and the value calculated by the above formula for large sample sizes. The question arises: what are 'small' sample sizes? To examine this I investigated the effect of sample sizes on the estimated readings, and the distribution of sample sizes in the data set.

Fig. 14.5 presents the estimated readings for sample sizes between 1 and 10mg. calculated at 0.1mg. intervals using a solution volume of 25ml. and a detection limit of 0.5ppm. The value of the estimated readings is very high for sample sizes <2 and then falls off rapidly. They level off after sample sizes of about 3.5mg. There is no clear elbow in the graph but an appropriate cut-off point for ‘small’ samples could be around 3–4mg.

Fig. 14.6 presents a stem-and-leaf plot (Shennan 1988, pp. 27–29) of the sample weights for single and nitric acid solutions. There is a trimodal distribution at $<$2mg., 4–5mg., and 8–11mg. Here we are interested in the lower sizes. There are two small breaks in the distribution, between 2.9 and 3.3mg., and between 3.6 and 3.9mg. On the basis of Figs. 14.5 and 14.6 we can take a slightly cautious approach and set the boundary for small samples at 3.8mg., or a slightly less cautious limit at 3mg. The former approach would affect 20 samples, the latter 16. I have used 3mg. as the boundary whilst noting possible problems with the four other samples, nos. 57, 60, 69 and 165. Therefore, samples $<$3mg. use estimated values, where necessary, of the median for that element, and samples $>$3mg. use estimated values calculated using the above formula.

We can repeat this procedure for the high-acid analyses which used a solution volume of 10ml. and a smaller sample sizes. In Fig. 14.7, which was constructed using a detection limit of 0.2 (the modal limit for gold), sample sizes from 0.5–4mg., and a solution volume of 10, we can see the curve levelling-off at 1–1.5mg. Fig. 14.8, however, clearly has 12 samples considerably lighter than the rest. Therefore, samples $<$1.3mg. used estimated values which were the median for the element, and samples $>$1.3mg. used estimates based on the formula presented above.

A formal comparison of the effects of the various methods for dealing with values below the detection limit would be desirable and will form the topic of another study.

A second problem to be overcome before proceeding to the statistical analysis is that the detection limits are not constant but vary from one run of the machine to the next. Within the coin data, for example, cobalt is very rarely above the limit, except for batch 6, which had an exceptionally low detection limit of 0.02ppm. It is difficult to use this data — the majority of the readings included in any global analysis would be estimates, and these estimates would be the result of the different sample sizes and detection limits producing a random noise which obscures any possible patterning in the measured data. Two alternatives are available: we can use the worst detection limit for each element and perform a global analysis on the resultant data, or we can analyse the samples by batch where a particularly low detection limit offers us extra information. After the univariate analysis, however, many of the elements were dropped from further consideration and thus the worst detection limit method was used in the multivariate methods with little loss of information.

The first stage was to ‘clean’ the data; this process is outlined in Appendix E along with the structure of the database constructed to handle the data set. The database itself is available on the CD-ROM. After the removal of those coins too brittle to sample and those samples too small for analysis, 193 were left for analysis. Of these, sample 191 is considered unreliable and no particular interpretation should be placed upon it. Furthermore, three coins analysed in the pilot study were reanalysed with the later batches using the two solution method. This left 196 analyses on 193 objects: 191 coins and 2 silver bars.

The data were then subjected to univariate, bivariate and multivariate statistical analyses and these are discussed below. In each case it was often very difficult to declare that an individual coin was a copy or genuine. Therefore, at each stage a list of coins was constructed about which we might be ‘suspicious’. A formal method of dividing the probably genuine from the possible

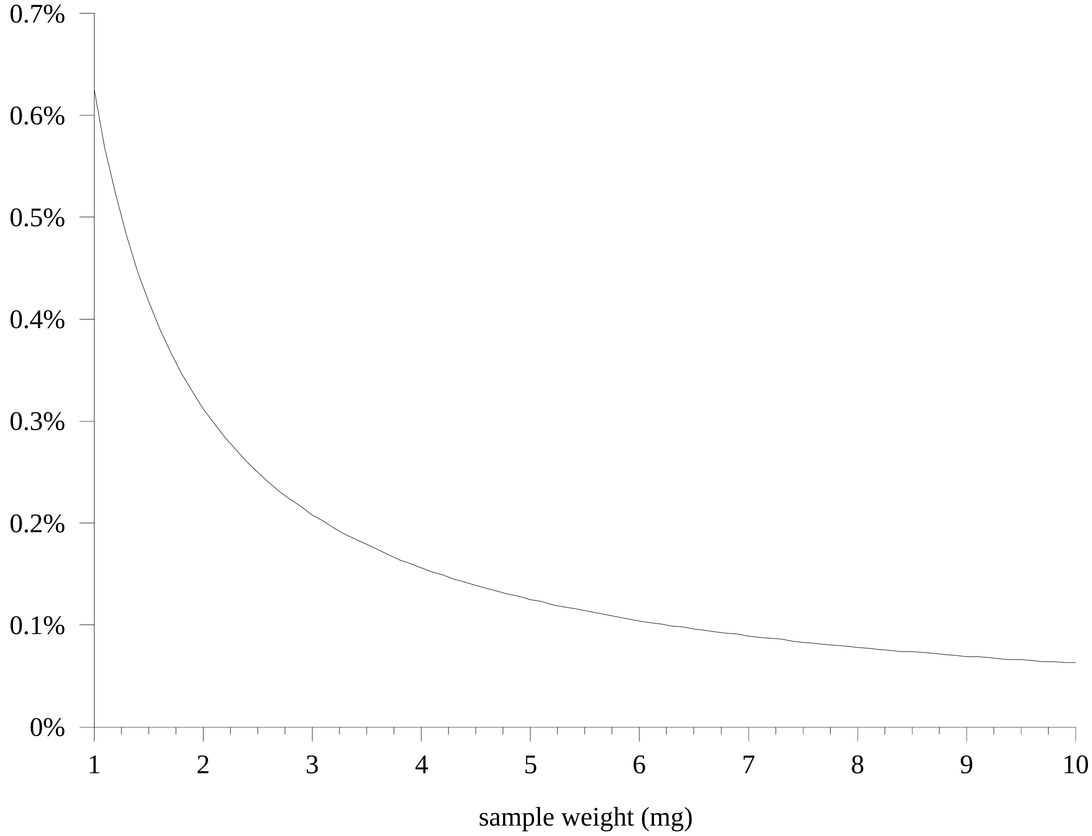


Figure 14.5: The effect of sample size on the value of estimated readings for 25ml. solutions — see text for details.

```
Freq. S & Leaf

10    1 | 1222234456
 6    2 | 124579
 6    3 | 334699
30    4 | 001122222333333456777777888889
14    5 | 01113344556789
 3    6 | 046
 2    7 | 25
15    8 | 011244444566788
66    9 | 000111111111222223333334444444444455566666666666777777788888899999
29   10 | 00000001111112333334455566778
 1   11 | 3
 0   12 |
 1   13 | 2
```

Figure 14.6: Stem-and-leaf plot of sample weights for single and nitric solutions. Modified output from STATGRAPHICS.

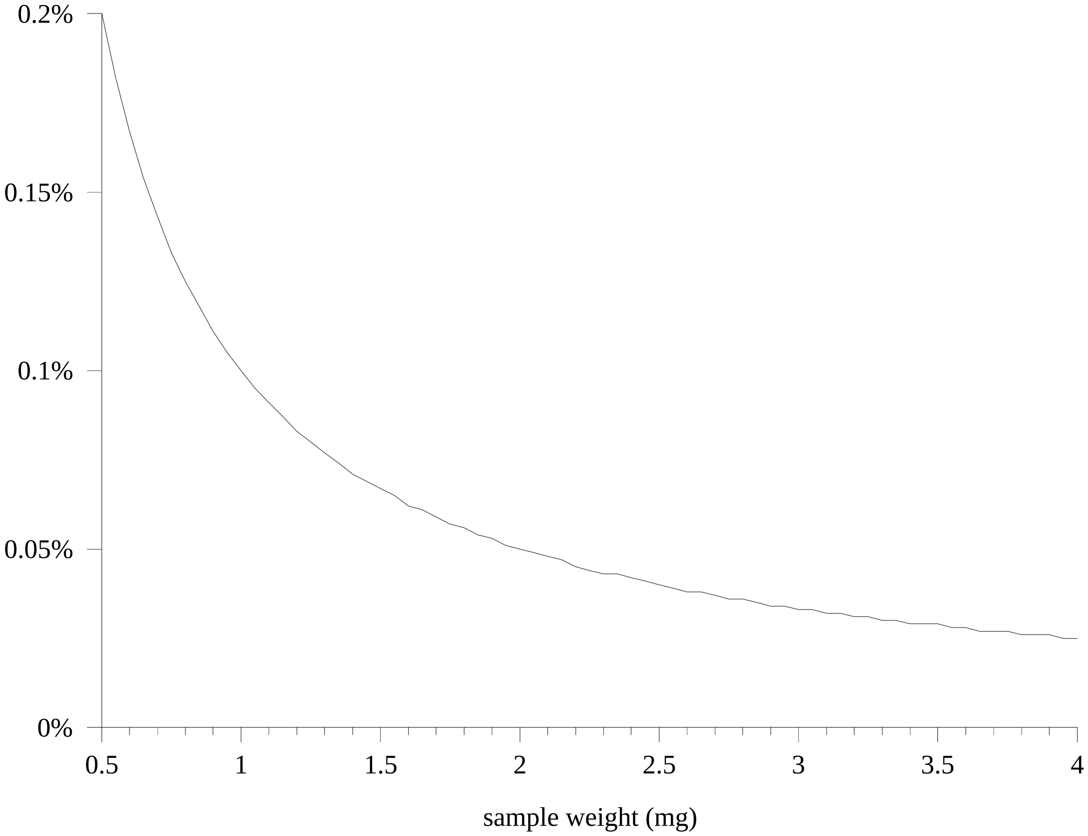


Figure 14.7: The effect of sample size on the value of estimated readings for 10ml. solutions — see text for details.

```
Freq.  S & Leaf

 12    LO|0,1,3,4,4,5,6,6,7,9,12,12

  1    1S|7
  3    1o|889
 20    2*|00000000011111111111
 27    2T|222222222222222222233333333
 22    2F|4444444444444455555555
 27    2S|666666666666677777777777777
 34    2o|8888888888888888888899999999999999
  4    3*|0000
  1    3T|2
```

Figure 14.8: Stem-and-leaf plot of sample weights for the high acid solution. Modified output from STATGRAPHICS.

copies did not seem appropriate in the light of the data to be presented, and a exploratory approach was adopted. The first stage of analysis was an examination of univariate dot-plots (Baxter 1994, pp. 28–30).

Silver

Unsurprisingly, all the coins which were analysed had a higher concentration than the detection limit. There were, however, some relatively low readings for silver. For example, the first analysis of sample 6 from the Zătreni hoard gave a result of 72% silver, but the total of all elements also only amounted to 75.5% (Table 14.11). At first it was thought that the short-fall must be accounted for by silver corrosion products such as silver chloride (Lockyear & Ponting 1993, p. 3). The sample was later reanalysed using the two sample method and this analysis gave a result of 95.6% silver, and a total percentage of 99.3%.[15] These very low total percentages are confined to the first single solution batch and were a factor in the decision to move to a two-solution method of analysis. Sample 191 was the only other sample with an unreliably low figure. Various summary statistics are given in Table 14.9.

Examination of the dot-plot for silver (Fig. 14.9) reveals a rather jagged profile although there is a definite peak in the 95–96% region. There is a long tail with a few coins with very low silver values. The coin with a value of only 80% is a copy of C. Piso Frugi from the Ashmolean Museum (sample 186). This is a timely reminder that coins from British museums can also be copies, and thus our comparative material cannot be assumed to be genuine.

From this dot-plot we should view with suspicion any coin with a silver content of $<$94%, although the silver figures must be seen in comparison to the other elements because of problems with precipitation of silver from solution.

Copper

All but one sample had a measurable quantity of copper (Table 14.9a). The upper quartile shows that most samples had $<$3.3% copper. The mean weight of 2.2% is strongly affected by some extreme outliers which can be seen in the dot-plot (Fig. 14.10). The two samples with very high copper levels are the copy of C. Piso Frugi mentioned above (no. 186) and sample 116 from Poroschia. This is type of a coin of Mark Antony and Octavian dating to 39 BC (RRC 528/3). There is a peak of coins at around 7.5% copper. This group includes a number of imitations of *denarii*, and the known cast copies from the Breaza hoard. In addition to the known cast copies, there are a further three coins with similar copper values from Breaza. These will be discussed futher below.

There is also a long tail of values from 2.5–6% with secondary peaks at 2.75 and 3.5%. For *denarii*, the further away from the main peak of copper at 0–2.5% the value lies, the greater the level of suspicion that must be attached to it, particularly when the level of copper rises above 4%.

[15] In AAS, it is impossible to ensure that the total composition sums to 100%. It is usually regarded that figures in the range of 97–103% are acceptable, although the closer and more consistent the results are to 100% the more confidence one will have in them.

	n	$\bar{x}$	median	s	min	max	Q1	Q3
Ag	196	94.64	95.48	4.44	72.07	102.19	93.77	97.15
Cu	195	2.199	1.26	2.315	0.05	12.751	0.57	3.224
Pb	188	0.68	0.576	0.39	0.15	2.811	0.414	0.821
Au	186	0.426	0.372	0.285	0.062	2.442	0.272	0.498
Zn	108	0.018	0.009	0.033	0.002	0.243	0.006	0.017
Sb	60	0.223	0.145	0.193	0.009	0.808	0.086	0.292
Co	38	0.078	0.042	0.077	0.005	0.296	0.018	0.135
Bi	131	0.188	0.148	0.138	0.009	0.917	0.115	0.218
Fe	49	0.061	0.047	0.062	0.005	0.284	0.011	0.083
Ni	34	0.034	0.02	0.037	0.005	0.16	0.014	0.036
Sn	44	0.85	0.724	0.488	0.106	2.319	0.509	1.01
As	26	0.522	0.457	0.323	0.142	1.261	0.241	0.673

(a) Summary statistics of all data with a measurable concentration.

	n	$\bar{x}$	median	s	min	max	Q1	Q3
Ag	196	94.64	95.48	4.44	72.07	102.19	93.77	97.15
Ag†	165	95.162	95.48	2.903	79.994	101.31	94.09	97.035
Cu	181	2.356	1.358	2.331	0.12	12.751	0.703	3.404
Pb	180	0.69	0.584	0.391	0.15	2.811	0.42	0.828
Au	181	0.434	0.379	0.283	0.062	2.442	0.277	0.501
Zn	47	0.031	0.017	0.047	0.006	0.243	0.013	0.025
Sb	36	0.284	0.185	0.207	0.009	0.808	0.145	0.438
Co	21	0.118	0.118	0.08	0.01	0.296	0.036	0.158
Bi	113	0.194	0.154	0.123	0.009	0.762	0.123	0.234
Fe	8	0.118	0.087	0.072	0.076	0.284	0.08	0.142
Ni	3	0.142	0.133	0.016	0.132	0.16	0.132	0.16
Sn	30	1.037	0.812	0.477	0.533	2.319	0.717	1.303
As	26	0.522	0.457	0.323	0.142	1.261	0.241	0.673

(b) Summary statistics of all data with a measurable concentration greater than the poorest detection limit. † Silver values without batch 1 results and sample 191.

	n	$\bar{x}$	median	s	min	max	Q1	Q3
Ag	196	94.64	95.48	4.44	72.07	102.19	93.77	97.15
Cu	196	2.188	1.253	2.315	0	12.751	0.569	3.211
Pb	190	0.673	0.569	0.393	0.042	2.811	0.413	0.82
Au	194	0.41	0.371	0.289	0.036	2.442	0.259	0.477
Zn	184	0.012	0.006	0.026	0	0.243	0.003	0.013
Sb	182	0.114	0.066	0.137	0.009	0.808	0.042	0.125
Co	182	0.036	0.022	0.047	0.002	0.296	0.013	0.027
Bi	187	0.152	0.125	0.13	0.009	0.917	0.063	0.186
Fe	155	0.039	0.03	0.04	0	0.284	0.017	0.042
Ni	155	0.031	0.025	0.032	0.003	0.188	0.013	0.028
Sn	160	0.414	0.281	0.377	0.058	2.319	0.223	0.464
As	30	0.488	0.353	0.313	0.142	1.261	0.25	0.653

(c) Summary statistics including estimated values for readings below the detection limit *but* with large sample weight as defined in main text.

Table 14.9: Summary statistics from metallurgical analyses.

Coins with $\geqslant$4% are listed in Table 14.10 where it can be seen that all the Breaza cast coins are listed, but none of the Poroschia struck copies; six of the 10 imitations are also listed.

Lead

The majority of the samples had measurable quantities of lead with most having $<$0.85%. The dot-plot (Fig. 14.11) shows less of a marked peak, but a similar long tail, to copper. The two extreme outliers are samples 18 (Poiana) and 110 (Poroschia). Neither coin has particularly extreme values for copper. Given the dot-plot and the upper quartile of 0.82% any *denarius* with more than 0.85% should be subject to further scrutiny. Table 14.10 shows that five of the six struck copies from Poroschia have more than 0.85% lead, but none of the Breaza cast coins do; only two of the imitations are listed.

Gold

Most samples had measurable quantities of gold. The distribution is skewed to the right similarly to copper and lead although the tail is less elongated: the distribution appears more regular. The three outliers with more than 1.5% are all samples from the Stăncuţa hoard: one *denarius*, one tetradrachm and one of the two silver ingots (nos. 58, 62, 64). This is highly suggestive and will be discussed further below.

Defining a point at which we might start to examine samples more carefully is difficult in this case. If we take 1 step (1.5$\times$ the interquartile range) from the median we would get an upper cut-off point at $\approx$0.72%. Seventeen samples are above this limit and are listed in Table 14.10.

Zinc

Only about half the samples have a measurable concentration of zinc (Table 14.9a), and this falls to 24% if the worst detection limit is used. In this case, and those below where many of the samples are below the limit, the summary statistics can be misleading as they are only calculated on measurable values. This will almost certainly result in the sample average not being a good estimate of the population average. The figures in Table 14.9c are calculated, therefore, using estimates for large sample weights as defined above. In the case of zinc, the difference between the values in Tables 14.9a, 14.9b and 14.9c is not great, but those in 14.9b can be seen to be too high.

The dot-plot (Fig.14.13) shows a strong peak of measured values at 0.015% and 4–5 extreme outliers. Of these outliers, one is sample 186, the copied coin of C. Piso Frugi mentioned above. The others include a cast coin from Breaza (no. 39), and two coins from Poiana (nos. 8 & 23). An upper boundary over which individual coins might be worth noting could again be defined as the median plus one step which is 0.035%.

Antimony

Only 30% of the samples had measurable values of this element, and only 18% had values above the worst limit. The summary statistics in Tables 14.9a–14.9b are likely to be too high and the lower

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-----+---------+---------+---------+---------+---------+-Ag
   80.0      85.0      90.0      95.0     100.0     105.0%
```

Figure 14.9: Dot plot for silver values omitting batch 1 results and sample 191. Output from MINITAB. Each vertical line is at 0.5% intervals.

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 +---------+---------+---------+---------+---------+-------Cu
0.0       2.5       5.0       7.5      10.0      12.5      %
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Figure 14.10: Dot-plot for copper concentration, all samples. Output from MINITAB.

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-------+---------+---------+---------+---------+---------Pb
      0.50      1.00      1.50      2.00      2.50      3.00%
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Figure 14.11: Dot-plot for lead concentration, all samples. Output from MINITAB.

readings in Table 14.9c should be examined additionally. The dot-plot, based on measured values, has a small peak at 0.15%; if the estimated values were added there would be a much larger peak at 0.06%. To select a cut-off point for considering samples 'suspicious' the median+1 step rule was applied using the figures from Table 14.9c; this gave a figure of 0.19%. All except two of these readings come from the first batch, and the majority from the Breaza hoard (Table 14.11). This is most probably a result of experimental error, and thus comparisons between the antimony levels of the first batch, and batches 2–9 analysed a year and a half later, will be invalid. The two samples in batches 2–9 with high antimony levels are samples 80 and 83, both from Poroschia.

Cobalt

Only 38 samples (19%) had measurable levels of cobalt, and of those 21 were from batch 1. The dot-plot of measureable values shows a wide spread and little real pattern although Table 14.9c indicates that there should probably be a peak around 0.036%. The four values above 0.16% all come from batch one, and there are no samples with levels higher than the maximum dectection limit not from batch 1. As with antinomy, this element is of little use.

Bismuth

Bismuth concentrations were measurable in 69% cases with a median value of 0.148%. The dot-plot (Fig. 14.16) shows a long tail of readings. There is a gap at 0.375% with 13 measurements above it, of which 8 are from batch 1. Of these 13 measurements, two were imitations (nos. 32 & 34), one was a cast copy from Breaza (no. 39), and two were from the Stăncuţa silver bars (nos. 62–3). This element may, therefore, be of use in the bivariate and multivariate analyses.

Iron, nickel, tin and arsenic

Iron, nickle and tin were rarely above the detection limit and are of little use in the multivariate analyses. The eight iron readings, and three nickle readings above the worst detection limit can be used to suggest that these samples be examined carefully. There is a problem with the tin results in that the eight samples above the maximum limit all come from batch 4, and are almost all in sequence. These readings should be treated with the utmost caution. Arsenic (Fig. 14.17), although appearing to be useful in the pilot analyses discussed below, was considered too unreliable by the analyst and was not tested for in batches 2–9.

Univariate examination — summary

The summary statistics and dot-plots have allowed us to examine the data, identify outliers, and spot problems. I have also proposed a series of subjective cut-off points above which concentration a coin may be considered 'suspect.' Only in a few cases, such as high copper levels in the Breaza coins, can this simple univariate examination allow us to classify coins with confidence. Table 14.10 provides a list of suspect coins from these analyses. In the pilot multivariate analysis, all the available elements were input to the analysis. With the full data set, however, many of the elements

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 +---------+---------+---------+---------+---------+-------Au
0.00      0.50      1.00      1.50      2.00      2.50     %
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Figure 14.12: Dot-plot for gold concentration, all samples. Output from MINITAB.

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 +---------+---------+---------+---------+---------+-Zn
0.000     0.050     0.100     0.150     0.200     0.250%
```

Figure 14.13: Dot-plot for zinc concentration, all samples. Output from MINITAB.

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 +---------+---------+---------+---------+---------+-------Sb
0.00      0.15      0.30      0.45      0.60      0.75     %
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Figure 14.14: Dot-plot for antimony concentration, all samples. Output from MINITAB.

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 +---------+---------+---------+---------+Co
0.00      0.08      0.16      0.24      0.32
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Figure 14.15: Dot-plot for cobalt concentration, all samples. Output from MINITAB.

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 +---------+---------+---------+---------+Bi
0.00      0.25      0.50      0.75      1.00%
```

Figure 14.16: Dot-plot for bismuth concentration, all samples. Output from MINITAB.

```
     .:      ..
    .::::. : ::   .  .. . .
 +---------+---------+---------+As
0.0       0.5       1.0       1.5%
```

Figure 14.17: Dot-plot for zinc concentration, all samples. Output from MINITAB.

were not measurable frequently enough to warrant their inclusion in the multivariate analyses and were dropped; four elements were retained: copper, lead, gold and bismuth.

14.4.4 Composition by date

A further possible cause of variation in the composition of genuine *denarii* is the date at which they were struck. Walker (1980) could not detect any change in the fineness of the coins he examined. Unfortunately, his use of XRF may make his results unreliable as noted above, and he also only took readings for silver. Figs. 14.18a–14.19b present the four elements for which we have sufficient data plotted against the date of issue. The cast and struck copies have been plotted against the date of issue of the prototype coin; imitations, tetradrachms of Thasos and the Stăncuţa silver bars have been omitted. The three Breaza coins not formally known to be copies, but with in excess of 7% copper, have been treated here as known cast copies.

Fig. 14.18a shows that there can be a wide spread of values for copper, but that the Breaza casts clearly stand out from the rest of the group. The Poroschia copies also stand relatively clear of the main mass of coins *but* five of the UK museum coins also lie in the bracket occupied by the Poroschia casts. There is a possibility that the quantity of copper in genuine *denarii* rose slightly during the 40s BC, and then fell again under Augustus. It would appear that the 4% cut off point suggested above is reasonable, if conservative. This should rise perhaps rise to 4.5% for issues in the 40s BC, but be set at about 2% for issues in the second century BC. Of the 11 UK museum *denarii* struck between 90–80 BC 9 have $<2\%$ copper, the remaining 2 coins $<4\%$. There is no

	reason	n	samples (*denarii*)	samples (copies *etc.*)
Cu	⩾4%	33	10, 13, 22, 47, 51, 52, 57, 69, 77, 80, 84, 90, 91, 94 115, 116, 133, 152, 153, 154, 178, 200	29[1], 34[1], 38[2], 39[2], 40[2], 41[2], 42[2], 66[1], 70[1], 71[1], 186[1]
Pb	⩾0.85%	41	1, 18, 47, 49, 51, 52, 69, 74, 78, 80, 85, 86, 91, 110 115, 116, 129, 130, 131, 145, 154, 155, 160, 161, 163, 164, 166, 168, 171, 173, 174, 177, 181, 201	31[1], 32[1], 81[3], 98[3], 99[3], 111[3], 122[3]
Au	⩾0.72%	17	55, 56, 58, 77, 89, 107, 112, 119, 142, 150, 194, 195	62[4], 64[5], 66[1], 81[3]
Zn	⩾0.035%	7	8, 23, 47, 105, 202	39[2], 186[1]
Sb	AML, not batch 1	2	80, 83	
Co	AML, not batch 1	0		
Bi	⩾0.325%	15	1, 2, 3, 57, 59, 67, 68, 74, 154, 189	32[1], 34[1], 39[2], 62[4], 63[5]
Fe	AML	8	12, 19, 20, 109, 118, 138, 188	38[2]
Ni	AML	3	83, 86, 123	
Sn	AML	8	118, 119, 120, 121, 125, 127, 133, 134	

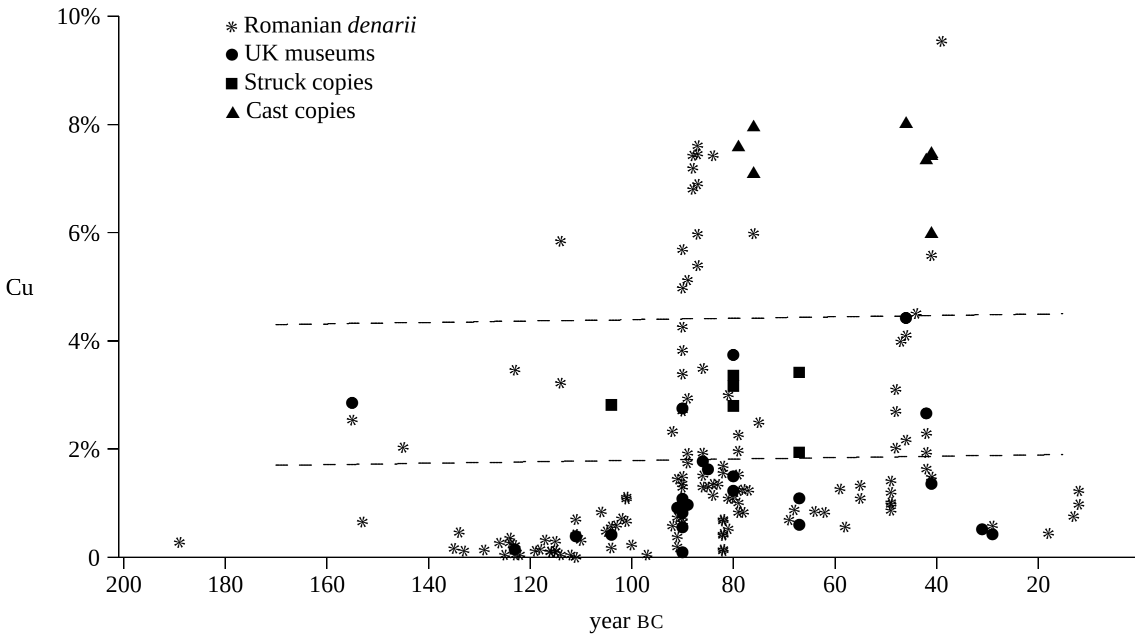
Table 14.10: Samples which appear to have extreme values based on the univariate analysis. AML= above maximum (worst) detection limit. [1]Imitations, [2]Breaza cast copies, [3]Poroschia struck copies, [4]silver bars, [5]tetradracms of Thasos.

evidence, therefore, for a large debasement during the Social War although there is a hint that the copper levels may have risen from 0.5% to *c.* 1–1.5%.

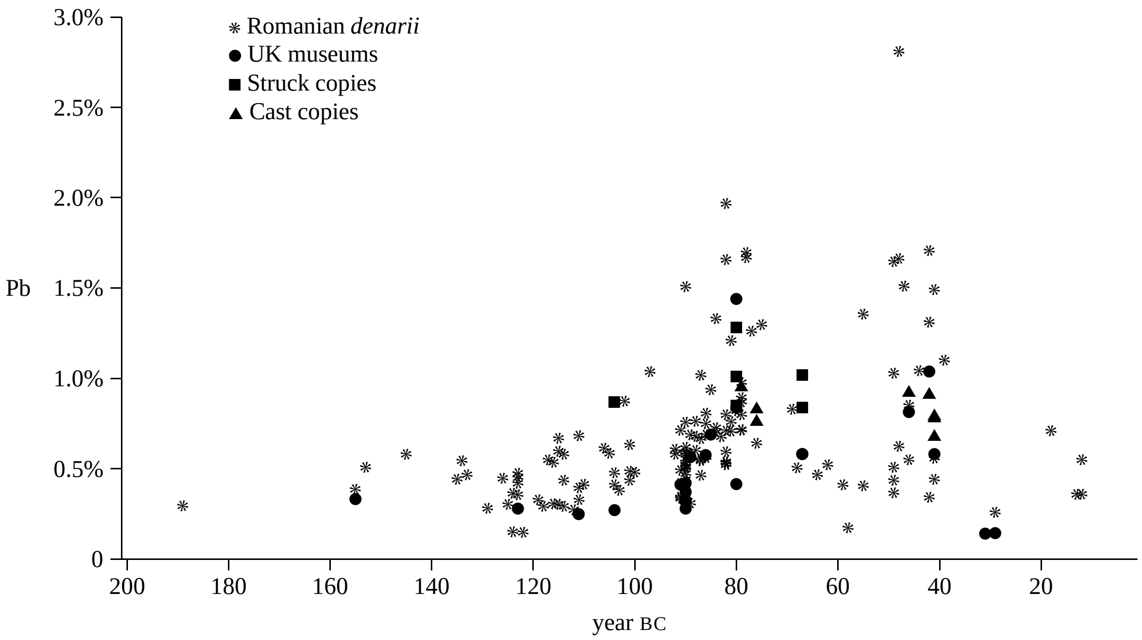
Fig. 14.18b reveals less of a possible temporal trend in the lead concentrations compared to copper. Of the coins struck 90–80 BC, 10 have less than 0.85% lead, and one coin has 1.44%; this coin (sample 181) has the highest level of lead of all the UK museum coins. There does seem to be an increase in lead levels in the 40s BC with the cast copies and the UK museum coins having much the same levels of lead. The three coins dating to 31–29 BC have very similar levels of lead.

Fig. 14.19a shows no temporal trend in the gold concentrations apart from the 3–4 latest coins which appear to have more gold than previously. The cast and struck copies have a small within-group variation in gold concentration. The cast coins are not clearly differentiated from the other coins but the struck copies have slightly more gold than many of the UK museum coins. Bismuth concentrations (Fig. 14.19b) again have no temporal patterning. The UK museum coins have levels are in the range 0.102–0.435%, the struck coins are in the range of 0.044–0.067%, and the cast coins are in the range of 0.029–0.148% with the exception of one coin (sample 39) which has a level of 0.424%. Many of the low bismuth readings are in fact estimates using the formula discussed above, *i.e.*, they had bismuth readings below the detection limit.

From these graphs we can see that the UK museum, cast and struck copies do not form totally distinct groups but there are definite discernible trends in the patterning. We should also be aware of the date of the type when assessing the significance of copper and lead concentrations.

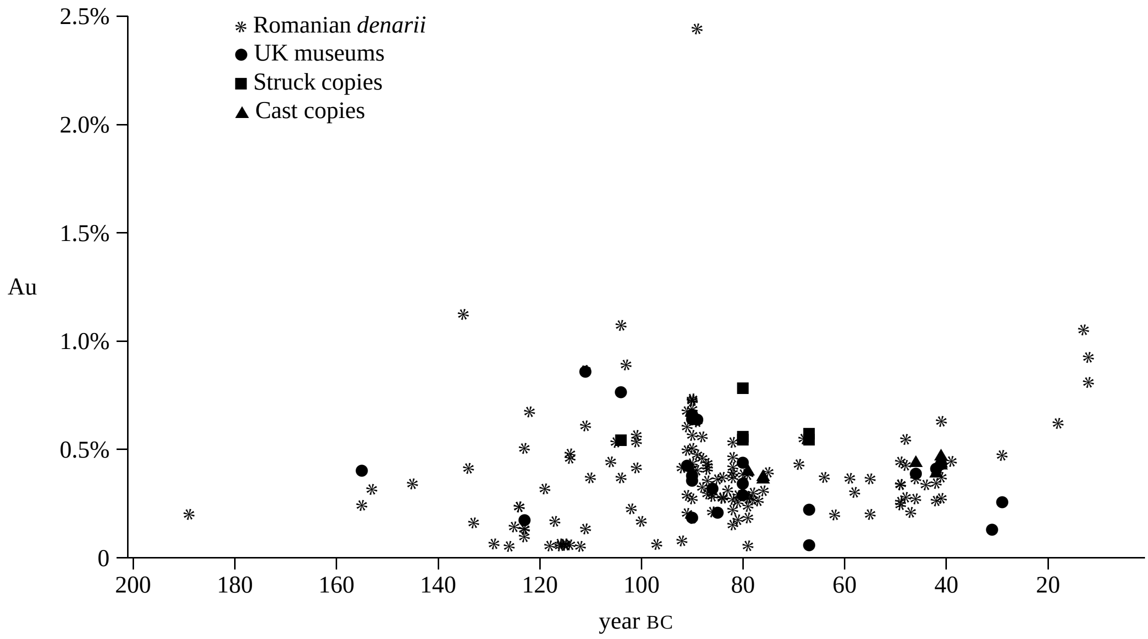


(a) Copper against date.

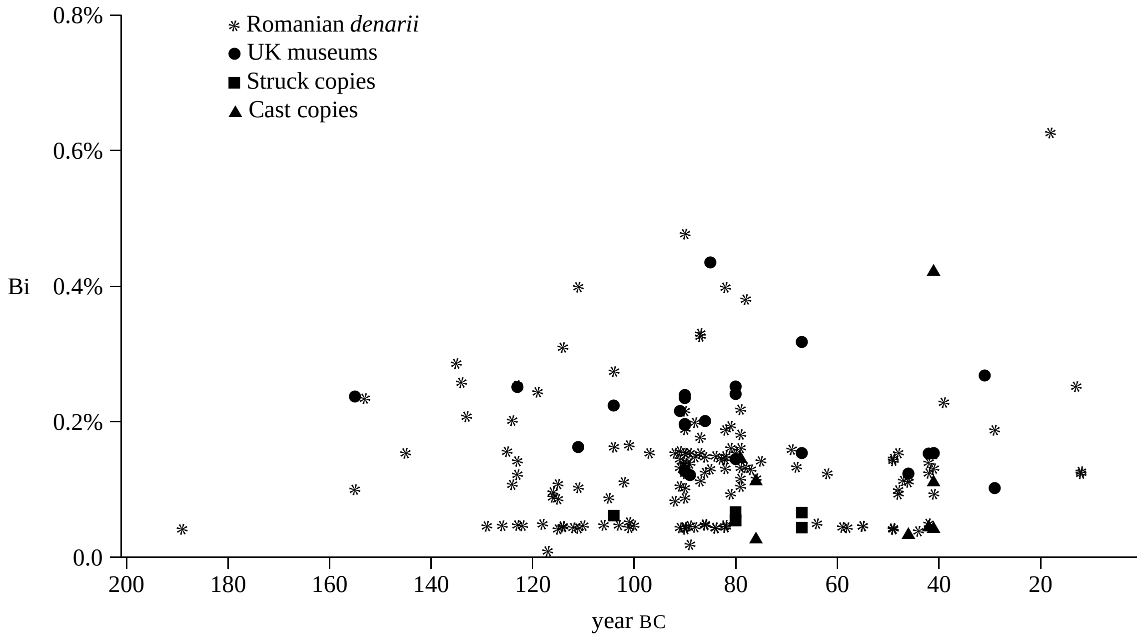


(b) Lead against date.

Figure 14.18: Elemental concentrations from AAS analysis of *denarii* against date of issue of the original coin type.



(a) Gold against date.



(b) Bismuth against date.

Figure 14.19: Elemental concentrations from AAS analysis of *denarii* against date of issue of the original coin type.

No.	Ref.	wght	Ag	Cu	Pb	Au	Zn	Sb	Co	Bi	As	Total
Zătreni												
1	385/1	4.74	98.05	1.26	1.67	0.269	0.026	(0.132)	(0.132)	0.380	(0.264)	101.6
2	362/1	4.71	97.49	0.71	0.71	0.154	0.016	(0.133)	0.021	0.398	(0.265)	99.5
3	299/1b	4.26	102.19	0.43	0.33	0.610	0.023	(0.147)	0.059	0.399	0.405	104.4
4	284/1a	5.30	78.63	0.33	0.55	0.170	0.019	0.066	(0.118)	0.009	0.509	80.3
5	275/1	5.63	80.61	0.22	0.45	0.098	(0.004)	0.129	(0.111)	0.142	0.187	81.8
6	367/5	6.67	72.07	1.69	0.8	0.465	(0.004)	0.184	(0.094)	0.131	0.221	75.6
Imitations												
29	—	1.15	96.59	4.28	0.54	0.239	(0.022)	(0.543)	(0.543)	0.174	1.261	103.1
32	—	1.28	99.14	1.6	1.39	0.176	(0.020)	(0.488)	(0.488)	0.762	1.055	104.1
34	—	2.52	95.64	4.63	0.82	0.367	(0.010)	(0.248)	0.139	0.704	0.675	103.0
Breaza												
39	517/5a	4.72	90.6	7.49	0.79	0.434	0.196	(0.132)	0.079	0.424	0.673	100.7
40	517/5a	5.51	91.91	7.45	0.8	0.476	0.014	0.009	0.163	(0.113)	0.581	101.4
41	390/2	5.42	78.93	7.12	0.77	0.383	0.032	(0.115)	0.221	(0.115)	0.646	88.1
42	390/2	4.25	92.53	7.98	0.84	0.371	0.018	0.294	(0.147)	0.029	1.006	103.1
43	289/1	4.05	99.55	0.12	0.67	0.062	0.012	0.438	(0.154)	0.086	1.148	102.1
44	337/3	4.72	95.2	0.92	0.42	0.498	0.016	0.471	0.042	(0.132)	0.869	98.4
45	340/1	4.37	97.53	0.73	0.53	0.366	0.017	0.652	0.154	0.189	0.280	100.5
46	344/1b	5.15	74.46	1.75	0.31	0.476	0.019	0.626	0.180	0.019	0.228	78.1
47	382/1b	4.23	91.52	7.61	0.96	0.408	0.035	0.437	0.296	(0.148)	0.195	101.4
48	405/3b	3.93	99.06	0.7	0.83	0.433	0.025	0.719	0.134	(0.159)	0.305	102.2
49	442/1a	4.27	98.2	1.2	1.03	0.340	0.029	0.808	0.152	(0.146)	0.252	102.0
50	444/1a	4.38	96.54	0.98	0.51	0.445	0.006	0.086	0.263	(0.143)	0.360	99.2
51	463/3	4.85	91.08	8.04	0.93	0.448	0.015	0.216	0.031	0.036	0.232	101.0
52	494/24	4.22	92.93	7.37	0.92	0.397	0.012	0.415	0.118	0.047	0.622	102.8
53	517/2	4.10	98.91	1.42	0.56	0.372	0.006	0.500	0.146	0.152	0.622	102.7
54	Asia 6	5.33	90.11	0.59	0.26	0.474	0.009	0.446	0.113	0.188	0.347	92.5
55	RIC 179	4.66	91.48	0.76	0.36	1.052	0.016	0.638	0.107	0.252	(0.268)	94.7
56	RIC 330	4.97	94.66	1.23	0.55	0.926	0.010	0.086	(0.126)	(0.126)	(0.252)	97.5
Voineşti												
66	—	4.77	93.08	7.77	0.79	0.739	0.010	0.168	0.026	(0.131)	0.142	102.7
67	340/1	4.82	96.93	1.5	0.44	0.379	0.010	0.285	0.010	0.477	0.244	100.3
68	RIC 289	4.87	99.93	0.45	0.71	0.621	0.010	0.344	0.021	0.626	0.513	103.2

Table 14.11: Results of pilot study conducted in 1993. Composition of *denarii* as a percentage. Figures in brackets are estimated values using the formula presented on page 410. Weight of sample given in milligrams.

14.4.5 Bi- and multivariate analyses — the pilot study

The first batch of 30 samples was analysed in 1993 (Lockyear & Ponting 1993). The data used in the initial analyses are presented in Table 14.11. It was decided to analyse the data using principal components analysis. As PCA is a linear technique, there can be problems with the analysis of compositional data such as this (Baxter 1994, pp. 72–77). In cases where one or two variables form a large proportion of the composition of the object, a method for avoiding closure is to omit these variables (Baxter 1992b, p. 269). In this case, this also means that the problem of samples with erroneous silver values can also be avoided.

Initially, a PCA of unstandardised variables was performed using all the data except silver. The package used was CANOCO. The first two principal axes accounted for 97.8% of the variation in the data. Fig. 14.20 is a map derived from this analysis. On the right-hand side of the map is a group of eight coins of which four are the cast copies from Breaza (nos. 39–42). In the same group

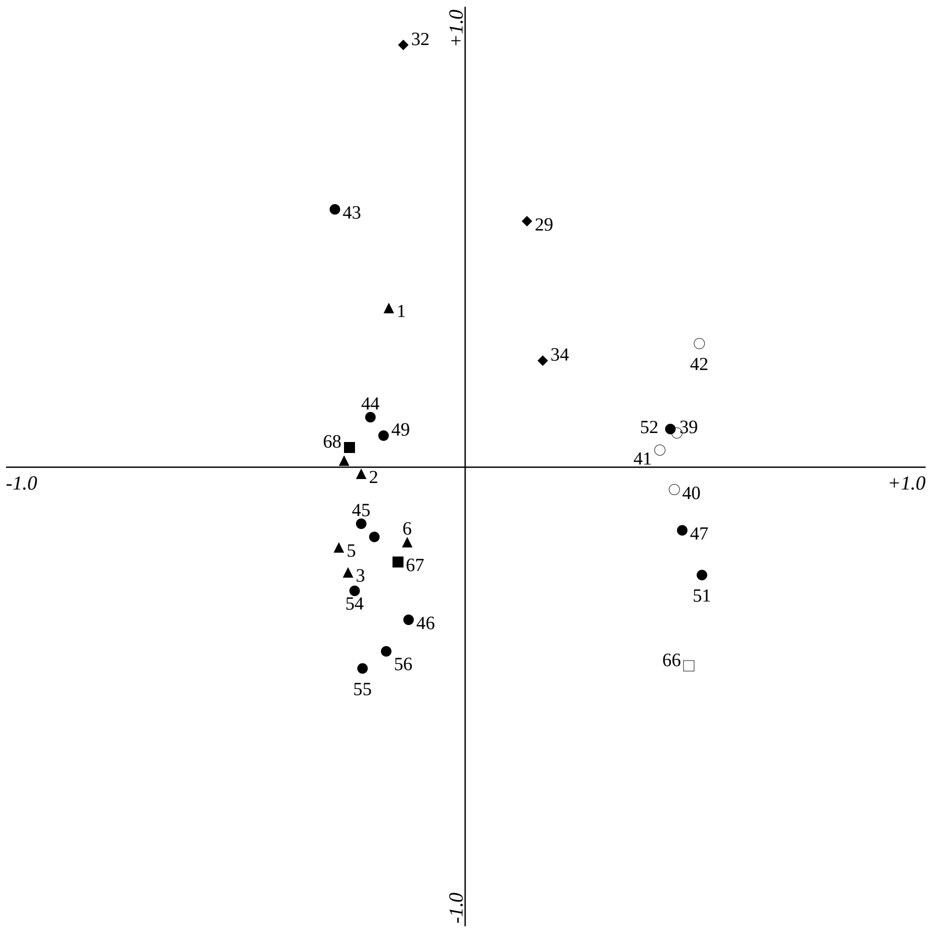


Figure 14.20: Sample map from PCA of pilot metallurgical study — see text for details. Numbers are sample numbers; triangles: Zătreni; lozenges: imitations; filled circles: Breaza; open circles: cast coins from Breaza; filled squares: Voineşti; open square: imitation from Voineşti.

there are a further three cast coins from Breaza (nos. 47, 51 and 52). An inspection of the biplot (Fig. 14.21) shows that the first axis is representing the variation in the copper levels of these coins. An examination of Table 14.11 reveals that all these coins have over 7% copper. The copper values for batch 1 have a trimodal distribution with most coins having $<2\%$, 2 coins having 4–5%, both of which are barbarous imitations, and 8 coins having $>7\%$ of which 7 are from Breaza and 1 is another barbarous imitation. From the copper levels alone, therefore, we have a clear indication that three more of the Breaza coins are likely to be copies. None of the *known* copies or imitations occur in the large group to the left of the map.

The second axis of inertia is primarily contrasting the gold levels with most of the other remaining elements, primarily lead, cobalt and arsenic (Fig. 14.21). A small number of coins are placed towards the top of the axis indicating that they have above average levels of these elements. Three of these are known imitations (nos. 29, 32, 34), but two are not (1 and 43). Inspecting the table we can see that sample 1 has the highest levels of lead, and samples 29 and 43 have high levels of arsenic.

This analysis is dominated by the copper readings which are by far the largest in the data analysed. In the case of this data set, this is not a problem as the copper levels also appear to be the

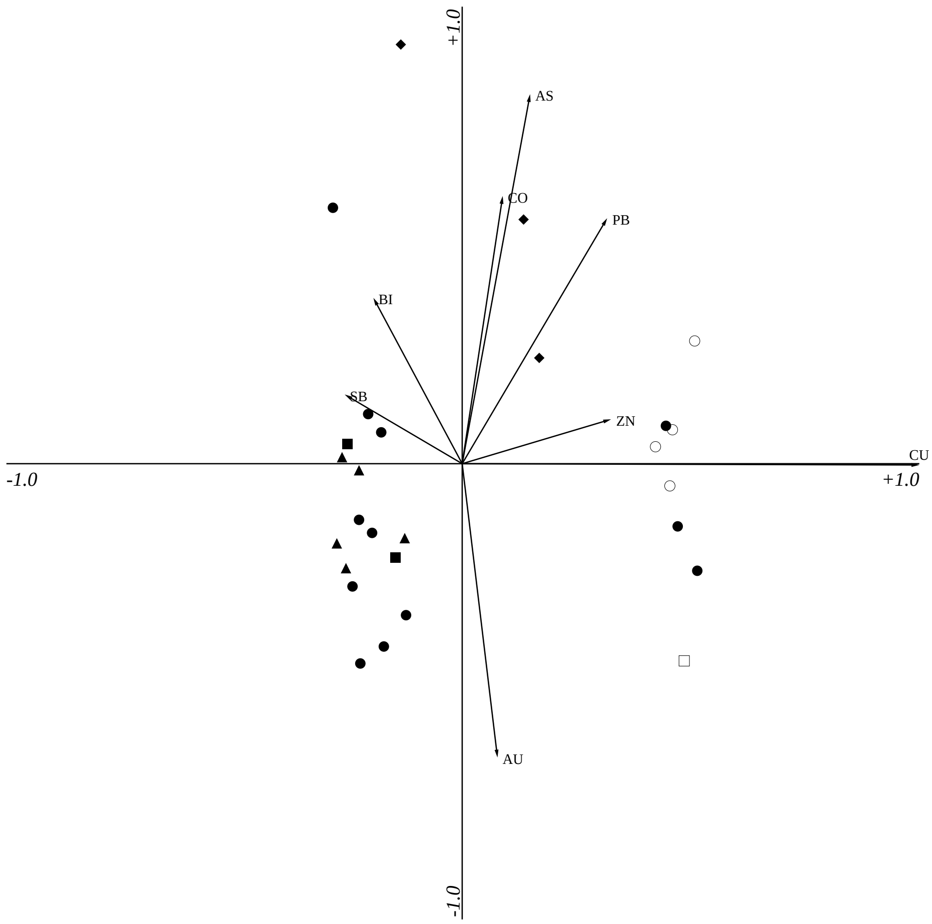


Figure 14.21: Biplot from PCA of pilot metallurgical study — see text for details. Numbers are sample numbers; triangles: Zătreni; lozenges: imitations; filled circles: Breaza; open circles: cast coins from Breaza; filled squares: Voineşti; open square: imitation from Voineşti.

major element enabling differentiation between copies, imitations and possibly genuine coins. The use of this method could, however, mask interesting variation in the minor elements. To examine this further a PCA of standardised values was performed. The biplot is shown in Fig. 14.22. We can still see two main groups of points: one in the top right quadrant, and another in the bottom left. The top right quadrant contains the Breaza copies, an imitation and now sample 1 from Zătreni. Sample 39, a cast Breaza coin is an outlier at the top of the plot because it has the highest levels of zinc in the data set. Bismuth appears to contribute little to the pattern revealed by the first two axes of inertia. This analysis, therefore, largely confirmed the results of the first although further doubt was cast on sample 1.

From this pilot study it was concluded that a further 3 of the Breaza coins were cast copies. The estimate of the proportion of copies in the hoard is given by a simple scaling:

$$p = x/n$$

where x is the number of copies in the sample, and n is the sample size. Obviously, this can be converted to a percentage by multiplying by 100. For the Breaza hoard, we had 3 copies in 14 coins

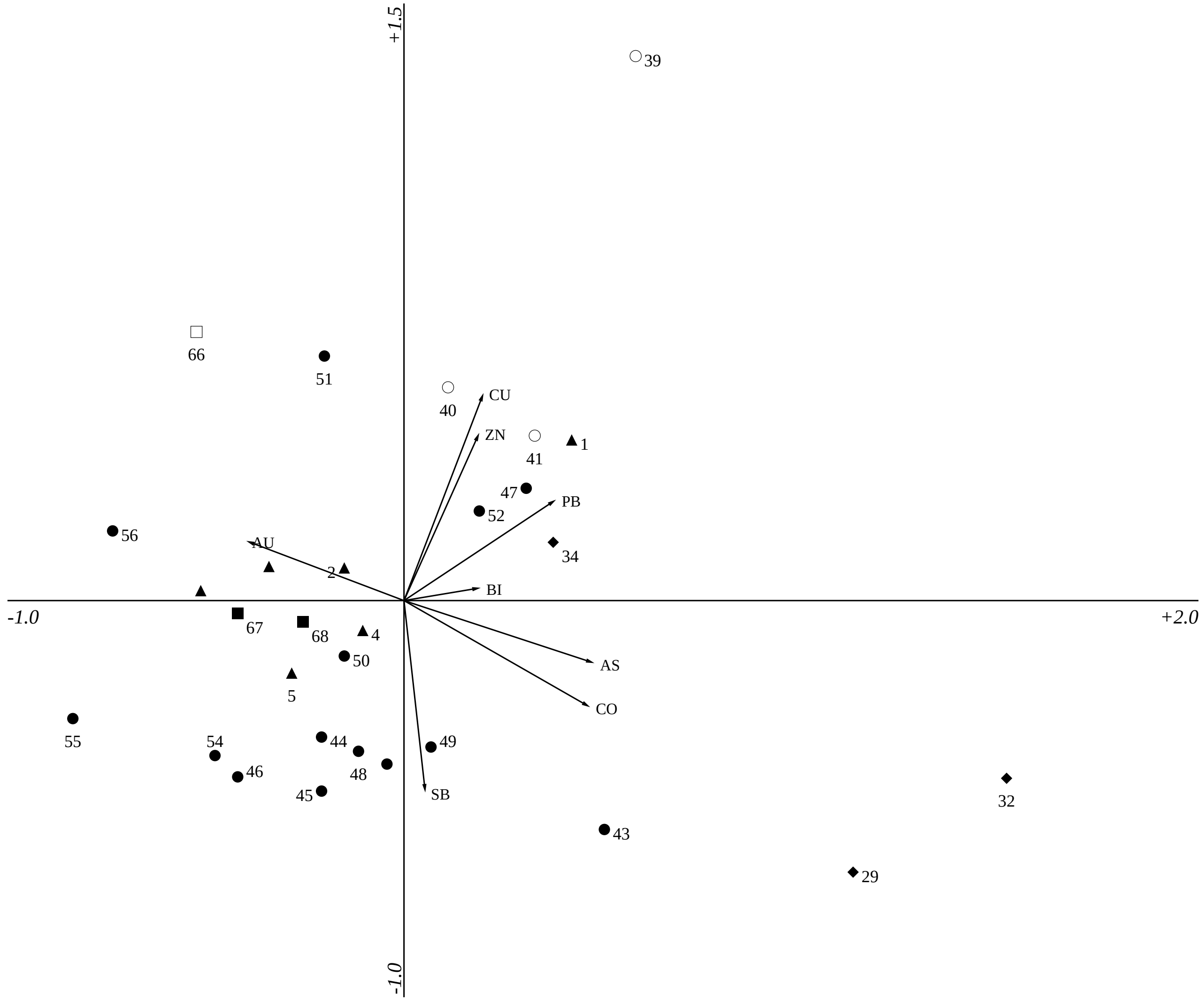


Figure 14.22: Biplot from PCA of pilot metallurgical study — PCA of correlation matrix. Numbers are sample numbers; triangles: Zătreni; lozenges: imitations; filled circles: Breaza; open circles: cast coins from Breaza; filled squares: Voineşti; open square: imitation from Voineşti.

which were not previously thought to be copies. This gives us:

$$p = (3/14) = 0.214$$

To obtain an estimate of the total number of copies:

$$X = pN$$

where N is the size of the hoard. Therefore, in the Breaza example:

$$X = 0.214 \times 111 = 23.8$$

where 111 is the total population available in the Breaza hoard. This is only an estimate of the number of copies and we need to be able to construct confidence limits. As our sample sizes are small the method outlined by Shennan (1988, pp. 310–313) is inappropriate. The 95% and 99% confidence limits for proportions of small samples can be obtained from Table P of Rohlf & Sokal (1995). This gives us a lower limit of 6.12% and an upper limit of 50%. Thus there is a 95% probability that the number of copied coins in the remaining 111 of the Breaza hoard is between 7–55. To this we should add the 11 already identified coins giving us 18–66 coins out of 122, or between 15–54% of the hoard. It should be noted that these estimates do not take into account the finite size of the hoard (Shennan 1988, p. 303f.). These calculations depend crucially on the assumption that the selection of the coins from the hoards was random (which was not the case with the Voineşti hoard).

In the Zătreni hoard we cannot be sure that any coin is a copy, although one possibly might be. If we assume that none are copies, we get 95% limits of 0–41.1%; if we assume that 1 coin is a copy we get limits of 0.8–58.8%. Again, these limits take no account of finite correction.

The three coins from the Voineşti hoard were sampled at the request of the curator. One was a known imitation leaving us with a sample of two from which no useful limits can be derived (0–95%).

Although the confidence limits are extremely wide, this pilot study was extremely encouraging. There were a number of important points which had to be noted, however. Firstly, there was a need for comparative material for analysis. Secondly, there is no *a priori* reason why a copied coin must have a different chemical composition to genuine *denarii*. Conversely, the Roman state at this time does appear to have controlled the fineness of their coin quite tightly although we ought to be aware of possible changes over time. Lastly, despite having shown that there are more copies in the Breaza hoard than those originally identified, this does not counter Crawford's (1980) argument that the hoard is unique.

14.4.6 Bi- and multivariate analyses — the full data set

Five elements had sufficient data to be of use. Of these, silver was dropped for two reasons: firstly the aberrant results caused by precipitation in the first batch, and secondly as a means to avoid the problem of closure discussed above.

As a preliminary stage, two scattergrams were constructed: copper *v.* lead, and gold *v.* bismuth (Figs. 14.23a–14.23b).[16] In Fig. 14.23a the cast coins from Breaza form a relatively compact group in the centre of the graph. The extreme outlier to the right is the imitation of C. Piso Frugi from the Ashmolean. Similarly, the struck copies from Poroschia form a relatively compact group. The main mass of points is, however, concentrated near the origin of the graph. Included in this large group are most of the UK museum coins although there are some outliers, notably samples 186 (4.2% Cu), 181 (3.7% Cu, 1.4% Pb) and 200 (2.7% Cu, 1% Pb). There is no clear unequivocal dividing line which can be used to separate copies from genuine.

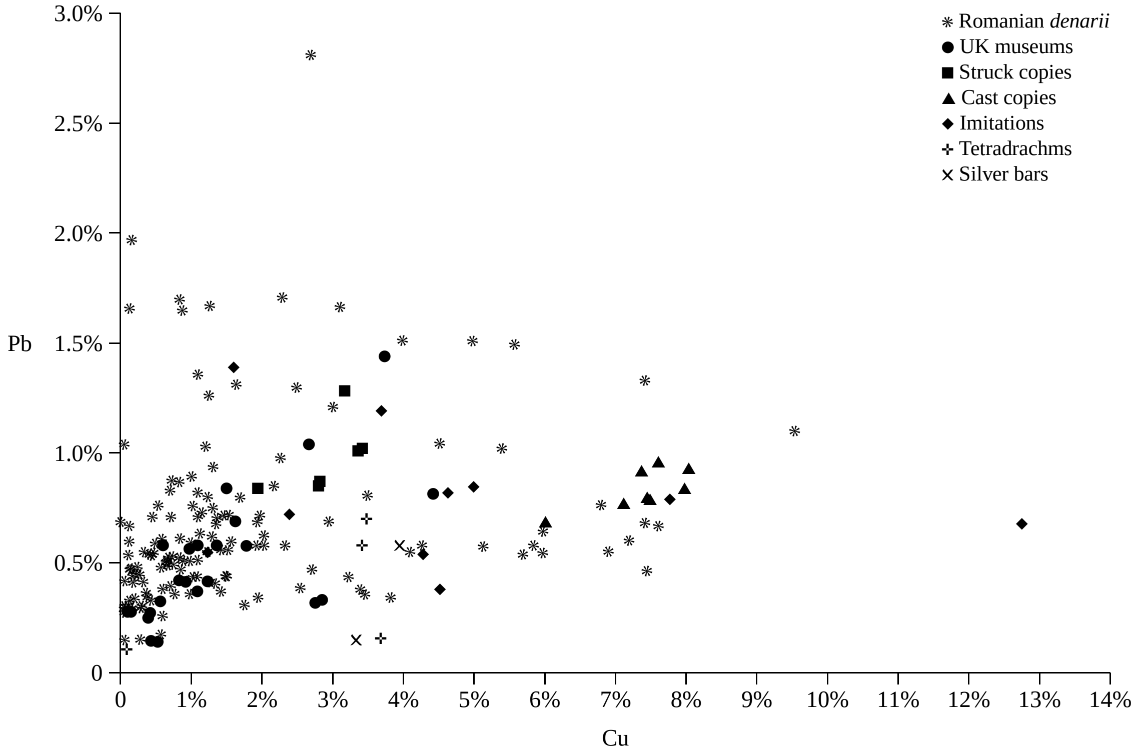
Fig. 14.23b also shows a dense cluster of points near the origin of the graph. The three extreme outliers to the right of the graph are all from Stăncuţa, one *denarius*, one tetradrachm and one silver bar. The two outliers at the top of the graph are two imitations of *denarii*. The cast and struck copies lie in a tight cluster at the bottom of the graph. They do not appear to have much differentiation in terms of their gold content but they do have less bismuth than most of the UK museum coins. The exception to this pattern is one of the Breaza cast coins which has a high level of bismuth.

The visualisation of distributions in crowded point patterns such as these is difficult. A number of methods have been proposed to help this situation. For example, Becketti & Gould (1987) propose a simple bivariate extension of the box-plot. A more sophisticated method is that of Goldberg & Iglewicz (1992) who develop a method based on ellipses. This latter paper suffers from the assumption that the data is bivariate normal. A more useful method is the use of *kernel density estimates* (KDE; Bowman & Foster 1993; Baxter & Beardah 1995). When applied to bivariate data, these KDEs can be used to produce a percentage contour plot. The 'contour' lines enclose a set proportion of the points, whilst minimising the area within which these points are contained. It is therefore possible to 'contour' separate bivariate point distributions and compare their distributions not via crowded point maps, but via the contour maps. Figs. 14.24a–14.24b are percentage contour maps of the scattergrams discussed above.[17] Fig. 14.24a shows that the cast and struck copies have an almost entirely discrete distribution from the UK museum coins. There are, however, three outliers from the UK museum data (samples 181, 200 and 201). Conversely, the struck and cast copies form two discrete groups as might be expected if each group had their origins in the same manufacturing episode. The dotted contour of all the data shows that there are a considerable number of other coins from Romania which do not fall within the boundary of the UK museum coins. At the same time, however, a close examinination of the scatterplot (Fig. 14.23a) shows that some imitations of *denarii* fall within the boundary of the UK museum material.

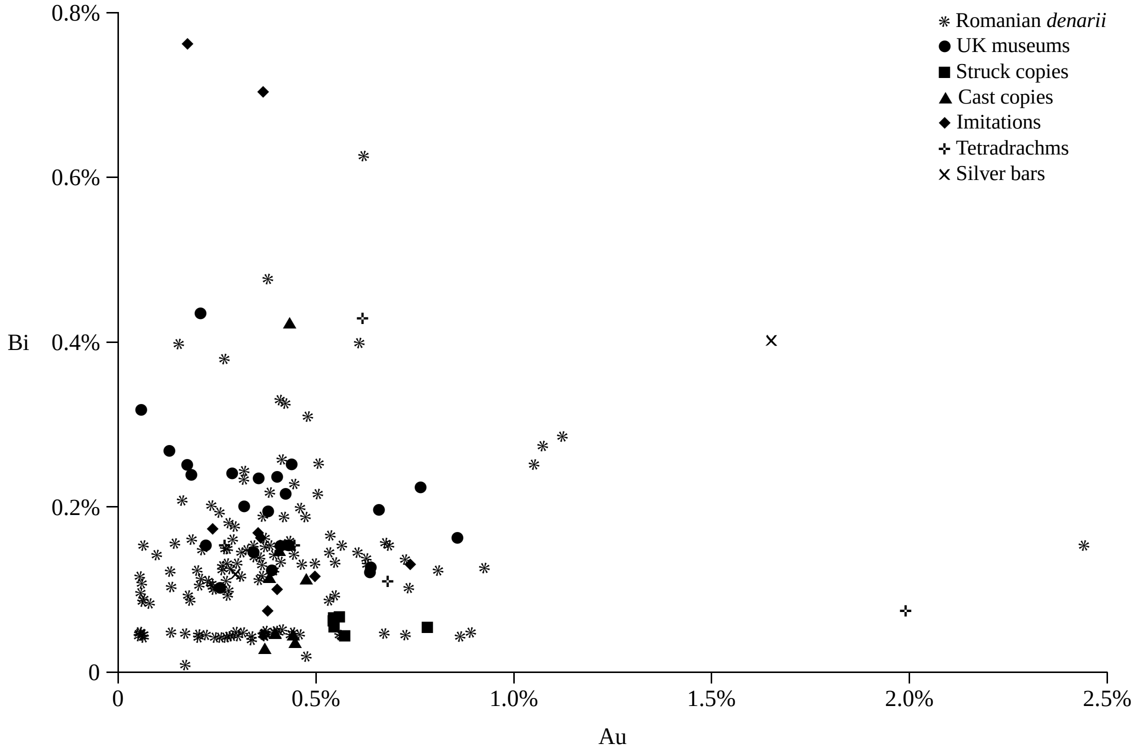
The next stage was to undertake a principal components analysis of the data. On this occasion it was decided to standardise the variables and thus analyse a correlation matrix. Again, the software used was CANOCO. The first two axes accounted for 59.1 of the variance, not particularly high

[16] These two comparisons were chosen as they represent two major elements and two minor elements. The results of the pilot study suggest that Cu *v*. Au would also have been a useful comparison.

[17] These plots were produced using MATLAB and the KDEDEMO2 macros written by Christian Beardah and available over the InterNet from Nottingham Trent University. They were produced using the *normal* kernel density estimate routine and the *solve the equation 2* method of determining 'h'. The latter was chosen as it did not appear to oversmooth the contour lines.

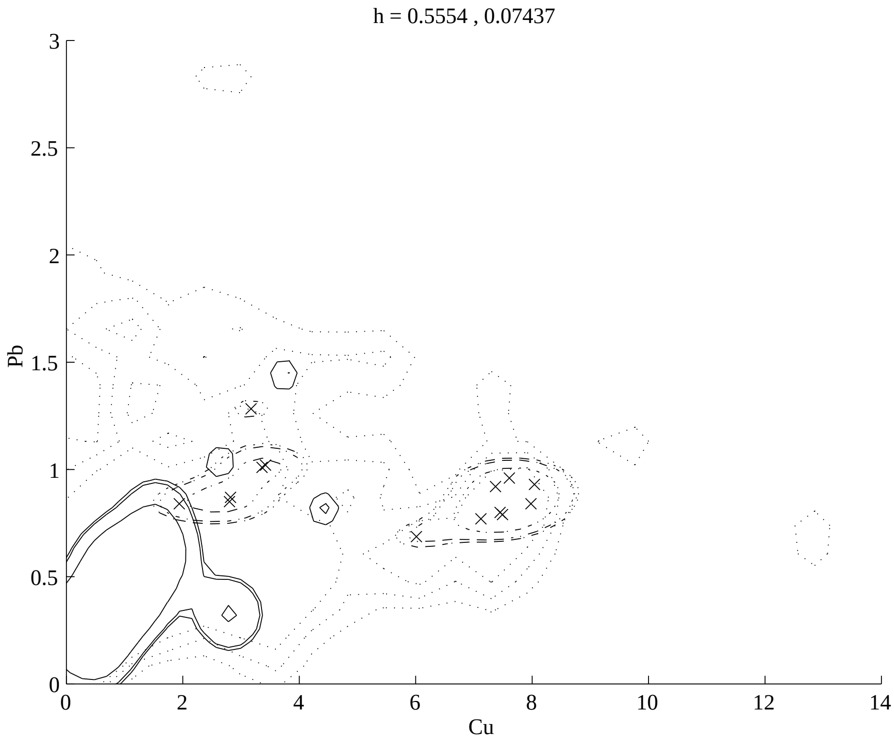


(a) Scattergram of Cu *v.* Pb

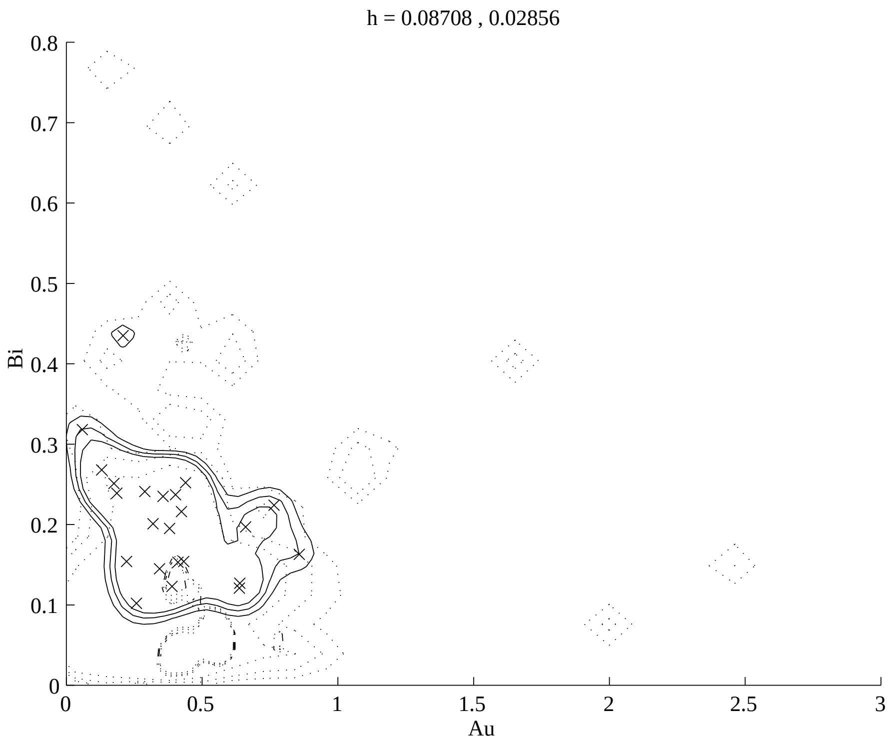


(b) Scattergram of Au *v.* Bi

Figure 14.23: Scattergrams for all samples except 191.



(a) Cu *v.* Pb. Crosses mark location of cast/struck copies.



(b) Au *v.* Bi. Crosses mark location of UK museum *denarii*.

Figure 14.24: Kernel density estimate percentage contour plot, 85, 95 and 100% contour lines for: all samples (dotted), UK museums (solid) and cast/struck copies (dashed). Sample 191 omitted.

	Axis			
	1	2	3	4
Eigenvalue	0.316	0.275	0.24	0.169
Perc. Var. Expl.	31.6	59.1	83.1	100

Table 14.12: Eigenvalues *etc.* from PCA of full metallurgical data set.

given that we are only dealing with four variables. Figs. 14.25–14.26 present the object loading map and the biplot for this analysis;[18] Table 14.12 presents the eigenvalues *etc.*

Examination of the biplot (Fig. 14.26) reveals that the first axis is mainly representing the variation in the copper and lead levels of the samples, and then second axis appears to be representing the variation in the gold and bismuth concentrations. All four arrows are pointing to the right-hand side of the biplot — this is because the samples on the left-hand side of the plot are associated with the missing element silver, *i.e.*, they are very fine coins. Looking at the plot symbols we can see that the majority of the UK museum coins are in the top-left quadrant, the majority of the cast and struck copies are in the bottom right quadrant. The three points at the top of the object loading map are the three Stăncuţa objects with high gold levels.

With a pattern like this, any method of drawing a dividing line is going to be subjective. Given, however, the nature of the distributions it was decided to use the KDE routines that had been applied to the bivariate scattergrams. Fig. 14.27a presents the 95% contours for all *denarii*, the cast and struck copies, and the UK museum coins. As can be seen, the copies and the UK museum coins form two almost completely distinct groups. Sample 58 was omitted from this map as it was such an extreme outlier it distorted the map. Fig. 14.27b presents a similar plot but with the individual data points plotted as well for comparison to the PCA maps.[19]

It was decided to divide the *denarii* in these analyses into four categories the first two of which were: 'far-out' samples which had scores of $>$0.5 on the x-axis, and $>$1.15 or $<$-0.35 on the y-axis and 'core' coins which were within the 95% contour of the UK museum material. An examination of the three samples for which there were two sets of analyses showed that there was a 0.25–0.31 difference in their co-ordinates, mainly on the x-axis. The coins that were left were therefore divided into those outside the 95% contour of UK museum coins but within a band 0.31 units from the contour ('penumbra' samples), and those outside this band ('outside' samples). A couple of points should be noted (Table 14.13). Firstly, only a single UK museum coin lies in the far-out category, and a further coin in the out-side category. In the case of the former (coin no. 181) it seems a distinct possibility that this represents a further copy within the Ashmolean coin collection. Of the cast coins from Breaza, all lie in the 'far-out' category, but the struck coins from Poroschia mainly lie in the penumbra or outside categories. The imitations occur in most groups including the core group.

[18] CANODRAW, the plotting program which accompanies CANOCO, sometimes omits data points rather than plotting a map which is too crowded. Therefore, the centre of the maps should have more points than are plotted.

[19] It seems to be impossible in MATLAB to scale scattergrams so that $1x = 1y$. This is a serious flaw.

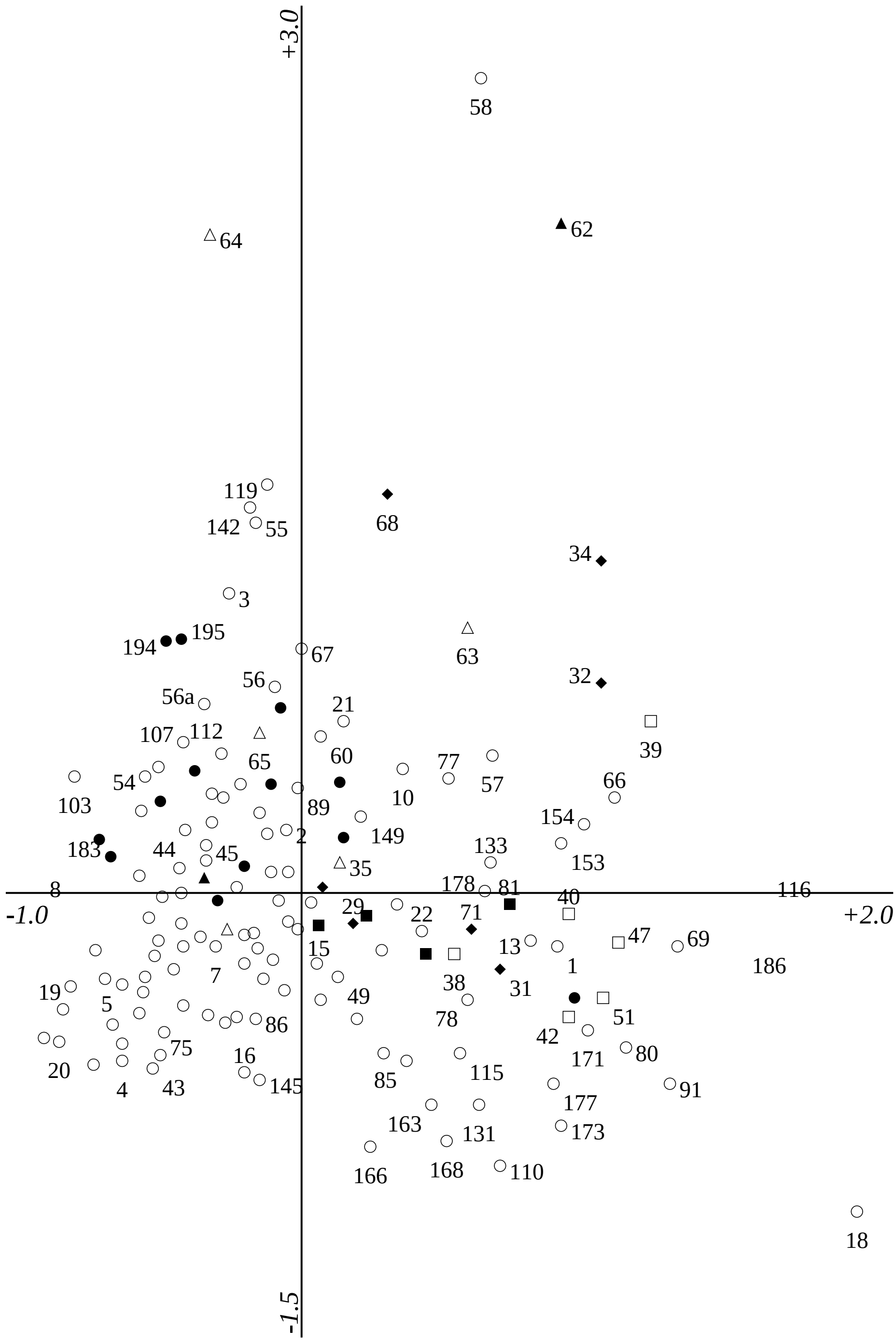


Figure 14.25: Map from PCA of full metallurgical data set omitting sample 191. 1st and 2nd axes of inertia. Open circles: *denarii* from Romania; filled circles UK museum *denarii*; open squares: cast copies from Breaza; filled squares: struck copies from Poroschia; open triangles: tetradrachms; filled triangles: silver bars; diamonds: imitations.

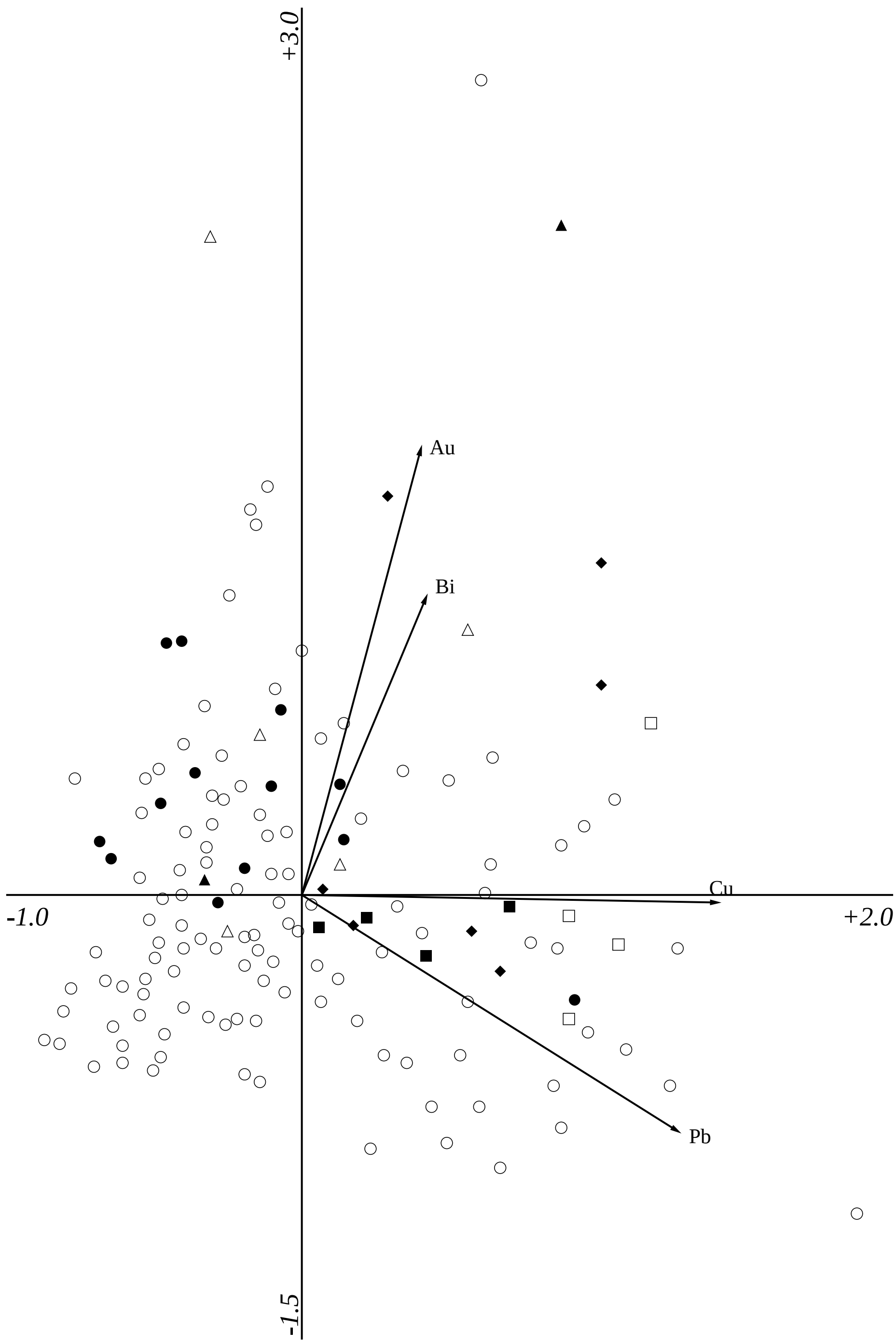
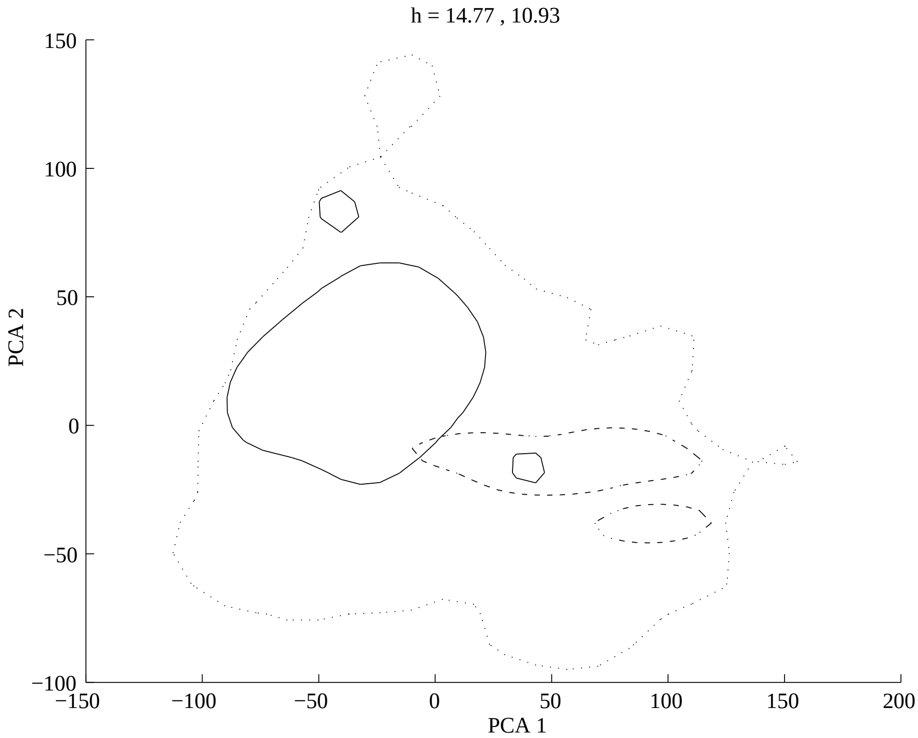
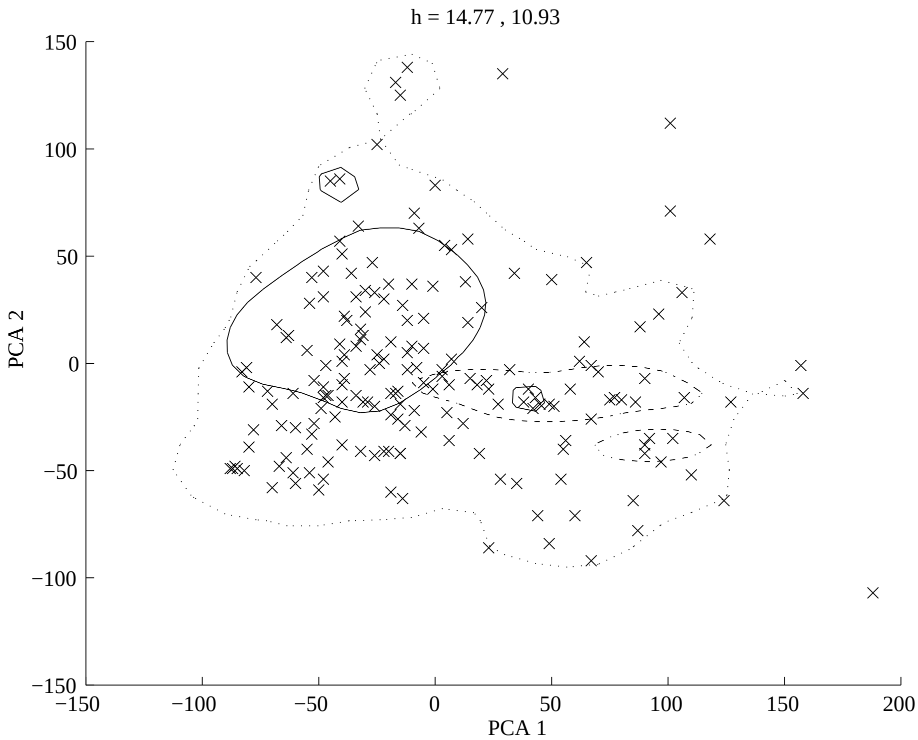


Figure 14.26: Biplot from PCA of full metallurgical data set omitting sample 191. 1st and 2nd axes of inertia. Symbols as for Fig. 14.25



(a) PCA 1 *v.* PCA 2. 95% percentage contour plot.



(b) PCA 1 *v.* PCA 2. 95% percentage contour plot. Individual points also marked.

Figure 14.27: Kernel density estimate percentage contour plot: all *denarii* (dotted), UK museums (solid) and cast/struck copies (dashed). Samples 58 & 191 omitted.

Some samples with apparently high copper levels occur in the core group. These samples usually have very low quantities of the other elements, *i.e.*, they are still relatively fine. The fact that all the elements are represented on the right-hand of the ordination diagram (Fig. 14.26), which means that the left-hand side represents 'lack' of elements (*i.e.*, purer silver), suggests that the process of omitting the silver from the analyses has not entirely solved the problem of closure. The results did, however, seem to make archaeological sense and were retained.

The final stage, therefore, is estimate how many copies were in each hoard. To do this I decided to use the number of coins in the far-out category as the total number of copies identified. No doubt some of the coins in this category are in fact genuine, but there is also a likelihood that some of the coins in the core category are copies as shown by the fact that some of the imitations have the same metallurgical composition to the main mass of points.

Taking the Şeica Mică hoard first. Until now, there had been no proof that this hoard contained any copies. If we count the samples which are far-out in this hoard we get 16 coins from 44, or 36.36%. Calculating the 95% confidence limits (Shennan 1988, p. 311) and using the finite correction factor, we get 95% limits of 36.3% $\pm$ 12.4% or between 83 and 169 of the total hoard. This figure seems very high. If we take an ultra-conservative line and only accept those 6 coins with very high copper levels as copies we still get 13.6% $\pm$ 8.8%, or 17–78 coins.

For the Poroschia hoard we find that of the 66 coins sampled, 4 were known imitations which leaves us with 62 samples. Unlike Breaza, where cast coins were deliberately chosen, the struck coins were chosen by the usual process and so they can be included in the calculations. Of the 62 samples, 30 were in the far-out category which gives us a mean estimate of 48% and 95% limits of $\pm$ 11%, or between 205–327 coins! If we use an ultra-conservative estimate of only coins with more than 3% copper we get 10 coins which gives us a mean estimate of 16% $\pm$ 8%, or between 44 and 132 coins in total.

For the Poiana hoard, we only have 15 samples in total so we have to resort to the use of Table P in Rohlf & Sokal (1995). There are 6 far-out samples in this hoard which gives us a mean estimate of 40%. The 95% limits are 19–67%, which translates to 29–101 coins. If we were to restrict ourselves to coins with $>$3% copper we would have only 1 coin which gives a mean estimate of 6.6% and 95% limits of 0.3%–30%, or 0.5(!)–45 coins.

For the Stăncuţa hoard we have 9 samples, but of those we only have 4 *denarii*. Of those 4 *denarii*, two are far-out. One of those has $>$5% copper, as well as a low weight, and the other has high levels of gold. This last is particularly suggestive as the only other objects in the assemblage with high levels of gold are one of the silver bars and one of the tetradrachms. If we accept both of these coins as copies we get a mean estimate of 50%, but confidence limits of 9–90%!

Of the hoards which had been previously analysed, Zătreni seems to have one or two copies in its assemblage. Due to the very small sample size this gives us a wide range at the 95% level: either 0.8–59% or 6–73%.

For the Breaza hoard we had previously identified a further 3 copies in the 14 samples not known to come from cast coins. A further two coins now appear in the far out-category. The first, no. 43, appeared odd in the the pilot analyses (Fig. 14.20), mainly due to the presence of minor trace elements. These elements have been omitted from this analysis but the coin still appears to be

Table 14.13: Results from metallurgical analysis. Starred coins were highlighted by univariate analyses. [1]Imitations, [2]Breaza cast copies, [3]Poroschia struck copies, [4]silver bars, [5]tetradracms of Thasos. PCA values ×100.

No.	hrd.	ref.	date	wght.	PCA1	PCA2	Cu	Pb	Au	Bi
'Core' samples										
2*	ZAT	362/1	82	3.79	−5	21	0.710	0.710	0.154	0.398
6	ZAT	367/5	82	3.89	3	−3	1.690	0.800	0.465	0.131
6a	ZAT	367/5	82	3.89	−12	20	1.566	0.597	0.534	0.145
7	1PO	200/1	155	3.61	−29	−18	2.540	0.387	0.242	0.100
8*	1PO	273/1	124	3.74	−83	−4	0.274	0.152	0.237	0.107
23*	1PO	336/1a–c	92	3.51	−5	7	2.326	0.580	0.417	0.154
28	1PO	380/1	80	3.80	−5	−9	1.088	0.822	0.385	0.154
35[5]	POP	—	0	0.00	13	11	3.417	0.580	0.446	0.154
36[5]	POP	—	0	0.00	−25	−12	1.360	0.580	0.270	0.154
44	BRZ	337/3	91	3.90	−39	22	0.920	0.420	0.498	0.132
45	BRZ	340/1	90	3.70	−32	11	0.730	0.530	0.366	0.189
46	BRZ	344/1b	89	3.90	−47	−1	1.750	0.310	0.476	0.019
48	BRZ	405/3b	69	3.95	−8	−2	0.700	0.830	0.433	0.159
50	BRZ	444/1a	49	3.75	−31	13	0.980	0.510	0.445	0.143
53	BRZ	517/2	41	3.80	−22	2	1.420	0.560	0.372	0.152
54	BRZ	RIC 1$^{(2)}$, Augustus 272	29	3.75	−53	40	0.590	0.260	0.474	0.188
59*	STN	342/5b	90	3.86	−14	27	1.360	0.580	0.566	0.154
60	STN	274/1	123	3.77	7	53	3.459	0.356	0.507	0.253
61[4]	STN	—	0	0.00	−33	6	3.333	0.150	0.297	0.119
65[5]	STN	—	0	14.51	−14	54	3.681	0.158	0.682	0.110
70[1]*	PRS	*cf.* 317/3a	104	3.99	3	−6	4.519	0.379	0.378	0.074
72[1]	PRS	*cf.* 372/1	81	4.89	−25	4	1.232	0.549	0.361	0.163
73[1]	PRS	*cf.* 379/2	80	3.47	7	2	2.387	0.721	0.498	0.116
74**	PRS	220/1	145	3.57	−12	−3	2.030	0.580	0.342	0.154
79	PRS	412/1	64	4.02	−48	−16	0.850	0.470	0.373	0.050
87	PRS	324/1	101	3.80	−30	34	1.081	0.439	0.537	0.166
88	PRS	326/1	101	3.74	−48	−11	0.666	0.489	0.415	0.052
89*	PRS	341/2	90	3.74	−1	36	3.820	0.344	0.727	0.045
96	PRS	421/1	59	3.95	−47	−15	1.269	0.414	0.368	0.045
97	PRS	431/1	55	3.90	−46	−15	1.334	0.408	0.366	0.046
107*	PRS	299/1b	111	3.91	−40	51	0.706	0.396	0.865	0.043
108	PRS	313/1c	106	3.92	−34	−15	0.839	0.613	0.443	0.048
112*	PRS	319/1	103	3.96	−41	57	0.593	0.383	0.892	0.048
117	PRS	248/1	133	3.80	−52	−8	0.128	0.470	0.162	0.208
118**	PRS	243/1	134	3.79	−26	33	0.464	0.546	0.414	0.258
120*	PRS	281/1	119	3.83	−54	28	0.125	0.330	0.319	0.244
121*	PRS	203/1b	153	3.56	−32	16	0.656	0.510	0.318	0.234
123*	PRS	317/3a	104	3.84	−41	9	0.570	0.480	0.371	0.163
125*	PRS	337/3	91	3.90	−48	43	0.379	0.346	0.606	0.145
126	PRS	340/1	90	3.90	−20	37	1.089	0.514	0.505	0.216
127*	PRS	378/1b	81	3.91	−19	−14	0.531	0.761	0.257	0.194
128	PRS	372/2	81	3.93	−17	−14	1.092	0.709	0.290	0.161
137	SEI	273/1	124	3.70	−55	6	0.360	0.364	0.236	0.202
140	SEI	300/1	110	3.86	−61	−14	0.319	0.415	0.370	0.047
143	SEI	324/1	101	3.77	−24	0	1.123	0.634	0.565	0.044
144	SEI	316/1	105	3.96	−34	8	0.488	0.588	0.533	0.087
146	SEI	340/1	90	3.80	−40	1	0.644	0.505	0.359	0.139
148	SEI	337/3	91	3.98	−27	47	0.744	0.493	0.676	0.157
149	SEI	344/2a	89	3.87	20	26	2.942	0.690	0.628	0.138
150*	SEI	342/5b	90	3.77	4	55	3.391	0.380	0.726	0.137
151	SEI	342/5b	90	3.94	−10	8	2.708	0.472	0.411	0.134
156	SEI	354/1	84	3.77	−15	−19	1.358	0.704	0.277	0.149
157	SEI	350A/2	86	3.80	−26	−20	1.520	0.561	0.213	0.148
158	SEI	363/1d	82	3.65	−40	−10	0.676	0.525	0.271	0.149

Table 14.13 continued from previous page…

No.	hrd.	ref.	date	wght.	PCA1	PCA2	Cu	Pb	Au	Bi
159	SEI	364/1d	83	3.77	−16	−13	1.349	0.678	0.312	0.145
165	SEI	407/2	68	3.71	−30	24	0.886	0.508	0.549	0.133
167	SEI	422/1b	58	3.87	−80	−11	0.568	0.174	0.303	0.044
175	SEI	511/3a	42	3.88	−39	−7	1.944	0.343	0.264	0.124
176	SEI	517/2	41	4.05	−40	−18	1.487	0.442	0.277	0.093
179	—	379/1	80	3.81	−39	4	1.229	0.417	0.343	0.145
180	—	379/1	80	3.89	14	19	1.496	0.839	0.439	0.252
182	—	340/1	90	3.82	−38	20	0.824	0.421	0.380	0.195
183	—	340/1	90	3.88	−64	12	0.097	0.278	0.186	0.239
184	—	340/1	90	3.98	−48	31	0.561	0.325	0.356	0.235
185	—	408/1a–b	67	3.96	−28	−3	0.602	0.580	0.059	0.318
187	—	408/1a–b	67	3.90	−31	−18	1.089	0.580	0.222	0.154
188*	—	342/5b	90	3.99	−7	63	2.754	0.319	0.660	0.197
189*	—	352/1c	85	0.00	13	38	1.625	0.690	0.209	0.435
190	—	RIC $1^{(2)}$ 1, Augustus 543a	31	4.00	−68	18	0.524	0.142	0.130	0.268
192	—	200/1	155	4.06	−10	37	2.851	0.333	0.402	0.237
193	—	275/1	123	3.84	−63	13	0.147	0.278	0.175	0.251
196	—	337/3	91	3.97	−34	31	0.922	0.413	0.424	0.216
197	—	342/5b	90	3.99	−36	42	1.087	0.370	0.639	0.127
198	—	344/1a	89	3.87	−22	30	0.971	0.564	0.637	0.121
199	—	350A/2	86	4.11	−12	5	1.780	0.577	0.319	0.201
201*	—	494/23	42	4.04	38	−18	2.662	1.039	0.411	0.153
202*	—	517/2	41	3.47	−19	10	1.360	0.580	0.432	0.154
203	—	RIC $1^{(2)}$ 1, Augustus 272	29	3.73	−81	−2	0.429	0.145	0.258	0.102
‘Penumbra’ samples										
5*	ZAT	275/1	123	3.59	−60	−30	0.220	0.450	0.098	0.142
10*	1PO	342/4a–5b	90	3.51	34	42	4.262	0.580	0.685	0.154
15	1PO	382/1b	79	3.56	−1	−12	1.970	0.716	0.280	0.181
19*	1PO	139/1	189	3.34	−78	−31	0.282	0.297	0.203	0.042
21	1PO	291/1	114	4.31	14	58	3.224	0.438	0.480	0.310
29[1]*	—	*cf.* 238/1	136	3.24	18	−10	4.280	0.540	0.239	0.174
49*	BRZ	442/1a	49	3.75	12	−28	1.200	1.030	0.340	0.146
56*	BRZ	RIC $1^{(2)}$ 1, Augustus 174	12	3.90	−9	70	1.230	0.550	0.926	0.126
56a	BRZ	RIC $1^{(2)}$ 1, Augustus 174	12	3.90	−33	64	0.981	0.360	0.809	0.123
67*	VOI	340/1	90	3.80	0	83	1.500	0.440	0.379	0.477
82[3]	PRS	408/1a–b	67	3.48	6	−10	1.940	0.840	0.573	0.044
83**	PRS	415/1	62	4.02	−43	−25	0.838	0.525	0.200	0.123
84*	PRS	463/1a	46	4.27	15	−7	4.095	0.551	0.365	0.117
93	PRS	340/1	90	3.86	−19	−24	1.019	0.759	0.437	0.045
94*	PRS	344/3	89	3.97	27	−19	5.129	0.575	0.405	0.047
99[3]*	PRS	379/2	80	3.46	22	−8	2.800	0.850	0.560	0.067
103	PRS	277/1	122	3.88	−77	40	0.053	0.150	0.673	0.047
109*	PRS	362/1	82	3.73	−49	−21	0.407	0.540	0.371	0.045
122[3]*	PRS	317/3b	104	3.51	23	−12	2.820	0.870	0.544	0.062
129*	PRS	383/1	79	4.05	32	−3	2.258	0.979	0.384	0.218
134*	PRS	350A/2	86	3.85	−9	−22	1.930	0.688	0.284	0.125
135	SEI	275/1	123	3.60	−66	−29	0.055	0.420	0.132	0.122
136	SEI	271/1	125	3.55	−72	−13	0.055	0.304	0.144	0.156
147	SEI	337/3	91	3.78	−70	−19	0.198	0.338	0.205	0.105
152*	SEI	345/1	88	3.95	75	−17	6.798	0.764	0.325	0.148
155*	SEI	352/1a	85	3.75	5	−23	1.307	0.938	0.364	0.130
161*	SEI	382/1b	79	4.05	−6	−32	1.004	0.895	0.276	0.132
162	SEI	383/1	79	4.11	−13	−29	1.534	0.719	0.186	0.161
169	SEI	443/1	49	3.83	−52	−28	1.418	0.370	0.259	0.042
170	SEI	449/1b	48	3.83	−16	−26	2.025	0.625	0.279	0.099

Table 14.13 continued from previous page. . .

No.	hrd.	ref.	date	wght.	PCA1	PCA2	Cu	Pb	Au	Bi
172	SEI	444/1b	49	3.86	−53	−33	1.021	0.438	0.245	0.042
194*	—	299/1b	111	3.86	−45	85	0.392	0.250	0.858	0.163
195*	—	317/3a	104	3.40	−41	86	0.418	0.272	0.765	0.224
Outside samples										
3*	ZAT	299/1b	111	3.61	−25	102	0.430	0.330	0.610	0.399
22*	1PO	290/1	114	3.71	40	−12	5.840	0.580	0.459	0.046
41a*	BRZ	390/2	76	3.55	49	−19	5.977	0.643	0.311	0.116
98[3]*	PRS	379/2	80	3.42	42	−21	3.360	1.010	0.546	0.055
111[3]*	PRS	408/1b	67	3.51	45	−19	3.420	1.020	0.545	0.066
200*	—	463/1a	46	4.02	43	−16	4.421	0.815	0.389	0.123
'Far-out' samples										
1**	ZAT	385/1	78	4.07	86	−18	1.260	1.670	0.269	0.380
4	ZAT	284/1a	117	3.59	−60	−56	0.330	0.550	0.170	0.009
12*	1PO	340/1	90	3.78	−40	−38	0.996	0.593	0.272	0.042
13*	1PO	348/2	87	3.95	77	−16	7.607	0.668	0.356	0.112
14	1PO	362/1	82	3.44	−55	−40	0.441	0.535	0.222	0.045
16	1PO	382/1a–b	79	3.83	−19	−60	1.231	0.801	0.055	0.116
18*	1PO	450/2	48	3.91	188	−107	2.692	2.811	0.429	0.154
20*	1PO	289/1	115	3.47	−82	−50	0.298	0.305	0.065	0.042
31[1]*	—	*cf.* 340/1	90	4.16	67	−26	3.692	1.192	0.410	0.154
32[1]**	—	*cf.* 389/1	76	3.95	101	71	1.600	1.390	0.176	0.762
34[1]**	—	*cf.* 319/1 & 280/1	103	3.91	101	112	4.630	0.820	0.367	0.704
38[2]**	BRZ	517/5a	41	3.60	51	−20	6.013	0.687	0.443	0.045
39[2]*	BRZ	517/5a	41	3.90	118	58	7.490	0.790	0.434	0.424
40[2]*	BRZ	517/5a	41	3.00	90	−7	7.450	0.800	0.476	0.113
41[2]*	BRZ	390/2	76	3.55	80	−17	7.120	0.770	0.383	0.115
42[2]*	BRZ	390/2	76	3.35	90	−42	7.980	0.840	0.371	0.029
43*	BRZ	289/1	115	3.80	−50	−59	0.120	0.670	0.062	0.086
47([2])***	BRZ	382/1b	79	3.50	107	−16	7.610	0.960	0.408	0.148
51([2])**	BRZ	463/3	46	4.10	102	−35	8.040	0.930	0.448	0.036
52([2])**	BRZ	494/24	42	3.40	90	−38	7.370	0.920	0.397	0.047
55*	BRZ	RIC 1[(2)] 1, Augustus 410	13	4.05	−15	125	0.760	0.360	1.052	0.252
57**	STN	348/3	87	3.57	65	47	5.970	0.546	0.409	0.330
58*	STN	344/1a–c	89	3.86	61	275	1.923	0.580	2.442	0.154
62[4]**	STN	—	0	0.00	87	226	3.951	0.580	1.652	0.402
63[5]*	STN	—	0	15.71	56	90	3.478	0.701	0.618	0.429
64[5]*	STN	—	0	16.02	−31	223	0.085	0.106	1.991	0.074
66*	VOI	—	211	0.00	106	33	7.770	0.790	0.739	0.131
68[1]*	VOI	RIC 1[(2)] 1, Augustus 134a	18	3.79	29	135	0.450	0.710	0.621	0.626
69**	PRS	517/2	41	2.50	127	−18	5.571	1.494	0.630	0.131
71[1]*	PRS	*cf.* 392/1b	75	5.01	58	−12	4.997	0.846	0.354	0.169
75	PRS	336/1c	92	3.83	−48	−54	0.580	0.610	0.080	0.083
76	PRS	340/1	90	3.86	−32	−41	1.290	0.622	0.183	0.087
77**	PRS	341/2	90	3.90	50	39	5.690	0.540	0.735	0.102
78*	PRS	391/3	75	3.90	56	−36	2.490	1.300	0.395	0.142
80***	PRS	342/5a–b	90	3.64	110	−52	4.981	1.509	0.394	0.123
81[3]**	PRS	379/2	80	3.53	70	−4	3.171	1.283	0.782	0.054
85*	PRS	494/28	42	3.89	35	−56	1.635	1.312	0.399	0.050
86**	PRS	321/1	102	3.83	−15	−42	0.724	0.875	0.227	0.111
90*	PRS	345/1	88	3.73	67	−1	7.192	0.604	0.560	0.045
91**	PRS	354/1	84	3.92	124	−64	7.417	1.332	0.372	0.044
92	PRS	337/3	91	3.83	−22	−41	1.457	0.716	0.288	0.044
95	PRS	354/1	84	3.99	−26	−43	1.148	0.729	0.279	0.043
100	PRS	268/1a	126	3.74	−70	−58	0.268	0.449	0.054	0.047
101	PRS	259/1	129	3.60	−86	−48	0.143	0.282	0.065	0.046

Table 14.13 continued from previous page…

No.	hrd.	ref.	date	wght.	PCA1	PCA2	Cu	Pb	Au	Bi
102	PRS	275/1	123	3.81	−67	−48	0.145	0.475	0.134	0.048
104	PRS	282/1	118	3.82	−85	−49	0.155	0.293	0.056	0.049
105	PRS	285/2	116	3.70	−80	−39	0.102	0.307	0.065	0.089
106	PRS	291/1	114	3.88	−87	−49	0.052	0.293	0.061	0.045
110*	PRS	366/4	82	3.93	67	−92	0.156	1.969	0.392	0.048
113	PRS	350A/2	86	4.18	19	−42	3.492	0.808	0.316	0.048
114	PRS	350A/2	86	3.66	−20	−41	1.302	0.751	0.298	0.049
115**	PRS	480/6	44	3.87	54	−54	4.511	1.044	0.338	0.039
116**	PRS	528/3	39	3.86	157	−1	9.538	1.101	0.446	0.228
119**	PRS	241/1a	135	3.71	−12	138	0.170	0.443	1.123	0.286
124	PRS	297/1a	112	3.85	−88	−49	0.051	0.276	0.053	0.044
130*	PRS	384/1	79	3.91	−15	−42	0.830	0.869	0.239	0.104
131*	PRS	386/1	78	3.62	60	−71	0.834	1.699	0.301	0.132
132	PRS	329/1a	100	3.80	−64	−44	0.235	0.482	0.170	0.047
133**	PRS	348/2	87	3.28	64	10	6.899	0.553	0.437	0.154
138	SEI	289/1	115	3.62	−54	−51	0.123	0.599	0.060	0.108
139	SEI	286/1	116	3.57	−61	−51	0.110	0.537	0.057	0.096
141	SEI	299/1a	111	3.66	−46	−46	0.000	0.686	0.135	0.103
142*	SEI	317/3a	104	3.71	−17	131	0.176	0.412	1.074	0.274
145*	SEI	334/1	97	3.63	−14	−63	0.050	1.039	0.064	0.154
153*	SEI	345/1	88	3.74	88	17	7.417	0.682	0.461	0.199
154**	SEI	348/3	87	3.59	96	23	5.393	1.021	0.423	0.326
160*	SEI	366/4	82	3.96	55	−40	0.126	1.659	0.420	0.188
163*	SEI	374/1	81	4.01	44	−71	3.004	1.209	0.177	0.093
164*	SEI	387/1	77	3.88	28	−54	1.246	1.262	0.264	0.129
166*	SEI	429/2b	55	3.90	23	−86	1.093	1.357	0.203	0.046
168	SEI	442/1a	49	3.84	49	−84	0.874	1.649	0.337	0.043
171*	SEI	449/1a	48	3.72	97	−46	3.101	1.665	0.548	0.093
173*	SEI	453/1a	47	3.87	87	−78	3.989	1.512	0.210	0.113
174*	SEI	467/1a	46	3.73	6	−36	2.169	0.852	0.273	0.111
177*	SEI	494/23	42	3.93	85	−64	2.289	1.709	0.345	0.140
178*	SEI	348/1	87	3.80	62	1	7.446	0.464	0.295	0.177
181*	—	379/2	80	3.92	92	−35	3.735	1.440	0.289	0.241
186[1]**	—	408/1a–b	67	3.39	158	−14	12.75	0.679	0.402	0.100

unusual because it is too pure! The second coin is in the far-out category because it has high levels of gold. If we accept these two coins as copies the percentage of copies rises to 38% with 95% confidence limits of 15–62%.

The metallurgical results have proved a difficult data set to analyse with many problems and pitfalls. The above estimates all have rather wide confidence limits and thus the exact proportion of copied coins in the hoards is still extremely unsure. It has been suggested that any further work would be more profitably done using inductively coupled plasma spectrometry (ICPS). Any further work would, however, benefit from a large scale analysis of *denarii* from outside Romania, preferably Italy, to replace the results produced by (Walker 1980) using x-ray flouresence. These results would be of use outside of the current problem.

We can be fairly confident that there were more copies in the Breaza and Poroschia hoards than Chiţescu or Crawford had allowed for. The second most important point of all is that there does seem to be good reason to believe that there are copies in the Poiana, Stăncuţa and Şeica Mică hoards; the Zătreni hoard remains a marginal case. We must, therefore, disagree with Crawford that the Breaza hoard is unique in having copies, and with the "a priori" assumption that the Dacians would not have bothered to match obverses and reverses. We can, however, *still* speak of a massive penetration of *denarii* into the region between *c.* 75–65 BC, but that the phenomenon is magnified because of the copying of these coins.

A point of methodology can be derived from this work. If an analytical program is examining a number of artefacts from different origins such as hoards or sites, it would be advisable to randomise the order in which they are analysed so that variations which can occur from one run of the technique to the next will be randomly distributed amongst the groups, rather than being associated with one group which was analysed as one batch.

14.4.7 Identifying copies — coin weights

As will be clear from some of the reviews presented in Chapter 3, any analysis which uses coin-weights has to account for a large variety of factors including variable target weights at minting, post-depositional alterations to the coin weights and errors in the weighing and publication of the coins (*e.g.*, see page 85). The statistical analysis of coin weights is also difficult as often many of the weighed coins come from the same hoard and thus the weights of the individual coins are not entirely independant. The pattern of hoarding also creates problems in that we have, for example, many hoards from the 70s BC, and many from the 40s BC but few for the period inbetween. This pattern will produce high values for the correlation coefficient from a regression analysis but they are invalid (Baxter 1994, pp. 33–38).

For this project an exploratory analysis of coin weights from the Poroschia hoard and some Italian hoards was undertaken (Lockyear 1993b). The method used was the construction of box-and-whisker plots and histograms. This showed quite clearly that there was a difference in the weights of the the cast copies compared to coins from Italian hoards. Various forms of multiple comparison procedures were also examined but often the data did not meet all the assumptions of the tests and thus there was doubt as to the validity of the results (O'Neill & Wetherill 1971).

To illustrate the problems Fig. 14.28 presents a histogram of the weight distribution of coins in the Şeica Mică hoard. There is a bimodal distribution with a peaks at 3.5–3.6g. and 3.7–3.8g. The lower peak corresponds well to the weight of the struck copies in the Poroschia hoard. Unfortunately, it also corresponds well to the weight of worn *denarii* in the Bylanse Waard hoard (BYL) from the Netherlands. The average weight of the 'far-out' samples from the metallurgical analysis is 3.69g.; that of the core samples 3.79g.

Sample weights could provide a method for casting suspicion on certain coins but in isolation it is insufficient. For the weights to be used to their full potential, much more comparative data needs to be amassed, and every care is needed to make sure the weights used are reliable and as little affected by post-depositonal factors as possible.

14.4.8 Comparison to previous analyses

The CAs presented in Part II did not clearly pick out any year or hoard from Romania as being sufficiently odd to be identified as being copies. However, with hindsight we can see some associations in the pattern. For example, 80 BC, the year in which Crawford assigns the issue of L. Procilus f. can be seen to be associated with the Poroschia hoard (section 8.3.18, page 224). The only year

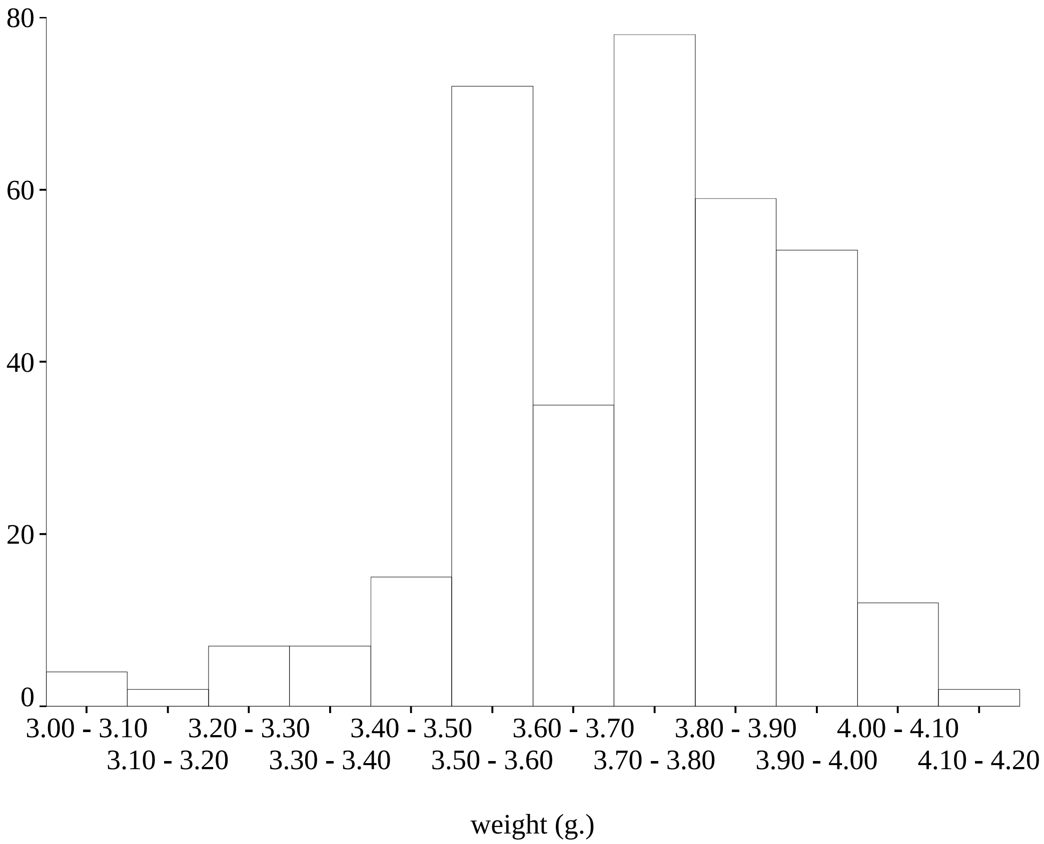


Figure 14.28: Weights of coins in the Şeica Mică hoard. Output from SPSS.

which appears anomalously to be associated with Romanian hoards is 135 BC. Only one coin of that date was analysed (no. 199 from Poroschia), and it is in the 'far-out' category. At present, it is only likely that the analysis of the hoard composition is going to help identify copies when an abnormally high number occur in the same hoard.

14.5 Coinage in Dacia — summary and conclusions

The results outlined above have raised more questions and opened more avenues for future research. Of particular interest would be a further examination of the spatial distribution of hoards, and examination of the patterning within hoards of silverware both including and excluding the coinage evidence. The problem of copies can be extended back to examine the pre-Roman coinages especially those of Macedonia Prima and Thasos. The spatial analysis of other classes of artefact and settlement type might also be of interest, although the fact that detailed maps are still 'official secrets' in Romania makes detailed level analyses impossible.

Tentative answers to some of the fundamental questions can be given. Hoards from Romania closing in the 70s BC are fundamentally identical to those from Italy in terms of their *denarius* contents. The tendency for them, even at this stage, to be slightly archaic suggests that the method of supply was non-state supply, *i.e.,* trade. The goods traded, using the term in its loosest sense, are unknown. Crawford's (1977b) suggestion that this influx of coinage was primarily a result of the slave trade cannot be ruled out, but the influx does appear to start *before* the supression of piracy in 67 BC. This interpretation relies, of course, on the accuracy of Crawford's dating scheme for the Republican coinage. The spatial distribution of the hoards is a topic for future research but there does appear to be three concentrations: around Poiana in southern Moldavia, in south-central Wallachia, and in Transylvania, especially in the south-west of that region. Mapping the classes of hoards from cluster analysis also suggested regional patterning, and the possibility that Republican coinage in the 40s BC was entering the region from the Black Sea. The pattern of supply to the area was erratic, with there being one major influx in the period *c.* 75–65 BC, and a possibility of a secondary influx in the 40s BC, perhaps associated with the Civil Wars.

The relationship of *denarii* to the pre-existing coinages is difficult to assess as differential hoarding is commonplace. However, it would appear likely that the main coinages in circulation at the period when *denarii* arrive in the region were *drachmae* of Apollonia and Dyrrachium, and tetradrachms of Thasos. These appear to fall out of use in favour of the *denarius*, probably mainly by 60 BC; *denarii* were then subsequently copied.

The number of copies within the Romanian corpus is not yet determined, but we can be sure that it is not a isolated phenomenon and I would not be surprised if the final total was in the region of about 30%. The date at which the copying starts is similarly unknown. Logically, one would suggest that the period after the large influx of *denarii*, *i.e., c.* 60 BC would be a likely context for these copies. The Zătreni hoard, however, closes in 75 BC and although this obviously only provides a *terminus post quem*, it would seem to cast doubt on the 'logical' context. If further work on this problem is undertaken, it should be a priority that early *denarii* hoards are examined in order to investigate this aspect of the problem.

Chapter 15

State, swindle or symbol?

> Progresul cunoaşterii noastre privind istoria şi cultura geto-dacilor depinde, după cum se pare, înainte de toate, de dezvoltarea în continuare şi perfecţionarea metodologică a cercetărilor arheologice. În abordarea acestui domeniu, arheologii trebuie să lucreze independent, pe cît posibil neinfluenţaţi de date şi teorii istorice.[1] (Babeş 1974, p. 242)

15.1 Introduction

This chapter has an ambitious aim: to integrate all the relevant data, analyses, facts and theories to present an alternative view of the late Iron Age in Dacia including, of course, the rôle of Roman Republican *denarii* and their copies. The ideas presented here are *not* intended to become a new orthodoxy, but represent one possible alternative past. These ideas are built upon the empirical data presented previously, but are an explanation, in the sense of Runciman and Shennan, of those data. The purpose of these explanations is to provoke discussion by questioning some of the past explanations, and to stimulate the formulation of new questions of the data.

This rest of this chapter will be divided into four sections. Section 15.2 will outline what we can now say about these coins in terms of *reportage*, and what I consider to be 'low level' explanation. Section 15.3 will then discuss these observations in reference to the current orthodoxy: Burebista and his state. Section 15.4 looks at one alternative proposal: the great Dacian fraud theory; the last section, 15.5, will look at the final, and preferred explanation, the rôle of the *denarii* as a symbol of power in the development of the late Iron Age polities in the region.

15.2 The coins

We can make some statements about Roman Republican *denarii* in Romania with some confidence. We know that large numbers of Roman Republican *denarii* entered Dacia in the first century BC, but can now also show that a large proportion of those coins arrived in the period *c.* 75–65 BC. The supply of these coins after this initial large influx decreased rather dramatically, although there

[1] The progress of our knowledge of Geto-Dacian history and culture depends, as we have seen, above all, on the continuing development and perfection of the methodology of archaeological research. To reach this aim, archaeologists must work independently, and if possible uninfluenced by historical data and theories. [Translation: KL]

appears to be a secondary, minor influx of coinage during the Civil Wars. The coins would have originally entered the area to fulfil a Roman need (in the widest sense of the word 'Roman') but having arrived in the area they then fulfilled a Dacian need. A proportion of the hoards recovered consist of locally made copies. This proportion originally appeared to be 10–20%, but the metallurgical analyses suggested that much higher levels of copying were possible. The manufacturers of these copies *were* concerned to make accurate replicas, *contra* Crawford (1980). This copying of *denarii* was only one manifestation of the copying of Mediterranean goods.

To these items of reportage we can add a series of 'low level' explanations. The copies show an obvious concern for accuracy in the copying of the *denarii*, which must be a reflection of some form of intent to deceive. In order to deceive, the objects must be intended to be given to others either in the form of gift, payment or exchange, as coins are an unlikely medium for the *display* of wealth, a function more successfully fulfilled by other forms of silverware such as spiral arm-bands, brooches or silver vessels. For whatever reason, the possession of these objects, and not just the material of which they are made, must be desirable. The need for deception must be to convince the recipient of the coins that they are indeed 'Roman' and three reasons can be suggested for the importance of the Roman origin of the coins.

1. The Roman state guarantees the weight and fineness of the coin, and thus its 'economic' value in the usual sense of the phrase.

2. That Roman coins were needed to purchase goods from traders who would only accept Roman coinage.

3. The symbolism of the coin was important; but it was not the detailed iconography that was important, but the fact that it was *Roman*.

The striking and casting of these copies of *denarii* must have been in response to a shortfall in the supply of originals. The most likely context for such a shortfall is the period from *c.* 60 BC onwards when, as we have seen, little new coinage entered the area. This idea, however, requires further testing.

It would also appear that at first these coins circulated alongside coins of Apollonia, Dyracchium and Thasos, but that they soon supplanted them. The Stăncuţa hoard is interesting in this regard. The archaeometallurgical analyses suggest that one *denarius*, one silver bar and one tetradrachm are made of essentially the same alloy which is characterised by high levels of gold. There is no way of telling which objects were being made from which, but two interesting possibilities are that either the tetradrachm and the *denarius* were being made from the silver bar, or that tetradrachms were being melted down and the alloy used to make copies of *denarii*. Crawford (1985) suggests that many of the tetradrachms of Thasos found in Dacia are copies and this is yet another problem which requires further detailed investigation. The possibility that the coins in the Stăncuţa hoard were being melted down to make jewellery seems unlikely, given the composition of those three artefacts.

Despite the concentration of coin hoards of all periods prior to the Roman conquest in the south-western area of Transylvania, there is a lack of coinage evidence from these sites apart from one small dispersed hoard at Căpîlna (CAP) and the new hoard from Piatra Roşie (PIA). Only the sites in Transylvania and Crişana have, however, Trajanic coins.

15.3 State?

The concept of the Dacian state was outlined in Chapter 13. This idea, although mentioned by Pârvan, was first elaborated at length by Daicoviciu (1950) and has been developed subsequently. The most recent elaboration of the function of Republican *denarii* in Romania and their copies is that of Chiţescu (1981). She sees the copies of *denarii* being an attempt by the great King Burebista to produce a national coinage for his newly formed state. Great Kings, however, have great egos. It seems extremely unlikely that a coinage would have been minted by the ruler of a huge and powerful state bearing the names of L. PISO FRVGI or some other little known Roman magistrate who happened to be in charge of the coinage for a year. It is more likely that this Great King would have minted coins proclaiming BVREBISTA REX — there are none.

The sites in the Munţii Orăştiei certainly represent a remarkable achievement. There is, however, no evidence whatsoever to associate these sites with Burebista. The same cannot be said for Decebalus: the remarkable vessel stamped DECEBALVS PER SCORILO from the civil settlement at Sarmizegetusa Regia is extremely suggestive, if not absolutely definite (Protase 1986). The Roman military evidence in the area, and the location of Sarmizegetusa Ulpia Traiana nearby on the plain, makes the connection fairly secure. Unfortunately the dating evidence for these sites is very poor and we cannot be sure when they began (Daicoviciu & Glodariu 1976). The sequences at Gradiştea Muncelului and Costeşti appear to be the longest, but there is no certainty about when they start.

If there is a 'state' in the late Iron Age of Dacia, it is much more likely to be a southern Transylvanian phenomenon of the time of Decebalus rather than a polity ruled by Burebista.

15.4 Swindle?

It has been suggested to me that the copying of coins in Dacia was mere swindle in the western, economic sense of the word. The copied coins are often about 0.3g. too light, and from the metallurgical analyses they have up to 5% more copper than would be expected. This means that for the same weight of silver a Dacian 'mint' would be able to strike 9 *denarii* instead of 8. If the Dacian mint wished to perpetrate such a fraud, why stop at debasing the coins by only 5%? It would be possible to add more copper with little visible effect on the coin, as the mint at Rome was to do the in following centuries. An alternative would be to produce plated coins as was not uncommon throughout the Ancient world. In this explanation, the accuracy of the copies is seen as a simple by-product of the mechanical way the dies were made, or because the coins were cast. This explanation does not really account for the effort taken to produce such accurate copies. As Bailey (*pers. comm.*) has pointed out, making bronze dies from silver coins is not a straightforward procedure.

This interpretation of the evidence is heavily ethnocentric and rather formalist in outlook, although it remains an explanation of the data which is concordant with it.

15.5 Symbol?

An explanation of the pattern observed in the archaeological evidence can be suggested which uses the anthropological insights discussed in Chapter 2.

Geto-Dacian society, prior to the influx of Roman *denarii*, had contacts with the Graeco-Roman world and Mediterranean goods had entered the area (Glodariu 1976). These goods could have been used in a prestige goods economy with the élites controlling access to these items (*cf.* Frankenstein & Rowlands 1978). The distribution pattern of luxury imports in Moldavia, for example, is dominated by the finds at the site of Poiana situated on the river Siret. This site is obviously controlling the movement of goods from the Black Sea region up the river valley into the hinterland of the site. Control of this flow of goods enabled the élite of this settlement to gain a dominant position. As Rowlands (1980) noted:

> ... relations of dominance and hierarchy depend directly on the manipulation of relations of circulation and exchange... Since alliances are established through exchange, involving material goods, women and symbolic knowledge, *success depends on maintaining flows of these resources*. However, alliances in themselves do not bring prestige, but instead form the support base for local leaders to compete with each other in ceremonial displays of feasting and fighting, in the recitation of heroic deeds, and in claims to ritual and geneaological ties with the ancestors and the supernatural world. (Emphasis mine.)

We have, therefore, the possibility that the presence of Greek goods, goods from 'outside', had a rôle in maintaining and mediating alliances between groups. In the west of Dacia this rôle was probably partly fulfilled by the *drachmae* of Apollonia and Dyrrachium. This is not to say that the coins were given as 'gifts' by the *issuing* authorities, but that they functioned as part of the gift exchange system when within the Geto-Dacian milieu. We should note that there does seem to be a preference for silver in this region, both in the form of coin and in the form of silverware. Guest (1993) notes that there is evidence for a continued preference for silver in the period after the Trajanic invasion.

With the arrival of the *denarius* in large numbers, however, the pattern was disrupted and *denarii* supplanted other items in the system. These *denarii* may have become highly valued for what they represented: the power of the Roman state. At this period of rapid expansion, the people on the periphery of the Roman world must, with varying degrees of accuracy, have heard of this powerful and warlike people. Thus the *denarius* was imbued with the power of the Roman state. When, however, the large scale supply of these coins to the region ceased, a need rapidly developed to replace and supplement these supplies. The Dacians, competent silver smiths with a long history of striking and copying coins, were able to supplement their supplies with excellent copies.

Two possiblities exist within this framework for the function of these coins: they could either be exchanged as gifts, or they could form part of a system of deliberate disposal and destruction

(Bradley 1982). Thus, the hoards which are so common in Dacia may be the outcome of such behaviour, rather than of deposition in 'times of trouble', the usual explanation.

Over the period 50 BC–AD 50 I would suggest that the polities which existed in this area gradually increased in size and influence. Burebista should be seen as just one of these.

If we push the chronology of most of the Dacian fortresses into the first century AD, and posit that they are not a representation of a centralised plan, but are another expression of élite competition centred around the religious site of Sarmizegetusa Regia, then a rather different image of these enigmatic settlements is possible. The differences between each site should be given as much weight as the similarities. Eventually, however, one of the rulers of the polities in the area gained predominace, and this dominance was no longer maintained through the exchange of gifts, or the destruction of wealth, but through the control of resources. At Sarmizegetusa Regia we have more evidence for iron working than in almost the rest of Dacia put together (Glodariu & Iaroslavschi 1979). If we couple this with the similarity between the circular sanctuaries at Sarmizegetusa Regia, and the mountain top sheep folds at Rudele and Meleia, a similarity already noted by Nandris (1981), we can see the interaction between the control of religion and the control of the economic base. Similarly, we could suggest that the 'terrace of wheat' at Sarmizegetusa Regia is not a granary burnt in the Roman invasion, but represents the accumulated debris from ritual activity on the terraces below, and thus represents control over arable agriculture as well as animal husbandry.

If there is a change to such an economy based on the control of resources, this could explain the lack of coinage on these sites, and in the region generally, in the years leading up to the Roman invasion. The close interaction of religion and the élites is an interpretation that could be suggested by Strabo.

At this stage of the development of the polity in southwestern Transylvania, we probably can start to speak of a state, whichever definition is used. Can we, however, define the borders of this state? It usually takes a Hadrian's Wall or an Offa's dyke to enable archaeology to detect political boundaries. One possible solution is offered by Millett (1990) who noted that in the invasion of Britain, the conquest of centralised polities proceeded by the conquest of the capital at which point the rest of the region fell. This is contrasted to decentralised polities where piecemeal capture of every settlement was necessary. Trajan's invasion resulted in the rapid capture of most of Transylvania and Oltenia, but not Muntenia, or large areas of Crişana. This area is precisely that within which fortresses with *murus dacicus* walls are found.

Appendix A

The Hoards

A.1 Introduction

This appendix lists all the hoards which have been input in detail to the CHRR database as of 25th April 1996. The hoards are firstly in order of their closing dates, and then alphabetically. Occasionally, the data presented here will differ slightly from the tables presented in the main text because of corrections to the database. None of the changes have been major. The data used in the analyses is preserved in the datafiles on the CD-ROM.

Firstly, the hoard name is given, followed by its three-letter unique identifier by which each hoard can be indentified, both in the text of this thesis, and in the databases on the attached CD-ROM. The country of origin of the hoard is then given, followed by its closing date. This date is the `date_from` of the latest genuine coin in the hoard. The total number of coins in the hoard is then given, followed by a breakdown of the hoard's contents by denomination and query code. For the meaning of the latter please see Table 5.1, page 126. The hoard's RRCH number (if it has one) is then given, followed by the source of the data input and any further bibliography. When new or fuller references than those in RRCH were available, these have been given. The data source codes are given in SMALL CAPITALS. All unpublished data sources are in the Department of Coins and Medals, the British Museum. The codes are: CHIT: Chiţescu (1981); HW: handwritten list (not MHC's); MHCCI: from Crawford's (MHC) card index, British Museum; MHCFC: MHC early list on filecards, uses Sydenham (1952) references; MHCHW: MHC handwritten list, usually without reference numbers; MHCLET: letter to MHC; MHCOP: MHC offprint or photocopy (often with partial bibliographic data); MHCPHOTO: photographs; MHCTS: MHC typescript, usually for hoards later published; MSC: RRC database created for Lockyear (1989) from RRC; PUB: from the publication; RRC: RRC (Crawford 1974); RRCH: RRCH (Crawford 1969c); SASIANU: Săşianu (1980); TS: typescript, not MHC's.

A.2 The data

1. Burgos (BUR)
Italy, 206 BC
27 coins:
27 *denarii* 27/–/–/–/–/–/–/–
PUB
Forteleoni (1971–1972)

2. Olteni (OLT)
Romania, 194 BC
2 coins:
2 *denarii* 1/–/–/1/–/–/–/–
RRCH 120; PUB
Mitrea (1958, p. 166, no. 22)

3. Fano (FAN)
Italy, 179 BC
88 coins:
88 *victoriati* 66/18/–/–/4/–/–/–
RRCH 117; MHCFC

4. Numantia (NUM)
Spain, 179 BC
115 coins:
115 *victoriati* 19/87/–/–/9/–/–/–
RRCH 118; MHCFC

5. San Angelo a Cupolo (CUP)
Italy, 179 BC
408 coins:
1 *denarius* 1/–/–/–/–/–/–/–
407 *victoriati* 402/–/–/–/5/–/–/–
RRCH 112; MHCHW

6. Santa Catalina del Monte (SCM)
Spain, 179 BC
89 coins:
89 *victoriati* 78/11/–/–/–/–/–/–
PUB
Lechuga Galindo (1984)

7. Mirabella Imbaccari (MIR)
Sicily, 169 BC
25 coins:
25 *denarii* 13/10/–/–/2/–/–/–
RRCH 124; MHCFC

8. Montoro Inferiore (INF)
Italy, 147 BC
337 coins:
337 *asses* 60/1/–/–/5/–/–/271
RRCH 143; MHCFC

9. Rome (ROM)
Italy, 147 BC
123 coins:
121 *denarii* 84/8/–/–/29/–/–/–
2 *victoriati* –/2/–/–/–/–/–/–
RRCH 131; RRC

10. Cani Islands (CAN)
Tunisia, 146 BC
150 coins:
132 *denarii* 55/26/–/–/40/–/–/11
18 tetradrachms –/–/–/–/–/–/–/18
RRCH 132; RRC/PUB

11. West Sicily (S01)
Sicily, 146 BC
38 coins:
38 *denarii* 32/2/–/–/4/–/–/–
RRCH 135; MHCTS

12. Lacco Ameno (AME)
Italy, 144 BC
30 coins:
30 *denarii* 28/2/–/–/–/–/–/–
RRCH 147; MHCFC

13. Petacciato (PET)
Italy, 141 BC
230 coins:
224 *denarii* 159/–/–/–/65/–/–/–
6 *victoriati* 1/–/–/–/5/–/–/–
RRCH 149; RRC

14. Pachino (PAC)
Sicily, 138 BC
46 coins:
44 *denarii* 29/14/–/–/1/–/–/–
2 *victoriati* 2/–/–/–/–/–/–/–
RRCH 151; MHCTS

15. Orsara (ORS)
Italy, 137 BC
2 coins:
2 *denarii* 1/–/–/–/1/–/–/–
RRCH 152; RRCH

16. Roginenza (ROG)
Sicily, 136 BC
16 coins:
16 *denarii* –/8/–/–/8/–/–/–
RRCH 153; MHCFC

17. Syracuse (SY2)
Sicily, 136 BC
77 coins:
76 *denarii* 49/4/–/–/10/–/13/–
1 *victoriatus* –/1/–/–/–/–/–/–
RRCH 154; MHCFC

18. Cerreto Sannita (CSN)
Italy, 134 BC
49 coins:
3 *denarii* 2/1/–/–/–/–/–/–
46 *victoriati* 33/9/–/–/4/–/–/–
RRCH 155; MHCFC

19. Fuente-Librilla (LIB)
Spain, 132 BC
2 coins:
2 *denarii* 2/–/–/–/–/–/–/–
PUB
Lechuga Galindo (1986, pp. 140–142)

20. Banzi (BAN)
Italy, 130 BC
129 coins:
124 *denarii* 82/–/–/–/42/–/–/–
5 *victoriati* 4/–/–/–/1/–/–/–
RRCH 157; RRC
Crawford (1974, Tables L & LIV)

21. Belfiore (BLF)
Italy, 127 BC
7 coins:
7 *denarii* 7/–/–/–/–/–/–/–
RRCH 159; MHCFC

22. Henchir-Djebel-Dis (HDD)
Tunisia, 126 BC
27 coins:
27 *denarii* 17/2/–/–/3/–/4/1
RRCH 160; MHCFC

23. 'Italy' (IT1)
Italy, 126 BC
21 coins:
21 *denarii* 17/–/–/–/4/–/–/–
MHCOP
Schweizerischer Bankverein (1978, nos. 55–75)

24. Maserà (MAS)
Italy, 125 BC
1205 coins:
1016 *denarii* 787/–/–/–/229/–/–/–
189 *victoriati* 163/–/–/–/26/–/–/–
RRCH 162; RRC

25. San Giovanni Incarico (SGI)
Italy, 125 BC
202 coins:
201 *denarii* 139/20/–/–/41/–/–/1
1 *victoriatus* –/1/–/–/–/–/–/–
RRCH 163; MHCOP
de Petra (1893)

26. Stobi (STO)
Yugoslavia, 125 BC
506 coins:
504 *denarii* 460/4/3/–/37/–/–/–
1 tetradrachm –/–/–/–/–/–/–/1
1 *victoriatus* 1/–/–/–/–/–/–/–
MHCOP

27. Fiume (FI1)
Yugoslavia, 121 BC
46 coins:
44 *denarii* 24/12/–/–/5/–/1/2
1 didrachm –/1/–/–/–/–/–/–
1 *victoriatus* 1/–/–/–/–/–/–/–
RRCH 165; MHCFC

28. Fossombrone (FOS)
Italy, 121 BC
79 coins:
66 *denarii* 55/–/–/–/11/–/–/–
13 *victoriati* –/13/–/–/–/–/–/–
MHCHW

29. Moratalla la Vieja (MLV)
Spain, 121 BC
10 coins:
10 *denarii* 10/–/–/–/–/–/–/–
PUB
Lechuga Galindo (1986, pp. 137–139)

30. Zasiok (ZAS)
Yugoslavia, 120 BC
186 coins:
183 *denarii* 134/21/–/–/28/–/–/–
3 *victoriati* –/2/–/–/1/–/–/–
RRCH 166; MHCFC

31. Gerenzago (GER)
Italy, 118 BC
122 coins:
60 *denarii* 47/3/–/–/2/–/–/8
54 *drachmae* –/–/–/54/–/–/–/–
2 *quinarii* –/2/–/–/–/–/–/–
6 *victoriati* –/6/–/–/–/–/–/–
RRCH 167; MHCFC
Patroni (1909); Ricci (1909)

32. Jesi (JES)
Italy, 118 BC
67 coins:
67 *denarii* 61/–/–/–/6/–/–/–
PUB
Sorda (1973)

33. Naples (NAP)
Italy, 118 BC
8 coins:
8 *denarii* 7/–/–/–/1/–/–/–
TS

34. Terranova di Sicilia (TDS)
Sicily, 118 BC
78 coins:
78 *denarii* 66/7/–/–/5/–/–/–
RRCH 168; MHCFC

35. Bevagna (BEV)
Italy, 117 BC
893 coins:
784 *denarii* 601/40/–/–/120/–/–/23
5 *sestertii* –/5/–/–/–/–/–/–
104 *victoriati* 24/73/–/–/2/–/–/5
RRCH 171; MHCTS

36. Lauterach (LAU)
Austria, 117 BC
27 coins:
23 *denarii* 17/1/–/–/5/–/–/–
4 misc. Celtic –/–/–/–/–/–/–/4
RRCH 170; MHCFC

37. Maddaloni (MAD)
Italy, 116 BC
362 coins:
1 misc. bronze –/–/–/–/–/–/1/–
335 *denarii* 269/27/–/–/14/–/25/–
26 *victoriati* 1/24/–/–/1/–/–/–
RRCH 172; MHCFC
Maiuri (1914)

38. Pozoblanco (PZ1)
Spain, 115 BC
84 coins:
84 *denarii* 72/5/–/–/7/–/–/–
RRCH 174; MHCFC

39. Taranto (TR1)
Italy, 114 BC
102 coins:
102 *denarii* 83/6/–/–/13/–/–/–
RRCH 176; MHCFC

40. Villanueva de Córdoba (CO1)
Spain, 113 BC
130 coins:
130 *denarii* 122/3/–/–/5/–/–/–
MHCHW

41. Borgonuovo (BRG)
Italy, 112 BC
310 coins:
289 *denarii* 169/71/–/–/46/–/–/3
21 *victoriati* –/21/–/–/–/–/–/–
MHCHW

42. Bugiuleşti (BUG)
Romania, 112 BC
2 coins:
2 *denarii* –/–/–/–/2/–/–/–
RRCH 177; CHIT

43. La Barroca (LAB)
Spain, 112 BC
118 coins:
76 *denarii* 64/5/–/–/5/–/–/2
42 *drachmae* –/–/–/–/–/–/–/42
RRCH 178; MHCFC

44. Segaró (SEG)
Spain, 112 BC
1015 coins:
49 *denarii* 41/4/–/–/2/–/–/2
963 *drachmae* –/–/–/–/–/–/–/963
3 miscellaenous –/–/–/–/–/–/3/–
RRCH 180; MHCFC

45. Torelló d'en Cintes (TOR)
Spain, 112 BC
383 coins:
231 *asses* 222/–/–/–/9/–/–/–
151 miscellaenous –/–/–/–/–/–/–/151
1 *semis* –/–/–/–/–/–/–/1
MHCOP
Tarradell Font (1982)

46. El Centenillo (EL1)
Spain, 110 BC
75 coins:
73 *denarii* 66/1/–/–/5/–/1/–
2 *victoriati* –/2/–/–/–/–/–/–
RRCH 181; PUB
Hill & Sandars (1912)

47. Baix Llobregat (LLO)
Spain, 109 BC
117 coins:
117 *denarii* 90/5/–/–/22/–/–/–
MHCOP
Villaronga (1977)

48. Cordoba (CO2)
Spain, 109 BC
306 coins:
304 *denarii* 189/8/2/–/25/–/–/80
1 *drachm* –/–/–/–/–/–/–/1
1 *victoriatus* –/1/–/–/–/–/–/–
RRCH 184; MHCOP
Mattingly (1925); Crawford (1969b, pp. 85–93)

49. Montoro (MON)
Spain, 109 BC
20 coins:
20 *denarii* 15/5/–/–/–/–/–/–
RRCH 182; MHCFC

50. Strongoli (STR)
Italy, 109 BC
8 coins:
3 *asses* 3/–/–/–/–/–/–/–
4 *denarii* 4/–/–/–/–/–/–/–
1 quadrans 1/–/–/–/–/–/–/–
RRCH 183; MHCFC

51. Sarrià (SAR)
Spain, 108 BC
50 coins:
49 *denarii* 45/1/–/–/3/–/–/–
1 *quadrans* 1/–/–/–/–/–/–/–
MHCOP
Villaronga (1982)

52. Albánchez de Ubeda (ADU)
Spain, 106 BC
16 coins:
16 *denarii* 15/1/–/–/–/–/–/–
PUB
de Paula Perez Sindreu (1984)

53. Torre de Juan Abad (JUA)
Spain, 105 BC
478 coins:
478 *denarii* 450/–/–/–/26/–/2/–
RRCH 189; PUB
Vidal Bardán (1982)

54. Avvocata (AVV)
Italy, 104 BC
25 coins:
25 *denarii* 19/4/–/–/2/–/–/–
RRCH 190; MHCFC

55. Aznalcóllar (AZN)
Spain, 104 BC
35 coins:
35 *denarii* 35/–/–/–/–/–/–/–
MHCLET
Crawford (1984)

56. Cogollos de Guadix (COG)
Spain, 104 BC
83 coins:
83 *denarii* 80/–/–/–/3/–/–/–
PUB
Mendoza Eguaras (1978)

57. Penhagarcía (PNH)
Portugal, 104 BC
110 coins:
110 *denarii* 92/7/–/–/11/–/–/–
RRCH 191; MHCFC

58. Manfria (MNF)
Sicily, 103 BC
33 coins:
33 *denarii* 26/1/–/–/6/–/–/–
RRCH 198; PUB
Griffo (1958)

59. Puebla de los Infantes (PUE)
Spain, 103 BC
151 coins:
145 *denarii* 128/14/–/–/3/–/–/–
2 didrachms –/2/–/–/–/–/–/–
2 *quinarii* 1/1/–/–/–/–/–/–
2 *victoriati* –/2/–/–/–/–/–/–
PUB
Chaves Tristan (1988)

60. Rio Tinto (RIO)
Spain, 102 BC
44 coins:
44 *denarii* 41/–/–/–/3/–/–/–
RRCH 194; MHCFC
Carson (1952)

61. San Lorenzo del Vallo (LOR)
Italy, 102 BC
311 coins:
311 *denarii* 274/11/1/–/25/–/–/–
RRCH 195; MHCFC
Procopio (1952)

62. Sierra Morena (SMR)
Spain, 102 BC
12 coins:
12 *denarii* 3/–/–/–/–/–/–/9
RRCH 196; MHCFC

63. Cachapets (CAC)
Spain, 101 BC
268 coins:
266 *denarii* 260/1/–/–/2/–/–/3
2 *victoriati* 2/–/–/–/–/–/–/–
PUB
González Prats & Abascal Palazón (n.d.)

64. Cástulo (CSL)
Spain, 101 BC
47 coins:
47 *denarii* 47/–/–/–/–/–/–/–
PUB
Collantes Pérez-Ardá (1978)

65. Chao de Lamas (CDL)
Portugal, 101 BC
7 coins:
7 *denarii* 5/–/–/–/–/–/–/2
PUB
Alfaro Asins (1989)

66. Elena (ELE)
Italy, 101 BC
62 coins:
62 *denarii* 58/3/–/–/1/–/–/–
RRCH 199; MHCFC

67. Ricina (RCN)
Italy, 101 BC
299 coins:
299 *denarii* 218/28/–/–/53/–/–/–
RRCH 201; MHCOP
Tambroni Armaroli (1882–1884)

68. Santa Elena (SEL)
Spain, 101 BC
574 coins:
574 *denarii* 461/26/–/–/76/–/–/11
RRCH 193; MHCOP
Sandars (1905)

69. Cerignola (CG2)
Italy, 100 BC
98 coins:
97 *denarii* 79/1/–/–/17/–/–/–
1 *victoriatus* 1/–/–/–/–/–/–/–
MHCHW

70. Crevillente (CRE)
Spain, 100 BC
5 coins:
5 *denarii* 2/–/–/–/2/–/–/1
RRCH 206; MHCFC

71. Idanha-a-Velha (IAV)
Portugal, 100 BC
1367 coins:
1362 *denarii* 1175/6/4/–/165/–/–/12
5 *drachmae* –/–/–/–/–/–/–/5
MHCOP
Villaronga (1980)

72. Imola (IMO)
Italy, 100 BC
544 coins:
532 *denarii* 457/8/–/–/43/–/–/24
12 *victoriati* –/12/–/–/–/–/–/–
RRCH 210; MHCFC
Negrioli (1916)

73. Olmeneta (OLM)
Italy, 100 BC
408 coins:
408 *denarii* 365/6/–/–/32/–/3/2
RRCH 203; MHCOP

74. Orce (ORC)
Spain, 100 BC
73 coins:
73 *denarii* 60/1/–/–/12/–/–/–
RRCH 211; MHCFC

75. Paterno (PAT)
Sicily, 100 BC
150 coins:
150 *denarii* 143/1/–/–/6/–/–/–
RRCH 207; MHCFC

76. Salvacañete (SAL)
Spain, 100 BC
74 coins:
74 *denarii* 9/3/–/–/–/–/–/62
RRCH 205; MHCFC

77. Crognaleto (CRG)
Italy, 97 BC
167 coins:
149 *denarii* 121/12/–/–/16/–/–/–
14 *quinarii* 11/3/–/–/–/–/–/–
4 *victoriati* –/4/–/–/–/–/–/–
RRCH 212; MHCFC

78. Gioia dei Marsi (GDM)
Italy, 97 BC
259 coins:
222 *denarii* 205/2/–/–/15/–/–/–
37 *quinarii* 37/–/–/–/–/–/–/–
RRCH 213; MHCTS

79. Largo di Torre Argentina, Rome (LTA)
Italy, 97 BC
19 coins:
16 *denarii* 11/1/–/–/4/–/–/–
3 *quinarii* 2/–/–/–/1/–/–/–
MHCHW

80. Carpena (CRP)
Italy, 92 BC
58 coins:
1 *as* –/–/–/–/–/–/–/1
52 *denarii* 43/–/–/–/8/–/–/1
5 *victoriati* –/5/–/–/–/–/–/–
RRCH 215; MHCFC

81. Claterna (CLA)
Italy, 92 BC
53 coins:
53 *denarii* 45/–/–/–/8/–/–/–
RRCH 217; MHCFC

82. Monteverde di Fermo (MDI)
Italy, 92 BC
46 coins:
45 *denarii* 41/1/–/–/3/–/–/–
1 *quinarius* –/–/–/–/1/–/–/–
RRCH 218; MHCTS
Sorda (1971–1972, pp. 123–128)

83. Nociglia (NOC)
Italy, 92 BC
58 coins:
58 *denarii* 48/3/–/–/7/–/–/–
RRCH 219; MHCFC

84. Cergnano (Mortara) (MTR)
Italy, 91 BC
300 coins:
300 *denarii* 299/–/–/–/1/–/–/–
RRCH 286; MHCHW
Perassi (1988)

85. Ancona (AN2)
Italy, 90 BC
108 coins:
100 *denarii* 99/–/–/–/1/–/–/–
8 *quinarii* 8/–/–/–/–/–/–/–
MHCLET

86. Fuscaldo (FUS)
Italy, 90 BC
871 coins:
863 *denarii* 685/21/–/–/126/–/–/31
8 *semisses* 8/–/–/–/–/–/–/–
RRCH 225; MHCOP

87. ‘Hoffmann’ (HF1)
Italy, 90 BC
154 coins:
154 *denarii* 118/8/–/–/14/–/–/14
RRCH 221; MHCFC

88. Tîrgu Mureş (TMR)
Romania, 90 BC
3 coins:
3 *denarii* 3/–/–/–/–/–/–/–
RRCH 224; CHIT

89. Hilib (HIL)
Romania, 89 BC
101 coins:
1 *denarius* 1/–/–/–/–/–/–/–
79 *drachmae* –/–/–/3/–/–/–/76
21 tetradrachms –/–/–/–/–/–/–/21
PUB
Zoltán (1980)

90. Luni (LUN)
Italy, 89 BC
17 coins:
17 *asses* 17/–/–/–/–/–/–/–
RRCH 230; MHCFC

91. Panicale (PAN)
Italy, 89 BC
39 coins:
33 *asses* –/–/–/–/–/–/–/33
3 *denarii* 3/–/–/–/–/–/–/–
3 *quinarii* 1/–/–/–/2/–/–/–
RRCH 226; MHCFC

92. Syracuse (SYR)
Sicily, 88 BC
1103 coins:
1103 *denarii* 874/4/–/–/210/–/–/15
RRCH 233; RRC

93. Zimnicea (ZIM)
Romania, 88 BC
3 coins:
3 *denarii* 2/–/–/–/–/–/–/1
CHITESCU
Mitrea (1969, p. 167)
NB. In Chitescu as isolated finds no. 215/c

94. Alife (ALI)
Italy, 87 BC
83 coins:
83 *denarii* 78/–/–/–/3/–/–/2
RRCH 234; MHCOP
Pozzi (1960–1961, pp. 155–162)

95. Cremenari (CRM)
Romania, 87 BC
4 coins:
2 *denarii* 2/–/–/–/–/–/–/–
2 *drachmae* –/–/–/–/–/–/–/2
RRCH 235; CHIT

96. Fundeni (FUN)
Romania, 87 BC
10 coins:
9 *denarii* 1/–/1/–/–/–/–/7
1 *drachm* –/–/–/–/–/–/–/1
RRCH 285; PUB
Mitrea (1958, p. 162, no. 17)

97. ‘Italy’ (CAH)
Italy, 87 BC
222 coins:
211 *denarii* 54/–/–/–/157/–/–/–
11 *quinarii* 1/–/–/–/10/–/–/–
RRCH 238; MHCFC

98. Oleggio (OLE)
Italy, 86 BC
229 coins:
229 *denarii* 205/7/–/–/16/–/1/–
RRCH 241; MHCFC

99. Oradea (ORA)
Romania, 86 BC
4 coins:
4 *denarii* 3/–/–/–/1/–/–/–
SĂSIANU

100. Peiraeus (PEI)
Greece, 86 BC
42 coins:
42 *denarii* 39/–/–/–/3/–/–/–
RRCH 242; MHCFC
Mattingly (1927)

101. Drăgeşti (DRG)
Romania, 85 BC
136 coins:
3 *denarii* 2/–/–/–/1/–/–/–
133 *drachmae* –/–/–/6/–/–/–/127
SĂSIANU

102. Pantelleria (PNT)
Nr. Sicily, 85 BC
88 coins:
88 *denarii* 29/4/–/–/11/–/–/44
RRCH 243; MHCFC

103. Amărăştii de Jos (ADJ)
Romania, 84 BC
4 coins:
4 *denarii* 3/–/–/–/1/–/–/–
MHCCI/CHIT

104. Iclănzel (ICL)
Romania, 84 BC
20 coins:
18 *denarii* 15/–/–/–/3/–/–/–
2 tetradrachms –/–/–/1/–/–/–/1
MHCOP
Chirilă & Grigorescu (1982)

105. Deva I (DV1)
Romania, 83 BC
9 coins:
8 *denarii* 5/1/–/–/1/–/1/–
1 *drachm* –/–/–/–/–/–/–/1
PUB
Winkler (1972b)

106. Fossalta (FSL)
Italy, 83 BC
260 coins:
260 *denarii* 241/1/–/–/18/–/–/–
PUB
Gorini (1975)

107. Berchidda (BER)
Sardinia, 82 BC
1399 coins:
1399 *denarii* 1002/4/–/–/393/–/–/–
RRCH 249; RRC
Perantoni Satta (1960–1961, No. 24, pp. 112–7)

108. Capranica (CPR)
Italy, 82 BC
30 coins:
29 *denarii* 28/–/–/–/1/–/–/–
1 *quinarius* 1/–/–/–/–/–/–/–
RRCH 253; MHCFC

109. Carovilli (CAR)
Italy, 82 BC
40 coins:
40 *denarii* 33/–/–/–/7/–/–/–
RRCH 251; MHCFC

110. Cervia (CER)
Italy, 82 BC
46 coins:
45 *denarii* 33/–/–/–/11/–/–/1
1 *quinarius* 1/–/–/–/–/–/–/–
RRCH 247; MHCFC

111. Luduş (LUD)
Romania, 82 BC
2 coins:
2 *denarii* 2/–/–/–/–/–/–/–
RRCH 254; CHIT

112. Santa Domenica di Tropea (DOM)
Italy, 82 BC
112 coins:
112 *denarii* 98/3/–/–/11/–/–/–
RRCH 256; MHCFC

113. Bellicello (BLC)
Sicily, 81 BC
38 coins:
38 *denarii* 33/2/1/–/2/–/–/–
RRCH 257; MHCTS
Tusa Cutroni (1957)

114. Capalbio (CPL)
Italy, 81 BC
93 coins:
59 *denarii* 51/–/–/–/8/–/–/–
33 *quinarii* 33/–/–/–/–/–/–/–
1 *victoriatus* –/–/1/–/–/–/–/–
RRCH 258; MHCOP

115. Ferentino (FER)
Italy, 81 BC
31 coins:
28 *denarii* 23/–/–/–/5/–/–/–
3 *quinarii* 3/–/–/–/–/–/–/–
RRCH 261; MHCFC

116. Palestrina (PL1)
Italy, 80 BC
65 coins:
65 *denarii* 45/1/–/–/19/–/–/–
MHCHW

117. Torres Novas (NOV)
Portugal, 80 BC
6 coins:
6 *denarii* 5/–/–/–/–/–/–/1
RRCH 264; MHCFC

118. Amaseno (AMA)
Italy, 79 BC
125 coins:
125 *denarii* 110/2/–/–/13/–/–/–
RRCH 265; MHCTS
Panvini Rosati (1949)

119. Bobaia (BOB)
Romania, 79 BC
251 coins:
41 *denarii* 40/–/–/–/1/–/–/–
185 *drachmae* –/–/–/17/–/–/–/168
25 tetradrachms –/–/–/13/–/–/–/12
PUB
Chirilă & Iaroslavschi (1987–1988); Daicoviciu & Glodariu (1976, p. 73)

120. ‘Central Italy’ (IT4)
Italy, 79 BC
140 coins:
140 *denarii* 127/–/–/–/13/–/–/–
RRCH 272; HW

121. Corvaro (CRV)
Italy, 79 BC
13 coins:
13 *denarii* 12/–/–/–/1/–/–/–
RRCH 273; MHCFC

122. Fragagnano (FRA)
Italy, 79 BC
86 coins:
86 *denarii* 67/–/–/–/19/–/–/–
RRCH 278; MHCOP
Quagliati (1907)

123. Gliganul de Jos (Rociu) (GDJ)
Romania, 79 BC
11 coins:
11 *denarii* 10/–/–/–/1/–/–/–
CHIT
Teodorescu, Rizea & Dupoi (1969)

124. Moisei (MSI)
Romania, 79 BC
5 coins:
5 *denarii* 5/–/–/–/–/–/–/–
PUB
Mitrea (1969, pp. 166–7)

125. Monroy (MNR)
Spain, 79 BC
24 coins:
24 *denarii* 17/–/–/–/7/–/–/–
MHCHW
Callejo Serrano (1965)

126. Montiano (MNT)
Italy, 79 BC
61 coins:
61 *denarii* 53/5/–/–/3/–/–/–
RRCH 266; MHCFC

127. Nedeia (NED)
Romania, 79 BC
19 coins:
19 *denarii* 19/–/–/–/–/–/–/–
RRCH 274; MHCFC/CHIT

128. Nuşfalău (NUS)
Romania, 79 BC
18 coins:
18 *denarii* 15/–/–/1/1/–/–/1
SASIANU

129. Pieve di Olmi (PDO)
Italy, 79 BC
15 coins:
15 *denarii* 15/–/–/–/–/–/–/–
RRCH 267; MHCFC

130. ‘Rizzi’ (RIZ)
—, 79 BC
219 coins:
219 *denarii* 201/4/–/–/14/–/–/–
RRCH 268; MHCFC

131. Sălaşuri I (SA1)
Romania, 79 BC
4 coins:
4 *denarii* 4/–/–/–/–/–/–/–
CHIT
Zoltán (1968, p. 455)

132. Spoleto (SPO)
Italy, 79 BC
146 coins:
146 *denarii* 124/1/–/–/21/–/–/–
RRCH 279; MHCTS

133. Suhaia I (SU1)
Romania, 79 BC
37 coins:
27 *denarii* 24/–/–/3/–/–/–/–
10 *drachmae* –/–/–/–/–/–/–/10
CHIT
Chiţescu (1968b)

134. Vukovar (VUK)
Yugoslavia, 79 BC
140 coins:
4 *denarii* 4/–/–/–/–/–/–/–
136 *drachmae* –/–/–/–/–/–/–/136
RRCH 276; MHCFC

135. Bălăneşti (BAL)
Romania, 78 BC
10 coins:
10 *denarii* 10/–/–/–/–/–/–/–
RRCH 280; CHIT
Mitrea (1958, pp. 154–156)

136. Kerassia (KER)
Greece, 78 BC
48 coins:
47 *denarii* 40/–/–/–/7/–/–/–
1 tetradrachm –/–/–/–/–/–/–/1
RRCH 283; MHCTS
Varoucha-Christodoulopoulou (1960, pp. 494–5, find a.)

137. Mainz (MNZ)
Germany, 78 BC
12 coins:
12 *denarii* 12/–/–/–/–/–/–/–
RRCH 281; MHCFC

138. Maluenda (MAL)
Spain, 78 BC
145 coins:
145 *denarii* 31/–/–/–/1/–/–/113
RRCH 282; MHCOP
Villaronga (1964–1965); Hernández Vera (1980)

139. Neresine, Lussino Island (NER)
Yugoslavia, 78 BC
42 coins:
42 *denarii* 27/–/–/–/15/–/–/–
MHCHW

140. Noyer (NOY)
France, 78 BC
51 coins:
51 *denarii* 51/–/–/–/–/–/–/–
PUB
Amandry (1981)

141. Alba di Massa (ADM)
Italy, 77 BC
99 coins:
83 *denarii* 77/1/–/–/5/–/–/–
15 *quinarii* 15/–/–/–/–/–/–/–
1 *victoriatus* 1/–/–/–/–/–/–/–
RRCH 289; MHCTS

142. Alexandria (ALX)
Romania, 77 BC
36 coins:
32 *denarii* 29/–/–/–/3/–/–/–
4 tetradrachms –/–/–/–/–/–/–/4
RRCH 295; PUB
Mitrea (1958, pp. 151–154)

143. Baños de Fortuna (BDF)
Spain, 77 BC
11 coins:
11 *denarii* 10/–/–/–/1/–/–/–
MHCCI
Amante Sánchez & Lechuga Galindo (1982)

144. Bompas (BOM)
France, 77 BC
613 coins:
13 *denarii* 9/–/–/–/4/–/–/–
600 Gallic coins –/–/–/–/–/–/–/600
RRCH 290; MHCFC
Amandry (1981, p. 11)

145. Brusc (BRU)
France, 77 BC
20 coins:
20 *denarii* 12/1/–/–/3/–/–/4
RRCH 284; MHCFC
Amandry (1981, p. 11)

146. Inuri (INU)
Romania, 77 BC
37 coins:
37 *denarii* 34/–/–/–/3/–/–/–
PUB
Floca (1956b)

147. Mierea (MIE)
Romania, 77 BC
3 coins:
3 *denarii* 3/–/–/–/–/–/–/–
RRCH 291; CHIT/PUB
Mitrea (1958, no. 19, pp. 163–4)

148. Puerto Serrano (PSE)
Spain, 77 BC
27 coins:
27 *denarii* 14/–/–/–/13/–/–/–
MHCHW

149. Randazzo (RAN)
Sicily, 77 BC
30 coins:
30 *denarii* 29/–/–/–/1/–/–/–
RRCH 287; MHCTS

150. Şomoşcheş (SOM)
Romania, 76 BC
10 coins:
10 *denarii* 9/–/–/–/1/–/–/–
PUB
Chirilă & Barbu (1979)

151. Cornetu (Căpreni) (COR)
Romania, 75 BC
129 coins:
128 *denarii* 117/–/–/–/11/–/–/–
1 *drachm* –/–/–/–/–/–/–/1
RRCH 296; CHIT
Mitrea (1941–1944, pp. 387–390); Iliescu (1960)

152. Mihai Bravu (MBR)
Romania, 75 BC
57 coins:
57 *denarii* 53/–/–/1/3/–/–/–
PUB
Mitrea (1968a)

153. Montalbano Ionico (ION)
Italy, 75 BC
46 coins:
46 *denarii* 38/1/–/–/7/–/–/–
RRCH 297; MHCFC

154. San Mango sul Calore (MAN)
Italy, 75 BC
112 coins:
81 *denarii* 75/–/–/–/6/–/–/–
31 *quinarii* 31/–/–/–/–/–/–/–
RRCH 294; MHCOP
Pozzi (1960–1961, pp. 162–172)

155. Zătreni (ZAT)
Romania, 75 BC
41 coins:
41 *denarii* 39/–/–/–/2/–/–/–
PUB
Mitrea (1941–1944, p. 385)

156. Barranco de Romero (BDR)
Spain, 74 BC
67 coins:
67 *denarii* 50/2/–/–/15/–/–/–
MHCTS

157. Cabeça de Corte (CAB)
Portugal, 74 BC
175 coins:
175 *denarii* 133/–/–/–/25/–/17/–
RRCH 300; MHCTS

158. Canturato (CTR)
Italy, 74 BC
50 coins:
50 *denarii* 42/–/–/–/8/–/–/–
RRCH 301; MHCTS

159. Carlentini (CRL)
Sicily, 74 BC
18 coins:
18 *denarii* 10/–/–/–/8/–/–/–
MHCCI

160. Castro de Romariz (CDR)
Portugal, 74 BC
72 coins:
72 *denarii* 70/–/–/–/–/–/–/2
MHCCI
Centeno (1976–1977)

161. Cosa (COS)
Italy, 74 BC
2004 coins:
2004 *denarii* 1803/1/4/–/196/–/–/–
RRCH 313; PUB
Buttrey (1980)

162. Hotărani (HOT)
Romania, 74 BC
25 coins:
25 *denarii* 24/–/–/–/1/–/–/–
PUB
Mitrea (1941–1944, p. 384)

163. Hunedoara IV (HN4)
Romania, 74 BC
74 coins:
42 *denarii* 40/–/–/–/2/–/–/–
32 *drachmae* –/–/–/–/–/–/–/32
RRCH 303; CHIT

164. 'Italy' (IT2)
Italy, 74 BC
50 coins:
47 *denarii* 47/–/–/–/–/–/–/–
3 *quinarii* 3/–/–/–/–/–/–/–
MHCOP

165. Jdioara (JDI)
Romania, 74 BC
69 coins:
69 *denarii* 59/2/–/–/8/–/–/–
PUB
Moga (1975)

166. Las Somblancas (SMB)
Spain, 74 BC
84 coins:
84 *denarii* 82/–/–/–/2/–/–/–
PUB
Amante Sánchez & Lechuga Galindo (1982); Lechuga Galindo (1986, pp. 80–90)

167. Licodia (LIC)
Sicily, 74 BC
120 coins:
120 *denarii* 103/–/–/–/17/–/–/–
RRCH 308; MHCFC

168. Lunca (LNC)
Romania, 74 BC
12 coins:
12 *denarii* 10/–/1/1/–/–/–/–
PUB
Poenaru Bordea & Chiţu (1980)

169. Maccarese (MAC)
Italy, 74 BC
1226 coins:
1226 *denarii* 869/14/–/–/343/–/–/–
RRCH 309; RRC/PUB
Pavini Rosati (1956)

170. Mihŭaeşti (MHA)
Romania, 74 BC
14 coins:
14 *denarii* 14/–/–/–/–/–/2/–
PUB
Poenaru Bordea & Chiţu (1976–1980)

171. Năsăud (NAS)
Romania, 74 BC
8 coins:
8 *denarii* 8/–/–/–/–/–/–/–
PUB
Mitrea (1974)

172. Oristà (ORI)
Spain, 74 BC
103 coins:
68 *denarii* 45/–/–/–/13/–/–/10
35 *drachmae* –/–/–/–/–/–/–/35
PUB
Benages & Villaronga (1987–1988)

173. Palenzuela (PLZ)
Spain, 74 BC
2642 coins:
2642 *denarii* 14/–/–/–/–/–/–/2628
RRCH 314; MHCFC

174. Palestrina (PL2)
Italy, 74 BC
399 coins:
364 *denarii* 212/6/1/–/145/–/–/–
34 *quinarii* 22/–/–/–/12/–/–/–
1 *victoriatus* –/1/–/–/–/–/–/–
RRCH 315; MHCOP

175. Peyriac-sur-Mer (PEY)
France, 74 BC
117 coins:
100 *denarii* 70/7/1/–/22/–/–/–
17 *quinarii* 15/–/–/–/2/–/–/–
RRCH 304; MHCFC
Amandry (1981, p. 11)

176. Poio (POO)
Portugal, 74 BC
212 coins:
212 *denarii* 167/1/–/–/44/–/–/–
RRCH 305; MHCFC

177. Pontecorvo (PON)
Italy, 74 BC
1236 coins:
945 *denarii* 855/–/–/–/87/–/3/–
290 *quinarii* 264/–/–/–/26/–/–/–
1 *victoriatus* 1/–/–/–/–/–/–/–
RRCH 311; PUB
Pozzi (1960–1961, pp. 173–245)

178. Potenza Picena (PIC)
Italy, 74 BC
446 coins:
446 *denarii* 408/7/–/–/31/–/–/–
RRCH 312; MHCFC
Moretti (1926)

179. Rignano (RIG)
Italy, 74 BC
97 coins:
94 *denarii* 60/1/–/–/32/–/–/1
1 miscellaenous –/–/–/–/–/–/–/1
2 *quinarii* 1/–/–/–/1/–/–/–
RRCH 564; MHCOP
Mau (1876)

180. Rio Marina (MAR)
Elba, 74 BC
44 coins:
44 *denarii* 39/–/1/–/4/–/–/–
RRCH 306; MHCTS

181. Sillein (SIL)
Hungary, 74 BC
30 coins:
30 *denarii* –/–/29/–/1/–/–/–
RRCH 330; MHCFC

182. 'Spain' (SP2)
Spain, 74 BC
246 coins:
246 *denarii* 215/–/–/–/31/–/–/–
RRCH 307; MHCTS

183. Sučurac (SUC)
Yugoslavia, 74 BC
168 coins:
168 *denarii* 155/3/–/–/10/–/–/–
RRCH 310; MHCFC

184. Tufara (TUF)
Italy, 74 BC
158 coins:
158 *denarii* 130/–/–/–/28/–/–/–
PUB
Ceglia (1985)

185. Ossero (OSS)
Italy, 72 BC
475 coins:
472 *denarii* 328/7/–/–/137/–/–/–
3 *quinarii* 2/–/–/–/1/–/–/–
RRCH 316; PUB
Bahrfeldt (1901a); Dukat & Mirnik (1982); Salata (1899)

186. Policoro (PLC)
Italy, 72 BC
534 coins:
302 *denarii* 281/–/–/–/21/–/–/–
232 *quinarii* 217/–/–/–/15/–/–/–
MHCOP
Siciliano (1974–1975)

187. Tolfa (TOL)
Italy, 72 BC
239 coins:
239 *denarii* 221/1/–/–/17/–/–/–
RRCH 317; MHCTS

188. Alt Empordà (EMP)

Spain, 71 BC
1161 coins:
1143 *denarii* 1069/–/–/–/53/–/–/21
10 *drachmae* –/–/–/–/–/–/–/10
8 *quinarii* 8/–/–/–/–/–/–/–
PUB
Vilaret I Monfort (1976)

189. Bancu (BNC)

Romania, 71 BC
3 coins:
3 *denarii* 3/–/–/–/–/–/–/–
RRCH 318; CHIT
Zoltán (1957, p. 471)

190. Castelnovo (CST)

Italy, 71 BC
403 coins:
403 *denarii* 266/8/–/–/125/–/3/1
MHCHW

191. Hotăroaia (HTR)

Romania, 71 BC
9 coins:
9 *denarii* 9/–/–/–/–/–/–/–
PUB
Mitrea (1973–5, pp. 319–320)

192. Sfinţeşti (SFI)

Romania, 71 BC
106 coins:
93 *denarii* 82/1/–/1/9/–/–/–
13 tetradrachms –/–/–/13/–/–/–/–
RRCH 320; PUB
Mitrea (1953)

193. Talpe-Beiuş (TAL)

Romania, 71 BC
85 coins:
21 *denarii* 16/2/–/–/2/–/–/1
64 *drachmae* –/–/–/5/–/–/–/59
PUB
Chiţescu (1968a)

194. Villa Potenza (VPT)

Italy, 71 BC
421 coins:
420 *denarii* 365/9/–/–/46/–/–/–
1 *victoriatus* –/1/–/–/–/–/–/–
RRCH 319; MHCTS
Sorda (1965–1967, pp. 85–109)

195. Mărtiniş (MTN)

Romania, 70 BC
16 coins:
15 *denarii* 14/–/–/–/1/–/–/–
1 tetradrachm –/–/–/–/–/–/–/1
RRCH 322; CHIT

196. Nicolae Bălcescu I (NB1)

Romania, 69 BC
14 coins:
13 *denarii* 13/–/–/–/–/–/–/–
1 tetradrachm –/–/–/–/–/–/–/1
RRCH 323; CHIT/PUB
Mitrea (1958, no. 21, pp. 164–166)

197. Tincova (TIN)

Romania, 69 BC
147 coins:
147 *denarii* 133/–/–/1/2/–/–/11
PUB
Bălănescu & Rogozea (1983–1985); Petrovszky & Petrovszky (1981)

198. Grădiştea (GRD)

Romania, 67 BC
22 coins:
21 *denarii* 20/–/–/–/1/–/–/–
1 tetradrachm –/–/–/–/–/–/–/1
RRCH 325; PUB
Preda (1958a, pp. 466–7)

199. Moita (MOI)

Portugal, 67 BC
10 coins:
10 *denarii* 8/–/–/–/2/–/–/–
RRCH 326; MHCFC

200. Pietrosale (PTS)
Romania, 67 BC
3 coins:
3 *denarii* –/–/1/1/1/–/–/–
RRCH 472; CHIT/PUB
Mitrea (1958, no. 23, pp. 166–167)

201. Curtea de Argeş (CUR)
Romania, 64 BC
10 coins:
10 *denarii* 9/–/–/–/1/–/–/–
RRCH 327; CHIT/PUB
Mitrea (1958, no. 10, pp. 159–160)

202. Baziaş (BAZ)
Romania, 63 BC
52 coins:
38 *denarii* 31/2/–/–/5/–/–/–
13 *drachmae* –/–/–/–/–/–/–/13
1 tetradrachm –/–/–/–/–/–/–/1
RRCH 293; CHIT

203. Gărvan (GAR)
Romania, 63 BC
29 coins:
29 *denarii* 28/–/–/–/1/–/–/–
PUB
Barnea (1971)

204. Stăncuţa (STN)
Romania, 63 BC
87 coins:
34 *denarii* 32/–/–/–/2/–/–/–
53 tetradrachms –/–/–/3/–/–/–/50
RRCH 331; PUB
Preda (1957, 1958b)

205. Bonţeşti (BON)
Romania, 62 BC
37 coins:
37 *denarii* 35/–/–/1/1/–/–/–
PUB
Mitrea & Untaru (1978)

206. Licuriciu (LCR)
Romania, 62 BC
63 coins:
63 *denarii* 62/–/–/–/1/–/–/–
RRCH 332; CHIT
Mitrea (1958, no. 18, pp. 162–163)

207. Şopotu (SOP)
Romania, 62 BC
32 coins:
32 *denarii* 29/–/–/3/–/–/–/–
PUB
Preda & Popilian (1968)

208. Roncolon (RON)
Italy, 61 BC
30 coins:
26 *denarii* 26/–/–/–/–/–/–/–
4 *quinarii* 4/–/–/–/–/–/–/–
MHCOP
Gorini (1979, pp. 139–144)

209. Alcalá de Henares (HEN)
Spain, 59 BC
51 coins:
51 *denarii* 24/–/–/–/3/–/–/24
RRCH 334; MHCFC

210. Alungeni (ALN)
Romania, 59 BC
33 coins:
33 *denarii* 30/–/–/1/2/–/–/–
RRCH 335; PUB
Székely (1945–7)

211. Kavalla (KAV)
Greece, 58 BC
83 coins:
59 *denarii* 55/–/–/–/4/–/–/–
24 tetradrachms –/–/–/–/–/–/–/24
RRCH 336; MHCTS

212. Mesagne (MES)
Italy, 58 BC
5940 coins:
5940 *denarii* 5814/–/–/–/126/–/–/–
PUB
Hersch & Walker (1984)

213. San Gregorio di Sassola (GRE)
Italy, 58 BC
563 coins:
530 *denarii* 422/1/–/–/107/–/–/–
30 *quinarii* 18/–/–/–/12/–/–/–
3 *semisses* 3/–/–/–/–/–/–/–
RRCH 337; MHCOP
Cesano (1903)

214. Chiţorani (CHT)
Romania, 57 BC
9 coins:
7 *denarii* 6/–/–/–/1/–/–/–
2 *drachmae* –/–/–/–/–/–/–/2
PUB
Simache (1971)

215. Amnaş (AMN)
Romania, 56 BC
157 coins:
157 *denarii* 146/–/–/2/9/–/–/–
RRCH 338; CHIT

216. Dunăreni (DUN)
Romania, 56 BC
128 coins:
128 *denarii* 117/–/–/–/11/–/–/–
PUB
Popilian (1970)

217. Frauendorf (Axente Sever) (FND)
Romania, 56 BC
563 coins:
563 *denarii* 518/–/–/–/45/–/–/–
RRCH 341; CHIT
Bahrfeldt (1877); Chirilă, Gudea & Moldovan (1972, pp. 9–11)

218. Icland (ICN)
Romania, 56 BC
36 coins:
34 *denarii* 33/–/–/1/–/–/–/–
2 tetradrachms –/–/–/–/–/–/–/2
PUB
Poenaru Bordea & Cojocărescu (1984)

219. Someşul Cald (SMC)
Romania, 56 BC
117 coins:
117 *denarii* 113/2/–/–/2/–/–/–
RRCH 321; CHIT

220. Sustinenza (SUS)
Italy, 56 BC
395 coins:
63 *denarii* 59/–/–/–/4/–/–/–
332 *quinarii* 84/–/–/–/248/–/–/–
RRCH 339; MHCHW

221. Ancona (AN1)
Italy, 55 BC
47 coins:
42 *denarii* 39/–/–/–/3/–/–/–
5 *quinarii* 5/–/–/–/–/–/–/–
RRCH 344; MHCFC

222. Bessan (BES)
France, 55 BC
113 coins:
27 *denarii* 12/–/–/–/15/–/–/–
86 *quinarii* 65/–/–/–/15/–/–/6
RRCH 342; MHCFC

223. Compito (COM)
Italy, 55 BC
972 coins:
946 *denarii* 721/10/–/–/208/–/7/–
23 *quinarii* 7/–/–/–/16/–/–/–
3 *victoriati* 1/2/–/–/–/–/–/–
RRCH 345; MHCOP
Baxter (1874)

224. Buzău (BUZ)
Romania, 54 BC
49 coins:
48 *denarii* 46/–/–/–/2/–/–/–
1 tetradrachm –/–/–/–/–/–/–/1
RRCH 346; CHIT
Mitrea (1958, no. 7, pp. 157–158)

225. Călineşti (CLN)
Romania, 54 BC
101 coins:
98 *denarii* 84/–/–/6/8/–/–/–
3 tetradrachms –/–/–/3/–/–/–/–
RRCH 347; CHIT

226. Grazzanise (GRA)
Italy, 54 BC
281 coins:
1 *as* 1/–/–/–/–/–/–/–
263 *denarii* 231/5/–/–/25/–/2/–
17 *quinarii* 16/–/–/–/–/–/1/–
RRCH 349; MHCFC

227. Karavelovo (KAR)
Bulgaria, 54 BC
37 coins:
36 *denarii* 35/–/–/–/–/–/–/1
1 *drachm* –/–/–/–/–/–/–/1
PUB

228. Sălaşul de Sus (SDS)
Romania, 54 BC
111 coins:
111 *denarii* 86/2/1/5/6/11/–/–
RRCH 348; PUB
Floca (1960); Pavel-Popa (1982–1983)

229. Thessalonica (THS)
Greece, 54 BC
51 coins:
51 *denarii* 45/–/–/–/6/–/–/–
MHCOP
Caramessini (1984)

230. Broni (BRO)
Italy, 51 BC
100 coins:
86 *denarii* 63/2/–/–/18/–/–/3
14 *quinarii* 10/–/–/–/–/–/–/4
RRCH 350; MHCOP
Taramelli (1902)

231. Casaleone (CAS)
Italy, 51 BC
1032 coins:
1 *as* –/–/–/–/–/–/–/1
714 *denarii* 585/2/–/–/127/–/–/–
317 *quinarii* 195/–/–/–/122/–/–/–
RRCH 351; RRC

232. La Grajuela (GRJ)
Spain, 51 BC
523 coins:
523 *denarii* 496/–/–/–/27/–/–/–
PUB
Lechuga Galindo (1986, pp. 96–135)

233. Albeşti (ALS)
Romania, 49 BC
10 coins:
10 *denarii* 9/–/–/–/1/–/–/–
MHCCI

234. Athens (ATH)
Greece, 49 BC
47 coins:
47 *denarii* 36/–/–/–/11/–/–/–
MHCHW

235. 'Bahrfeldt' (BHR)
—, 49 BC
432 coins:
431 *denarii* 241/5/–/–/185/–/–/–
1 *quinarius* –/–/–/–/1/–/–/–
MHCTS

236. Brandosa (BRA)
Italy, 49 BC
422 coins:
422 *denarii* 389/6/–/–/26/–/1/–
RRCH 352; MHCTS
Pavini Rosati (1957, pp. 83–108)

237. Brîncoveanu (BRN)
Romania, 49 BC
14 coins:
14 *denarii* 11/–/–/2/1/–/–/–
CHIT
Mitrea (1969, p. 166)

238. Gottolengo (GOT)
Italy, 49 BC
6 coins:
6 *denarii* 1/–/–/–/5/–/–/–
RRCH 353; MHCFC
Barocelli (1926)

239. Langelille (LAN)
Netherlands, 49 BC
2 coins:
2 *denarii* 2/–/–/–/–/–/–/–
RRCH 354; PUB
van Es (1960)

240. Mignano (MIG)
Italy, 49 BC
35 coins:
33 *denarii* 28/–/–/–/5/–/–/–
2 *victoriati* 1/1/–/–/–/–/–/–
RRCH 355; MHCOP

241. Roata de Jos (ROA)
Romania, 49 BC
35 coins:
35 *denarii* 28/–/–/–/7/–/–/–
RRCH 356; CHIT
Mitrea (1958, no. 29, pp. 169–170)

242. Satu Nou (SAT)
Romania, 49 BC
130 coins:
129 *denarii* 111/–/4/–/14/–/–/–
1 tetradrachm –/–/–/1/–/–/–/–
RRCH 368; CHIT

243. Taranto (TR2)
Italy, 49 BC
57 coins:
52 *denarii* 33/–/–/–/19/–/–/–
5 *quinarii* –/–/–/–/5/–/–/–
MHCHW

244. Bucureşti (BUC)
Romania, 48 BC
7 coins:
6 *denarii* 5/–/–/–/1/–/–/–
1 tetradrachm –/–/–/1/–/–/–/–
RRCH 363; CHIT
Mitrea (1958, no. 6 bis, pp. 156–157)

245. Carbonara (CR1)
Italy, 48 BC
426 coins:
383 *denarii* 316/–/–/–/67/–/–/–
43 *quinarii* 36/–/–/–/7/–/–/–
RRCH 362; MHCTS
Quagliati (1904)

246. Cuceu (CUC)
Romania, 48 BC
523 coins:
488 *denarii* 475/–/–/3/10/–/–/–
1 *drachm* –/–/–/–/–/–/–/1
34 tetradrachms –/–/–/–/–/–/–/34
MHCOP
Chirilă & Matei (1983); Chirilă & Matei (1984)

247. Locusteni (LOC)
Romania, 48 BC
89 coins:
89 *denarii* 82/–/1/–/6/–/–/–
RRCH 367; PUB
Preda (1960)

248. Orbeasca de Sus (ODS)
Romania, 48 BC
143 coins:
143 *denarii* 126/1/1/2/13/–/–/–
CHIT

249. Padova (P05)
Italy, 48 BC
9 coins:
8 *denarii* 6/–/–/–/2/–/–/–
1 *quinarius* –/–/–/–/1/–/–/–
RRCH 360; MHCFC

250. Padova (P06)
Italy, 48 BC
75 coins:
59 *denarii* 44/1/–/–/10/–/–/4
16 *quinarii* 15/–/–/–/1/–/–/–
RRCH 364; MHCFC

251. Ploieşti (PLO)
Romania, 48 BC
6 coins:
6 *denarii* 5/1/–/–/–/–/–/–
RRCH 361; MHCFC

252. Tîrnava (TI1)
Romania, 48 BC
21 coins:
20 *denarii* 19/–/–/–/1/–/–/–
1 *drachm* –/–/–/–/–/–/–/1
PUB
Mitrea (1968b)

253. Birsa (BIR)
Romania, 47 BC
29 coins:
29 *denarii* 21/1/–/–/7/–/–/–
SASIANU

254. Mingechaur (MIN)
Former USSR, 47 BC
5 coins:
3 *denarii* 1/2/–/–/–/–/–/–
2 *drachmae* –/–/–/–/–/–/–/2
RRCH 387; MHCFC

255. Rua (RUA)
Portugal, 47 BC
4 coins:
4 *denarii* 3/–/–/–/1/–/–/–
RRCH 372; PUB
de Castro Hipólito (1960–1961, p. 53)

256. 'Transylvania' (TRN)
Romania, 47 BC
43 coins:
43 *denarii* 34/–/5/1/2/–/–/1
RRCH 369; CHIT

257. Aidona (AID)
Greece, 46 BC
8 coins:
4 *denarii* 4/–/–/–/–/–/–/–
4 staters –/–/–/–/–/–/–/4
RRCH 376

258. Bad Dürkheim-Limburg (BAD)
Germany, 46 BC
16 coins:
13 *denarii* 11/–/–/–/2/–/–/–
2 *drachmae* –/–/–/–/–/–/–/2
1 *quinarius* –/1/–/–/–/–/–/–
RRCH 422; MHCFC

259. Crotone (CRO)
Italy, 46 BC
90 coins:
88 *denarii* 80/1/–/–/6/–/–/1
2 *quinarii* 2/–/–/–/–/–/–/–
RRCH 383; MHCFC

260. Dračevica (DRA)
Yugoslavia, 46 BC
109 coins:
109 *denarii* 92/–/–/–/17/–/–/–
RRCH 379; MHCFC

261. El Centenillo (EL2)
Spain, 46 BC
59 coins:
59 *denarii* 51/–/–/–/6/–/–/2
RRCH 385; MHCFC
Hill & Sandars (1911)

262. Érd (ERD)
Hungary, 46 BC
52 coins:
52 *denarii* 40/1/–/–/11/–/–/–
RRCH 373; MHCFC

263. Fuente de Cantos (FDC)
Spain, 46 BC
387 coins:
387 *denarii* 383/–/–/–/4/–/–/–
PUB
Chinchilla Sánchez (1982)

264. Goranu (GOR)
Romania, 46 BC
5 coins:
5 *denarii* 5/–/–/–/–/–/–/–
PUB
Dumitraşcu (1980)

265. Gulgancy (GUL)
Bulgaria, 46 BC
463 coins:
463 *denarii* 420/–/–/3/39/–/–/1
RRCH 377; MHCOP

266. Ilieni (ILI)
Romania, 46 BC
111 coins:
1 *aureus* 1/–/–/–/–/–/–/–
110 *denarii* 99/–/–/–/9/–/–/2
CHIT

267. Jaén (JAE)
Spain, 46 BC
90 coins:
86 *denarii* 62/2/–/–/3/–/18/1
1 didrachm –/–/–/–/–/–/1/–
3 *quinarii* 3/–/–/–/–/–/–/–
RRCH 386; MHCFC

268. Mirabella Eclano (ECL)
Italy, 46 BC
85 coins:
85 *denarii* 77/–/–/–/8/–/–/–
MHCHW
Grella (1978)

269. Monselice (MNS)
Italy, 46 BC
4 coins:
4 *denarii* 4/–/–/–/–/–/–/–
PUB
Gorini (1971, p. 96)

270. Morrovalle (MOR)
Italy, 46 BC
130 coins:
130 *denarii* 111/5/–/–/14/–/–/–
RRCH 380; MHCTS
Sorda (1965–1967, pp. 109–118)

271. Padova (P04)
Italy, 46 BC
14 coins:
14 *denarii* 11/–/–/–/3/–/–/–
MHCOP
Gorini (1971, pp. 92–95)

272. Policoro (PLI)
Italy, 46 BC
52 coins:
42 *denarii* 38/–/–/–/4/–/–/–
10 *quinarii* 10/–/–/–/–/–/–/–
PUB
Siciliano (1976)

273. Puy D'Issolu (ISS)
France, 46 BC
40 coins:
39 *denarii* 36/–/–/–/3/–/–/–
1 *quinarius* 1/–/–/–/–/–/–/–
MHCLET

274. Roeşti (ROE)
Romania, 46 BC
21 coins:
21 *denarii* 15/2/–/–/–/–/–/4
PUB
Mitrea (1941–1944, pp. 385–6)

275. Sendinho da Senhora (SEN)
Portugal, 46 BC
76 coins:
76 *denarii* 55/–/–/–/21/–/–/–
RRCH 388; MHCFC

276. Sînvăsii (SIN)
Romania, 46 BC
44 coins:
44 *denarii* 43/–/1/–/–/–/–/–
PUB
Chirilă, Gudea, Lazăr & Zrinyi (1980, pp. 7–22)

277. Spoiano (SPN)
Italy, 46 BC
264 coins:
264 *denarii* 238/–/–/–/26/–/–/–
MHCCI

278. Sprîncenata (SPR)
Romania, 46 BC
110 coins:
110 *denarii* 103/–/–/–/7/–/–/–
PUB
Nania (1972)

279. Surbo (SUR)
Italy, 46 BC
141 coins:
1 misc. bronze –/–/–/–/–/–/1/–
138 *denarii* 121/–/–/–/17/–/–/–
2 *quinarii* 2/–/–/–/–/–/–/–
RRCH 381; MHCFC

280. Tîrnava (TI2)
Romania, 46 BC
148 coins:
148 *denarii* 134/–/–/–/14/–/–/–
PUB
Preda & Beda (1975)

281. Văşad (VAS)
Romania, 46 BC
54 coins:
53 *denarii* 49/–/–/–/4/–/–/–
1 *drachm* –/–/–/–/–/–/–/1
SASIANU

282. Viverols (VIV)
France, 46 BC
7 coins:
7 *denarii* 6/–/–/–/1/–/–/–
RRCH 375; MHCFC

283. Vlădeni (VLA)
Romania, 46 BC
14 coins:
14 *denarii* 13/–/–/–/1/–/–/–
PUB
Simache (1971)

284. Cavriago (CAV)
Italy, 45 BC
7 coins:
7 *aurei* 7/–/–/–/–/–/–/–
RRCH 394; MHCFC

285. Padova (P07)
Italy, 45 BC
659 coins:
659 *denarii* 615/–/–/–/40/–/–/4
RRCH 391; MHCOP
Ferrari (1942–1954); Gorini (1968–1969)

286. Villette (VLL)
France, 45 BC
1336 coins:
340 *denarii* 247/–/–/–/93/–/–/–
20 *quinarii* 18/–/–/–/2/–/–/–
976 unknown –/–/–/–/–/–/–/976
RRCH 393; MHCFC

287. Catalunya (CAT)
Spain, 44 BC
89 coins:
89 *denarii* 88/–/–/–/1/–/–/–
MHCOP
Campo (1984)

288. Čitluk (CIT)
Yugoslavia, 44 BC
14 coins:
14 *denarii* 10/1/–/–/3/–/–/–
RRCH 396; MHCFC

289. Jegălia (JEG)
Romania, 43 BC
484 coins:
482 *denarii* 417/–/–/24/33/3/–/5
2 tetradrachms –/–/–/2/–/–/–/–
PUB
Conovici & Scăunaş (1989); Chiţescu & Anghelescu (1972)

290. Padova (P03)
Italy, 43 BC
42 coins:
42 *denarii* 40/–/–/–/2/–/–/–
MHCOP
Gorini (1974, pp. 119–121); Gorini (1971, pp. 89–92)

291. 'Pasquariello' (PAS)
Italy, 43 BC
200 coins:
107 *denarii* 100/2/–/–/5/–/–/–
93 *quinarii* 92/1/–/–/–/–/–/–
RRCH 398; MHCTS

292. Piatra Roşie (PIA)
Romania, 43 BC
277 coins:
277 *denarii* 268/–/2/7/–/–/–/–
PUB
Pavel & Andriţoiu (1994)

293. Potenza (POT)
Italy, 43 BC
408 coins:
408 *denarii* 201/2/–/–/203/–/2/–
RRCH 400; MHCOP
Correra (1902)

294. Suhaia II (SU2)
Romania, 43 BC
10 coins:
10 *denarii* 10/–/–/–/–/–/–/–
PUB
Chiţescu (1968b)

295. Thrace (THR)
Greece, 43 BC
56 coins:
2 *aurei* 2/–/–/–/–/–/–/–
54 *denarii* 24/–/–/–/30/–/–/–
RRCH 402; MHCFC
Varoucha-Christodoulopoulou (1962, pp. 423–4, find 1.)

296. Alvignano (ALV)
Italy, 42 BC
2339 coins:
2335 *denarii* 1433/–/–/–/902/–/–/–
3 *quinarii* 3/–/–/–/–/–/–/–
1 *victoriatus* 1/–/–/–/–/–/–/–
RRCH 417; RRC
Crawford (1974, Table L)

297. Borzano (BOR)
Italy, 42 BC
1111 coins:
597 *denarii* 422/11/–/–/160/–/–/4
514 *quinarii* 298/–/–/–/204/–/–/12
RRCH 418; MHCOP
Bahrfeldt (1901b)

298. Bran Poartă (BPT)
Romania, 42 BC
63 coins:
63 *denarii* 59/–/–/–/–/–/–/4
RRCH 408; CHIT
Winkler (1958, pp. 402–403)

299. Cernatu de Jos (CDJ)
Romania, 42 BC
5 coins:
4 *denarii* 3/–/–/–/1/–/–/–
1 *drachm* –/–/–/–/–/–/–/1
CHIT

300. Civitella in Val di Chiana (CHI)
Italy, 42 BC
251 coins:
251 *denarii* 222/5/–/–/24/–/–/–
RRCH 419; MHCFC
Minto (1928)

301. Fărcaşele (FA1)
Romania, 42 BC
84 coins:
84 *denarii* 76/–/–/3/5/–/–/–
RRCH 420; PUB
Mitrea (1941–1944)

302. Fărcaşele (FA2)
Romania, 42 BC
120 coins:
120 *denarii* 112/1/–/6/1/–/–/–
MHCCI
Petolescu (1983–1985)

303. Haggen (HAG)
Switzerland, 42 BC
66 coins:
61 *denarii* 60/–/–/–/1/–/–/–
2 *quinarii* 2/–/–/–/–/–/–/–
2 *quadrantes* –/–/–/–/–/–/2/–
1 *victoriatus* 1/–/–/–/–/–/–/–
RRCH 405; MHCOP

304. Islaz (ISL)
Romania, 42 BC
160 coins:
2 misc bronze –/–/–/–/–/–/2/–
158 *denarii* 115/5/2/3/9/–/6/18
MHCOP
Mitrea (1971); Mitrea (1941–1944, p. 383)

305. Kempten-Lindenberg (KEM)
Germany, 42 BC
12 coins:
12 *denarii* 8/1/–/–/–/–/–/3
RRCH 451; MHCFC

306. Lipov (LIP)
Romania, 42 BC
7 coins:
7 *denarii* 7/–/–/–/–/–/–/–
PUB
Popilian (1976–1980, pp. 153–154, 159)

307. Lissac (LIS)
France, 42 BC
53 coins:
53 *denarii* 41/–/–/–/11/–/–/1
RRCH 409; MHCOP
Gounot (1965)

308. Makotchevo I (MK1)
Bulgaria, 42 BC
19 coins:
19 *denarii* 17/–/–/–/1/–/1/–
MHCCI

309. Makotchevo II (MK2)
Bulgaria, 42 BC
25 coins:
25 *denarii* 22/–/–/–/3/–/–/–
MHCCI

310. Marsala (MRS)
Sicily, 42 BC
10 coins:
10 *denarii* 9/–/–/–/1/–/–/–
RRCH 410; MHCFC

311. Menoita (MEN)
Portugal, 42 BC
102 coins:
102 *denarii* 69/1/–/–/28/–/–/4
RRCH 414; MHCOP
de Castro Hipólito (1960–1961, pp. 57f.)

312. Moroda I (MR1)
Romania, 42 BC
10 coins:
10 *denarii* 5/–/–/1/4/–/–/–
MHCCI

313. Murighiol (MUR)
Romania, 42 BC
9 coins:
9 *denarii* 6/–/–/1/2/–/–/–
CHIT

314. Nagykágya (NAG)
Romania, 42 BC
154 coins:
154 *denarii* 102/–/–/23/29/–/–/–
RRCH 411; MHCOP
Kerényi (1947–1948); Săşianu (1980, no. 23/I, pp.97–9)

315. Nicolae Bălcescu (NB2)
Romania, 42 BC
45 coins:
45 *denarii* 37/–/–/2/5/1/–/–
PUB
Chiţescu (1975, pp. 209–210); Chiţescu & Beda (1976–1980)

316. Padova (P02)
Italy, 42 BC
16 coins:
15 *denarii* 13/–/–/–/2/–/–/–
1 *quinarius* 1/–/–/–/–/–/–/–
MHCOP
Gorini (1971, pp. 87–89)

317. Piedmonte d'Alife (PIE)
Italy, 42 BC
196 coins:
1 *as* –/1/–/–/–/–/–/–
191 *denarii* 166/1/–/–/24/–/–/–
4 *quinarii* 4/–/–/–/–/–/–/–
RRCH 406; MHCHW

318. Prejmer (PRE)
Romania, 42 BC
158 coins:
158 *denarii* 132/–/–/8/18/–/–/–
RRCH 412; CHIT

319. Agnona (AGN)
Italy, 41 BC
278 coins:
275 *denarii* 245/3/–/–/27/–/–/–
1 *quinarius* 1/–/–/–/–/–/–/–
2 *victoriati* –/2/–/–/–/–/–/–
RRCH 424; MHCOP
Serena Fava (1960)

320. Bodrum (BOD)
Turkey, 41 BC
99 coins:
36 *cistophori* –/–/–/–/–/–/–/36
62 *denarii* 62/–/–/–/–/–/–/–
1 *drachm* –/–/–/–/–/–/–/1
PUB
Overbeck (1978)

321. Calvatone (CAL)
Italy, 41 BC
8 coins:
7 *denarii* 7/–/–/–/–/–/–/–
1 *quinarius* 1/–/–/–/–/–/–/–
RRCH 434; MHCFC

322. Francin (FRN)
France, 41 BC
45 coins:
45 *denarii* 36/2/–/–/7/–/–/–
RRCH 413; MHCHW

323. Işalniţa (ISA)
Romania, 41 BC
134 coins:
134 *denarii* 124/–/–/–/10/–/–/–
RRCH 428; MHCFC
Mitrea (1941–1944, p. 386); Mitrea & Nicolăescu-Plopşor (1953)

324. Sadova II (SD2)
Romania, 41 BC
30 coins:
30 *denarii* 29/–/–/–/1/–/–/–
CHIT/PUB
Poenaru Bordea, Stoica & Cuică (1976–1980)

325. San Pietro Vernotico (Valesio) (VAL)
Italy, 41 BC
204 coins:
204 *denarii* 192/3/–/–/9/–/–/–
MHCTS

326. Stupini (STP)
Romania, 41 BC
231 coins:
230 *denarii* 213/3/–/–/12/2/–/–
1 *quinarius* 1/–/–/–/–/–/–/–
PUB
Tanţău (1971)

327. 'Turkey' (TU3)
Turkey, 41 BC
71 coins:
71 *denarii* 65/1/–/–/5/–/–/–
MHCLET

328. Vişina (VIS)
Romania, 41 BC
146 coins:
146 *denarii* 132/1/–/6/6/1/–/–
CHIT

329. West Sicily (S03)
Sicily, 40 BC
172 coins:
172 *denarii* 145/10/–/–/17/–/–/–
RRCH 435; MHCTS

330. Arbanats (ARB)
France, 39 BC
931 coins:
930 *denarii* 432/–/1/–/497/–/–/–
1 misc. Gallic coin –/–/–/–/–/–/–/1
RRCH 430; MHCOP
Cavedoni (1863)

331. Brescello (BRE)
Italy, 39 BC
13 coins:
13 *aurei* 13/–/–/–/–/–/–/–
RRCH 441; MHCOP

332. Contigliano (CTG)
Italy, 39 BC
644 coins:
644 *denarii* 489/7/–/–/145/–/–/3
RRCH 432; MHCOP

333. Jersey (JER)
Jersey, 39 BC
714 coins:
14 *denarii* 10/1/–/–/3/–/–/–
700 Gallic AE –/–/–/–/–/–/–/700
RRCH 431; MHCFC

334. Meolo (ME2)
Italy, 39 BC
1028 coins:
1022 *denarii* 954/8/–/–/59/–/–/1
6 *quinarii* 3/1/–/–/2/–/–/–
RRCH 437; MHCHW

335. Poroschia (PRS)
Romania, 39 BC
552 coins:
552 *denarii* 473/–/–/8/8/60/–/3
RRCH 436; CHIT
Chiţescu (1965); Chiţescu (1980); Mitrea (1965, p. 612, no. 32)

336. Răcătău de Jos II (RAC)
Romania, 39 BC
55 coins:
55 *denarii* 52/–/–/2/1/–/–/–
PUB
Căpitanu & Ursachi (1975, pp. 46–48)

337. Avetrana (AVE)
Italy, 38 BC
1919 coins:
1676 *denarii* 1467/20/–/–/185/–/–/4
243 *quinarii* 227/–/–/–/16/–/–/–
RRCH 440; MHCTS

338. Dobrogea (DOB)
Romania, 38 BC
17 coins:
17 *denarii* 14/–/–/3/–/–/–/–
RRCH 439; CHIT
Preda & Simion (1960); Ocheşeanu (1986, p. 84, no. 3)

339. Mornico Losana (LOS)
Italy, 38 BC
1187 coins:
1105 *denarii* 631/9/–/–/457/–/–/8
82 *quinarii* 63/–/–/–/19/–/–/–
RRCH 442; MHCOP
Bonazzi (1919)

340. Carbonara (CR2)
Italy, 36 BC
2420 coins:
2420 *denarii* 1671/48/–/–/701/–/–/–
RRCH 443; MHCOP
de Petra (1884)

341. Cerignola (CG1)
Italy, 36 BC
20 coins:
20 *denarii* 18/–/–/–/–/–/–/2
RRCH 444; MHCFC

342. Ljubuški (LJU)
Yugoslavia, 36 BC
10 coins:
10 *denarii* 7/–/–/–/3/–/–/–
RRCH 446; MHCFC

343. Brindisi (BRI)
Italy, 34 BC
2 coins:
2 *aurei* 2/–/–/–/–/–/–/–
RRCH 448;

344. Actium (ACT)
Greece, 32 BC
41 coins:
41 *denarii* 40/1/–/–/–/–/–/–
RRCH 473; MHCFC
Varoucha-Christodoulopoulou (1960, p. 495, find b.)

345. Belmonte del Sannio (BDS)
Italy, 32 BC
54 coins:
54 *denarii* 49/–/–/–/4/–/–/1
RRCH 460; MHCFC

346. Breasta (BRS)
Romania, 32 BC
11 coins:
11 *denarii* 9/–/–/2/–/–/–/–
MHCOP
Poenaru Bordea & Stoica (1980)

347. Corfu (CRF)
Corfu, 32 BC
28 coins:
28 *denarii* 14/–/–/–/14/–/–/–
MHCHW

348. Costineşti (CTN)
Romania, 32 BC
17 coins:
17 *denarii* 13/3/–/–/1/–/–/–
PUB
Mitrea (1970a)

349. Delos (DEL)
Greece, 32 BC
650 coins:
650 *denarii* 644/–/–/–/5/–/–/1
RRCH 465; MHCOP

350. Deva (DV3)
Romania, 32 BC
146 coins:
2 *denarii* –/–/–/–/2/–/–/–
144 *drachmae* –/–/–/1/–/–/–/143
PUB
Chirilă & Rusu (1980)

351. Guiães (GUS)
Portugal, 32 BC
10 coins:
10 *denarii* 8/–/–/–/2/–/–/–
PUB
Faria (1987, pp. 195–197)

352. Gura Padini (GUR)
Romania, 32 BC
234 coins:
232 *denarii* 216/–/–/–/16/–/–/–
1 *drachm* –/–/–/–/–/–/–/1
1 tetradrachm –/–/–/–/–/–/–/1
PUB
Mitrea (1970b)

353. Moggio (MOG)
Italy, 32 BC
149 coins:
69 *denarii* 52/–/–/–/17/–/–/–
80 *quinarii* –/–/–/–/–/–/–/80
RRCH 470; MHCOP

354. Mont Beuvray (BEU)
France, 32 BC
44 coins:
33 *denarii* 25/–/–/–/7/–/–/1
11 Gallic coins –/–/–/–/–/–/–/11
RRCH 471; MHCFC

355. Monte Mozinho (MOZ)
Portugal, 32 BC
4 coins:
4 *denarii* 4/–/–/–/–/–/–/–
MHCOP

356. Obislav (OBI)
Romania, 32 BC
53 coins:
53 *denarii* 48/1/–/2/1/1/–/–
PUB
Mitrea & Drob (1981–1982)

357. Roşiori de Vede (ROS)
Romania, 32 BC
6 coins:
6 *denarii* 6/–/–/–/–/–/–/–
RRCH 474; MHCFC
Mitrea (1965, p. 612, no. 33)

358. Segonzac (SGZ)
France, 32 BC
7 coins:
7 *denarii* 5/–/–/–/2/–/–/–
RRCH 453; MHCFC

359. 'West Sicily' (S02)
Sicily, 32 BC
26 coins:
26 *denarii* 26/–/–/–/–/–/–/–
RRCH 477; MHCTS

360. Weston (WES)
Britain, 32 BC
303 coins:
3 *denarii* 2/–/–/–/1/–/–/–
300 British AE –/–/–/–/–/–/–/300
RRCH 476; MHCFC

361. Beauvoisin (BEA)
France, 29 BC
246 coins:
195 *denarii* 181/–/–/–/14/–/–/–
11 *quinarii* 11/–/–/–/–/–/–/–
40 Gallic AE –/–/–/–/–/–/–/40
RRCH 459; MHCHW

362. Castro de Alvarelhos (CDA)
Portugal, 29 BC
3454 coins:
3447 *denarii* 3425/–/–/–/22/–/–/–
6 *quinarii* 6/–/–/–/–/–/–/–
1 *sestertius* 1/–/–/–/–/–/–/–
PUB
Torres (1979)

363. Cerriolo (CRR)
Italy, 29 BC
40 coins:
38 *denarii* 26/–/–/–/11/–/–/1
2 *quinarii* 2/–/–/–/–/–/–/–
RRCH 478; MHCFC

364. Citânia de Sanfins (CDS)
Portugal, 29 BC
288 coins:
288 *denarii* 241/6/–/–/40/–/–/1
RRCH 463; MHCOP

365. Cortijo del Álamo (ALA)
Spain, 29 BC
131 coins:
131 *denarii* 122/1/–/–/8/–/–/–
RRCH 464; MHCOP
López Serrano (1958)

366. Este (ES1)
Italy, 29 BC
71 coins:
71 *denarii* 60/2/–/–/7/–/–/2
RRCH 466; MHCHW

367. Gajine (GAJ)
Yugoslavia, 29 BC
107 coins:
2 *asses* 1/1/–/–/–/–/–/–
95 *denarii* 81/4/–/–/7/–/–/3
10 *quinarii* 10/–/–/–/–/–/–/–
RRCH 479; MHCOP

368. Lampersberg (LMP)
Austria, 29 BC
56 coins:
56 *denarii* 49/4/–/–/3/–/–/–
RRCH 468; MHCFC
Bruck (1963)

369. Meolo (ME1)
Italy, 29 BC
515 coins:
510 *denarii* 477/–/–/–/33/–/–/–
4 *drachmae* –/–/–/–/–/–/–/4
1 *quinarius* 1/–/–/–/–/–/–/–
MHCOP
Gorini (1974–1975)

370. Niederlangen (NIE)
Germany, 29 BC
62 coins:
62 *denarii* 50/–/–/–/12/–/–/–
RRCH 452; MHCOP
Willers (1899, pp. 342–345)

371. Şeica Mică (SEI)
Romania, 29 BC
348 coins:
348 *denarii* 327/–/–/–/21/–/–/–
RRCH 456; CHIT
Floca (1956a, pp. 18–40)

372. Stuhlingen (STU)
Germany, 29 BC
15 coins:
14 *denarii* 14/–/–/–/–/–/–/–
1 *quinarius* 1/–/–/–/–/–/–/–
RRCH 481; MHCFC

373. Topolovo (TOP)
Bulgaria, 29 BC
165 coins:
125 *denarii* 115/–/–/–/10/–/–/–
40 tetradrachms –/–/–/40/–/–/–/–
RRCH 457; MHCFC

374. Valachia Mică (VLM)
Romania, 29 BC
17 coins:
17 *denarii* 13/–/–/–/4/–/–/–
RRCH 454; MHCFC
Mitrea (1941–1944, p. 390)

375. Vigatto (VIG)
Italy, 29 BC
742 coins:
742 *denarii* 516/3/–/–/221/–/–/2
RRCH 475; RRC

376. Ramallas (RAM)
Spain, 25 BC
27 coins:
27 *denarii* 27/–/–/–/–/–/–/–
RRCH 484; MHCOP
Mattingly (1935)

377. Bastasi (BAS)
Yugoslavia, 19 BC
11 coins:
11 *denarii* 10/–/–/–/1/–/–/–
RRCH 489; MHCFC

378. Căpîlna (CAP)
Romania, 19 BC
28 coins:
28 *denarii* 26/–/–/–/2/–/–/–
MHCOP
Pavel & Berciu (1974)

379. Dăeşti (DAE)
Romania, 19 BC
4 coins:
4 *denarii* 4/–/–/–/–/–/–/–
RRCH 487; MHCFC
Mitrea (1941–1944, pp. 385–6)

380. Maillé (MAI)
France, 19 BC
424 coins:
424 *denarii* 385/–/–/–/36/–/–/3
RRCH 488; PUB
Giard (1963); Crawford (1974, Table L)

381. Medovo (MED)
Bulgaria, 19 BC
156 coins:
151 *denarii* 136/–/1/–/14/–/–/–
5 tetradrachms –/–/–/5/–/–/–/–
RRCH 490; MHCOP
Nikolov (1964, pp. 154–166)

382. Plopşor (PLP)
Romania, 19 BC
52 coins:
52 *denarii* 48/–/–/–/4/–/–/–
PUB
Popilian (1971)

383. Santo Stefano Roero (SSR)
Italy, 19 BC
146 coins:
98 *denarii* 62/1/–/–/35/–/–/–
48 *quinarii* 45/–/–/–/3/–/–/–
RRCH 485; MHCOP
Barocelli (1914)

384. Tiermes (TIE)
Spain, 19 BC
12 coins:
12 *denarii* 9/–/–/–/–/–/–/3
PUB
Vidal Bardán (1988)

385. Bourgueil (BOU)
France, 18 BC
693 coins:
693 *denarii* 480/–/–/–/209/–/–/4
RRCH 493; RRC
de Beaumont (1905)

386. Cornii de Sus (CRN)
Romania, 18 BC
113 coins:
113 *denarii* 102/–/–/1/8/–/–/2
PUB
Căpitanu & Buzdugan (1969)

387. Zara (ZAR)
Italy, 18 BC
276 coins:
276 *denarii* 231/1/–/–/40/–/–/4
PUB
Sorda (1971–1972, pp. 128–152)

388. Scurta (SCU)
Romania, 17 BC
14 coins:
14 *denarii* 12/–/–/2/–/–/–/–
PUB
Mitrea (1973–5)

389. Bordeşti (BRD)
Romania, 16 BC
44 coins:
44 *denarii* 41/–/–/–/2/–/–/1
PUB
Constantinescu (1978)

390. Pettau (PTT)
Yugoslavia, 16 BC
28 coins:
28 *denarii* 17/–/–/–/11/–/–/–
RRCH 492; MHCFC

391. Abertura (ABE)
Spain, 15 BC
38 coins:
38 *denarii* 30/–/–/–/8/–/–/–
RRCH 496; MHCOP

392. Conţeşti (CNT)
Romania, 15 BC
145 coins:
145 *denarii* 126/–/–/4/14/1/–/–
CHIT
Bold (1958)

393. Goldenstedt (GOL)
Germany, 15 BC
9 coins:
9 *denarii* 7/–/–/–/2/–/–/–
RRCH 499; MHCFC

394. Laibacher-Moor (Ljubljana) (LAI)
Yugoslavia, 15 BC
5 coins:
1 *as* 1/–/–/–/–/–/–/–
4 *denarii* 1/2/–/–/1/–/–/–
RRCH 536; MHCFC

395. Penamacor (PEN)
Portugal, 15 BC
84 coins:
84 *denarii* 63/3/–/–/18/–/–/–
RRCH 502; MHCOP

396. Pîrgăreşti (PIR)
Romania, 15 BC
6 coins:
6 *denarii* 4/–/–/–/2/–/–/–
RRCH 503; PUB/CHIT
Buzdugan (1968)

397. Poiana (1PO)
Romania, 15 BC
152 coins:
152 *denarii* 127/2/–/1/14/–/–/8
CHIT
Dunăreanu-Vulpe (1934)

398. Şpring (SPG)
Romania, 15 BC
50 coins:
49 *denarii* 49/–/–/–/–/–/–/–
1 *quinarius* 1/–/–/–/–/–/–/–
PUB
Pavel (1978)

399. Cetăţeni (CET)
Romania, 13 BC
127 coins:
127 *denarii* 110/–/–/3/8/6/–/–
PUB
Mitrea & Rosetti (1974); Mitrea & Rosetti (1972)

400. Gallignano (GAL)
Italy, 13 BC
441 coins:
441 *denarii* 331/5/–/–/101/–/–/4
RRCH 505; RRC
Moretti (1930)

401. Sfîntu Gheorghe (SG1)
Romania, 13 BC
61 coins:
61 *denarii* 59/–/–/–/2/–/–/–
PUB
Székely (1968)

402. Ciuperceni (CIU)
Romania, 12 BC
161 coins:
161 *denarii* 148/–/–/–/13/–/–/–
CHIT

403. Strîmba (STB)
Romania, 11 BC
215 coins:
215 *denarii* 176/2/–/3/33/–/–/1
RRCH 512; PUB
Mitrea (1958)

404. Breaza (BRZ)
Romania, 8 BC
132 coins:
132 *denarii* 116/1/–/–/4/11/–/–
PUB
Poenaru Bordea & Ştirbu (1971); Lupu (1969)

405. Pravoslav (PRA)
Bulgaria, 8 BC
58 coins:
58 *denarii* 56/–/–/–/2/–/–/–
RRCH 520; MHCOP
Nikolov (1964, pp. 166–171)

406. Răcătău de Jos I (RDJ)
Romania, 8 BC
71 coins:
71 *denarii* 62/–/–/3/5/–/–/1
PUB
Căpitanu & Ursachi (1971, pp. 168–171)

407. Este (ES2)
Italy, 7 BC
286 coins:
1 *as* 1/–/–/–/–/–/–/–
283 *denarii* 220/–/–/–/61/–/–/2
2 *quinarii* 2/–/–/–/–/–/–/–
RRCH 519; MHCOP
Prosdocimi (1899)

408. Fronfeste (FRO)
Germany, 6 BC
33 coins:
32 *asses* 23/1/–/–/1/–/–/7
1 *dupondius* –/–/–/–/–/–/–/1
RRCH 515; MHCFC

409. Aggius (AGG)
Sardinia, 2 BC
18 coins:
18 *denarii* 12/–/–/–/6/–/–/–
RRCH 521; MHCFC
Taramelli (1927); Perantoni Satta (1960–1961, No. 25, pp. 117–8)

410. Aquileia (AQU)
Italy, 2 BC
560 coins:
559 *denarii* 423/–/–/–/136/–/–/–
1 *victoriatus* 1/–/–/–/–/–/–/–
RRCH 522; RRC/PUB
Brusin (1928)

411. Bagheria (BAG)
Sicily, 2 BC
313 coins:
1 misc. bronze –/–/–/–/–/–/1/–
311 *denarii* 196/–/–/–/115/–/–/–
1 *semuncia* –/–/–/–/–/–/1/–
RRCH 523; MHCTS
Crawford (1974, Table L)

412. Bylandse Waard (BYL)
Netherlands, 2 BC
61 coins:
61 *denarii* 55/–/–/–/6/–/–/–
RRCH 525; PUB
Zadoks & Jitta (1954); MacDowall, Hubrecht & de Jong (1992)

413. Köln (I) (KL1)
Germany, 2 BC
36 coins:
36 *denarii* 17/–/–/–/16/–/–/3
MHCCI
Hagen (1924)

414. Mesnil-sur-Oger (MSO)
France, 2 BC
19 coins:
19 *denarii* 8/–/–/–/9/–/–/2
RRCH 539; MHCFC

415. Stojanovo (STJ)
Bulgaria, 2 BC
71 coins:
71 *denarii* 60/1/–/–/10/–/–/–
MHCTS

416. Vico Pisano (PIS)
Italy, 2 BC
191 coins:
1 *cistophorus* 1/–/–/–/–/–/–/–
165 *denarii* 122/4/–/–/37/–/–/2
25 *quinarii* 24/–/–/–/1/–/–/–
RRCH 549; MHCFC

417. Viile (VII)
Romania, 2 BC
51 coins:
51 *denarii* 48/1/–/–/2/–/–/–
PUB
Ocheşeanu & Papuc (1983–1985)

418. 'Wightman' (WIG)
—, 2 BC
16 coins:
16 *denarii* 15/–/–/–/1/–/–/–
MHCTS

419. Fuente Álamo (FAL)
Spain, 'Roman Republican'
1269 coins:
1269 *denarii* –/–/–/–/–/–/–/1269
PUB
Lechuga Galindo (1986, pp. 135–136)

420. 'Hoffmann' (HF2)
Italy, 'Roman Republican'
15 coins:
14 *denarii* –/–/–/–/–/–/–/14
1 triobol –/–/–/–/–/–/–/1
RRCH 222; MHCFC

Appendix B

Concordances

B.1 Introduction

This appendix provides concordances between Appendix A and the database hoard codes, and between Appendix A and RRCH (Crawford 1969c).

B.2 Database codes

1PO	397
ABE	391
ACT	344
ADJ	103
ADM	141
ADU	52
AGG	409
AGN	319
AID	257
ALA	365
ALI	94
ALN	210
ALS	233
ALV	296
ALX	142
AMA	118
AME	12
AMN	215
AN1	221
AN2	85
AQU	410
ARB	330
ATH	234
AVE	337
AVV	54
AZN	55
BAD	258
BAG	411
BAL	135
BAN	20
BAS	377
BAZ	202
BDF	143
BDR	156
BDS	345
BEA	361
BER	107
BES	222
BEU	354
BEV	35
BHR	235
BIR	253
BLC	113
BLF	21
BNC	189
BOB	119
BOD	320
BOM	144
BON	205
BOR	297
BOU	385
BPT	298
BRA	236
BRD	389
BRE	331
BRG	41
BRI	343
BRN	237
BRO	230
BRS	346
BRU	145
BRZ	404
BUC	244
BUG	42
BUR	1
BUZ	224
BYL	412
CAB	157
CAC	63
CAH	97
CAL	321
CAN	10
CAP	378
CAR	109
CAS	231
CAT	287
CAV	284
CDA	362
CDJ	299
CDL	65
CDR	160
CDS	364
CER	110
CET	399
CG1	341
CG2	69
CHI	300
CHT	214
CIT	288
CIU	402
CLA	81
CLN	225
CNT	392
CO1	40
CO2	48
COG	56
COM	223
COR	151
COS	161
CPL	114
CPR	108
CR1	245
CR2	340
CRE	70
CRF	347
CRG	77
CRL	159
CRM	95
CRN	386
CRO	259
CRP	80
CRR	363
CRV	121
CSL	64
CSN	18
CST	190

B.3 Roman Republican Coin Hoards

254	111
256	112
257	113
258	114
261	115
264	117
265	118
266	126
267	129
268	130
272	120
273	121
274	127
276	134
278	122
279	132
280	135
281	137
282	138
283	136
284	145
285	96
286	84
287	149
289	141
290	144
291	147
293	202
294	154
295	142
296	151
297	153
300	157
301	158
303	163
304	175
305	176
306	180
307	182
308	167
309	169
310	183
311	177
312	178
313	161
314	173
315	174
316	185
317	187
318	189
319	194
320	192
321	219
322	195
323	196
325	198
326	199
327	201
330	181
331	204
332	206
334	209
335	210
336	211
337	213
338	215
339	220
341	217
342	222
344	221
345	223
346	224
347	225
348	228
349	226
350	230
351	231
352	236
353	238
354	239
355	240
356	241
360	249
361	251
362	245
363	244
364	250
367	247
368	242
369	256
372	255
373	262
375	282
376	257
377	265
379	260
380	270
381	279
383	259
385	261
386	267
387	254
388	275
391	285
393	286
394	284
396	288
398	291
400	293
402	295
405	303
406	317
408	298
409	307
410	310
411	314
412	318
413	322
414	311
417	296
418	297
419	300
420	301
422	258
424	319
428	323
430	330
431	333
432	332
434	321
435	329
436	335
437	334
439	338
440	337
441	331
442	339
443	340
444	341
446	342
448	343
451	305
452	370
453	358
454	374
456	371
457	373
459	361
460	345
463	364
464	365
465	349
466	366
468	368
470	353
471	354
472	200
473	344
474	357
475	375
476	360
477	359
478	363
479	367
481	372
484	376
485	383
487	379
488	380
489	377
490	381
492	390
493	385
496	391
499	393
502	395
503	396
505	400
512	403
515	408
519	407
520	405
521	409
522	410
523	411
525	412
536	394
539	414
549	416
564	179

Appendix C

Supplementary data for the simulation study

C.1 Introduction

This appendix gives supplementary data for the simulation study presented in Chapter 11. Firstly, the dBASE program code is given. Then the die estimates (RISC) figures derived from RRC and Lockyear (1989) are presented. The former is given as the cynical may wish to check the manner in which the simulated populations were produced. The value of κ has, however, been censored.

C.2 The SIM2 program

```
********************************************************
*  SIM2.PRG    (c) Kris Lockyear 1995                  *
*                                                      *
*  This program takes a file of die estimates and      *
*  calculates theoretical coin populations for every   *
*  year from 157 to 50 BC.                             *
*  Results written to a user supplied file             *
********************************************************

close all
set talk off
set exact on
set decimals to 6

****************************
* USER SUPPLIED PARAMETERS *
****************************

?
accept "Enter a decay rate (delta): " to temp
decay=val(temp)
?
? "If you wish to use the default ‘large number’ press return"
accept "Total number of coins per die (kappa): " to temp
IF temp=""
      dietot=XXXXXXX
ELSE
      dietot=val(temp)
```

```
ENDIF
?
accept "Enter an introduction delay: " to temp
intro=val(temp)
xdate=157


********************************************************************
* Create data file for results based on structure of tempfile.dbf *
********************************************************************

sele 1
use tempfile
accept "Enter a new filename : " to temp
temp=temp+".dbf"
copy stru to &temp
use &temp


******************************
* Data file of die estimates *
******************************

sele 2
?
accept "Die estimate data file (default MCDIESY): " to temp
IF temp=""
      temp="mcdiesy"
ENDIF
use &temp


*********************************************************
* Main loop calculating the total numbers of coins per *
* issue year for every date 157--50 bc                 *
*********************************************************

?
? "Working ......."
?
DO while .not. eof()
      IF dies>0
            xtotal=(dies*dietot)/intro
            xiss=year
            xdate=year
            sele 1
            x=1
            DO WHILE xdate<=-50
                  IF x>1
                        oldtot=totalcoins
                  ENDIF
                  appe blank
                  DO CASE
                  CASE x=1
                        replace totalcoins with xtotal, ;
                              issyear with xiss, ;
```

```
                              date with xdate
                        x=x+1
                  CASE x>1 .and. x<=intro
                        xsub=(oldtot/100)*decay
                        xtot=xtotal+(oldtot-xsub)
                        replace totalcoins with xtot, ;
                              issyear with xiss, ;
                              date with xdate
                        x=x+1
                  CASE x>intro
                        xsub=(oldtot/100)*decay
                        xtot=(oldtot-xsub)
                        replace totalcoins with xtot, ;
                              issyear with xiss, ;
                              date with xdate
                  ENDCASE
                  xdate=xdate+1
            ENDDO
      ELSE
            xiss=year
            xdate=year
            sele 1
            DO WHILE xdate<=-50
                  appe blank
                  replace date with xdate, issyear with xiss, ;
                        totalcoins with 0
                  xdate=xdate+1
            ENDDO
      ENDIF
      sele 2
      skip
ENDDO


**********************************
* Calculating yearly totals      *
**********************************

sele 2
accept "Enter a new filename for yearly totals : " to temp
temp=temp+".dbf"
use tempfil2
copy to &temp
use &temp

IF file('temp.ndx')
      dele file temp.ndx
ENDIF

index on year to temp

*** calculating yearly grand totals
?
? "Calculating yearly grand totals......... "

sele 1
```

```
go top
DO WHILE .not. eof()
      xyear=date
      xtot=totalcoins
      sele 2
      seek xyear
      replace totalcoins with totalcoins+xtot
      sele 1
      skip
ENDDO


*****************************************
* calculating percentages for each year *
*****************************************

?
? "Calculating percentages......... "

sele 1
go top
DO WHILE .not. eof()
      xyear=date
      sele 2
      seek xyear
      gtot=totalcoins
      sele 1
      replace perc with (totalcoins/gtot)*100
      skip
ENDDO

close all
set talk on

*******************************************
* END sim2.prg    (c) Kris Lockyear 1995  *
*******************************************
```

C.3 Crawford's and Lockyear's RISC figures

year	Crawford	Lockyear	year	Crawford	Lockyear	year	Crawford	Lockyear
157	187	179	121	293	155	85	643	739
156	0	0	120	163	87	84	412	303
155	101	98	119	393	213	83	496	377
154	90	87	118	370	200	82	1039	753
153	89	87	117	170	24	81	547	397
152	117	116	116	537	95	80	322	256
151	83	83	115	617	304	79	634	489
150	137	138	114	425	353	78	252	271
149	157	151	113	163	246	77	294	248
148	218	223	112	274	246	76	334	288
147	128	132	111	727	432	75	147	84
146	120	125	110	393	236	74	239	203
145	121	126	109	866	527	73	10	3
144	24	25	108	445	270	72	24	1
143	29	31	107	0	0	71	112	94
142	43	46	106	385	243	70	46	37
141	48	44	105	487	311	69	153	149
140	71	73	104	557	353	68	154	139
139	29	31	103	345	227	67	303	274
138	280	314	102	185	122	66	100	115
137	474	536	101	367	248	65	10	6
136	526	600	100	433	278	64	218	187
135	86	99	99	0	0	63	204	242
134	243	357	98	0	0	62	472	578
133	116	127	97	30	21	61	50	27
132	199	235	96	343	246	60	70	91
131	133	159	95	0	0	59	56	75
130	200	241	94	0	0	58	356	495
129	99	119	93	0	0	57	109	98
128	167	205	92	122	92	56	642	621
127	83	76	91	677	709	55	654	670
126	155	197	90	2362	2990	54	427	496
125	245	124	89	836	780	53	10	3
124	300	154	88	807	902	52	10	1
123	510	264	87	476	534	51	76	40
122	310	162	86	508	556	50	30	38

Appendix D

Late Iron Age sites in Romania

D.1 Introduction

This appendix contains information regarding late Iron Age sites in Romania. It provides a more detailed background and bibliography to the discussions in Chapters 13–15.

Section D.2 is a survey of the published evidence for the three counties of Alba, Sibiu and Hunedoara. Section D.3 lists some other important sites mentioned in the main text. Section D.4 lists sites which have special finds or buildings.

D.2 Survey of the counties of Alba, Hunedoara and Sibiu

This survey of the published evidence for late Iron Age settlement and finds in the three counties was primarily performed by using the bibliography of Comşa (1993) for references before 1982. For the post-1982 references the major journals and the county journals, where possible, were examined; also useful was Preda (1994f). This survey has no pretence of completeness, and in particular early references have not been persued as many have been summarised in later publications.

It was not possible to examine all references, and those not consulted by the author are marked §. The sites are divided into the three counties (sections D.2.1–D.2.3), and then listed alphabetically and numbered sequentially. For the immediate area around the Munţii Orăştiei, Daicoviciu *et al.* (1989) list large numbers of findspots. This work builds on the earlier surveys by Daicoviciu & Ferenczi (1951) and Daicoviciu (1964). Some of these findspots have been sumararily included (section D.2.4). Very early references to finds in this region have been summarised by Daicoviciu *et al.* (1989, Chapter 1). Most general works on this period, such as those by Pârvan (1926), Daicoviciu (1972) or Crişan (1993), discuss these sites but references to these works have not been included.

In listing these sites I have taken the dating and interpretations of the excavators at face value. The level of detail for each site also varied according to the quality and/or nature of the investigations and the publications. For a discussion of the sites in their context, problems with dating and interpretation *etc.*, please see the main text.

D.2.1 Alba

1. Aiud

Type of site/find: Settlement and two cemeteries.

Phases: "Celtic", 4th–2nd centuries BC.

Investigations: Mainly chance finds; excavation of grave by Herepey in late 19th century; finds and observations from excavation of foundations at 'Microraionul III' in 1968–1972.

Description: Various finds from around the town. Crişan has identified from earlier finds two cemeteries which he identifies as "celtic". The first is in the north of the town, partly in the park, from which has been found a variety of ceramic vessels and iron objects. The second is in the south of the town and is smaller, but from which various iron objects have been found. These objects have been dated by Crişan to 4–2nd centuries BC. The grave excavated by Herepey contained a cracked vase under which was a dagger and in which was an iron fibula. Nearby was the leg of a horse—the rest of the skeleton could not be excavated. Cemetaries showed evidence of cremations and inhumations. The settlement at 'Microraionul III' is a multiperiod site, the last levels of which revealed both "Dacian" and "celtic" ceramics including bowls and graphite ware. Dated to 3rd–2nd centuries BC on the basis of comparison to cemeteries. Ciugudeanu believes the presence of both Dacian and celtic finds in the same site is evidence of contact between the two populations.

Finds:

Imports: Graphite ware, perhaps some of the iron-work from the cemetery. Possible Greek vase or copy thereof from first cemetary.

Special: Amongst the cemetery assemblage: a sword with a sheath which is decorated in relief and has gold-decorated rivets stands out; also chain for a sword, iron bracelet (with nodes), iron fibula and an ornamental plaque.

Domestic: Pottery including *vase borcan* and a large celtic vase; various knives, shears, spearheads, horse-bits and bronze harness attachments.

References: Crişan (1974); Ciugudeanu (1978, p. 44 & Fig. 3).

2. Aiud

Type of site/find: Hoard.

Phases: Dacian.

Description: Three silver arm-rings.

References: Popescu (1937–1940, p. 197); Horedt (1973, find no. 2).

3. Alba Iulia

Type of site/find: Possible rural settlement.

Phases: ??Dacian, Roman.

Description: Some Dacian finds from excavation of Roman town.

Finds:

Domestic: Some fragments of wheel-made pottery.

References: Berciu & Moga (1972, pp. 71, 73).

4. Blandiana

Type of site/find: Find of "celtic" vessels; Dacian burial.

Phases: Both 3rd–2nd centuries BC.

Investigations: 1974 & 1979.

Description: Four vessels found in digging of a ditch in 1974. Probably from a burial but no information available. The vessels consist of three vases and a handled cup. The three vases are "celtic", the cup probably local 'Dacian.' The burial was found in the spring of 1979 when it was washed out of the bank of the Mureş. It was a cremation buried with various iron artefacts.

Finds:

Special: The burial contained: a curved iron dagger of typical Dacian type, a fragment of an iron sheath, a spearhead, an iron buckle, a highly ornate horse-bit.

Domestic: The four vessels from the first find; a vessel and two ceramic fragments from the burial.

References: Aldea (1976); Ciugudean (1980).

5. Căpîlna, Sebeş

Type of site/find: Fortified hill top settlement.

Phases: Mid 1st C. BC–106 AD.

Investigations: Excavations 1939, 1942, 1954, 1965–7 & 1982–3.

Description: Fortress on a 610m. high hill. The main approach is from the south and is defended by a ditch, a semi-lunar bank with a shallow internal ditch, and a palisade. The hill top is extensively terraced. Facing the entrance works is a tower with a base of *murus dacicus* laced with timber and topped with an adobe brick wall. The hill top is enclosed by a wall of the same construction and one smaller tower to the east of the main tower. A smaller secondary entrance occurs on the northern side. The hill summit may have had a further tower but this would have been destroyed in the medieval period (see plan of site and reconstruction in Glodariu & Moga 1989, Figs. 99 & 110). The limestone used in the construction of the fortress is probably from Măgura Călanului, 70km. away. The northern wall also contains four circular slabs similar to those used in rectangular sanctuaries elsewhere. These are of two sizes, 1m and 0.66m in diameter, leading the excavators to suggest that at least two rectangular sanctuaries once existed. Excavations outside the fortress have failed to locate any external civilian settlement. Some evidence exists for internal wooden structures but their form is unclear.

Finds:

Coins: 28 Roman coins found in and around the entrance tower. Probably a dispersed hoard (hoard CAP) dating to Augustus. Three other coins later recovered.

Imports: Some fragments of ?Roman *amphorae*; a bronze *situla*; imported glass vessels from Italy.

Special: Painted pottery with geometric designs; broaches include five silver 'spoon' broaches (*fibulă-linguriţă*), and bronze variants of Nauheim type broaches; two spiral silver finger rings, two silver finger rings; glass bracelet and three glass beads.

Domestic: Large range of Dacian pottery types, both hand and wheel made including cups, *fructiere* (fruit-bowls), various types of 'vases', *etc.*; forms also include copies of imported vessels such as *kantharoi* but no imported vessels except for a few fragments of probably Roman *amphorae*; other ceramic objects include pottery burnishers, spindle whorls, weights and small *tessarae*; various iron tools found including hammers, tongs, punches, axes and chisels; agricultural tools included plough shares, hoes, scissors and sickles; building materials included nails, bolts and two pulleys; household implements including knives, skewers and an iron vessel; various pieces of harness including a horse bit of 'Thracian' type; weapons included a shield boss, various knives including curved daggers (*sicae*), spear points and arrow heads; personal ornaments include broaches (silver, bronze and iron), rings and pins; stone implements include whetstones, and andesite rotary querns; fragment of crucibles; faunal evidence shows dominance of sheep/goat, then pigs and cattle; seed evidence included *Triticum monococcum* and *Triticum dicoccum* but was dominated by *Horoleum vulgare vulgare* and *Setaria Italica*.

References: Macrea & Berciu (1965)§; Popa (1971); Berciu & Moga (1972, pp. 67–68); Pavel & Berciu (1974); Glodariu & Moga (1989); Moga (1992); Glodariu (1994b).

6. Cetea

Type of site/find: Rural settlement?

Phases: Dacian 1st BC–1st c. AD.

Investigations: Excavations by D. and I. Berciu prior to 1946; observations by Ciugudeanu in 1972.

Description: Site is 3km. from the village at 'La Pietri'; it had 'rich vestiges dating to the Dacian period' from five cultural layers. In 1972, Ciugudeanu observed a sunken-floored building in the bank of the river. It had been largely destroyed but had a rich pottery assemblage including a complete *vas borcan*.

Finds:

Imports: Hellenistic pottery.

Special: Geometric painted pottery; imitation of a *oinochoe*.

Domestic: Spindle whorls, metal fragments and pottery. Ciugudeanu recovered much pot, all hand made including a complete vessel.

References: Crişan (1969a, p. 257, no. 61); Berciu & Moga (1972, p. 73); Ciugudeanu (1978, pp. 45, 48 & Fig. 5).

7. Cicău, 15km NNW of Aiud

Type of site/find: Rural settlement.

Phases: Bronze Age, Halstatt and Dacian (pre- and post-Hadrianic invasion), prefeudal and Avar.

Investigations: Excavations from 1969–1973.

Description: Rural site, no details of Dacian settlement as destroyed by later Roman and post-Roman settlement. A few hearths and pits recovered. No evidence for fortifications.

Finds:

Coins:	Two Roman imperial coins.
Imports:	None definitely from Dacian levels.
Special:	Three late broaches from Roman levels.
Domestic:	Both wheel and hand made pottery. Various iron tools recovered some of which may be Dacian as there was little change in tool forms during the Roman period.

References: Winkler *et al.* (1978, p. 265); Winkler *et al.* (1979a, pp. 129–135); Winkler *et al.* (1979b)

8. Ciugud

Type of site/find: Isolated find.

Description: Chance discovery of hand and wheel-made pottery with incised lines, buttons *etc.* Found at point *Crişma lui Bran*, 300m. from excavations at *Gruieţ*.

References: Berciu & Moga (1972, p. 73).

9. Colţeşti

Type of site/find: Hoard of jewelry.

Phases: Late Iron Age.

Description: Hoard of silver torques.

References: Popescu (1937–1940, p. 198); Popescu (1971, Fig. 32); Horedt (1973, no. 18); Ciugudeanu (1978, p. 50).

10. Crăciunelul de Sus

Type of site/find: Hoard of jewelry.

Phases: Late Iron Age.

Description: Hoard of fibulae with nodes.

References: Popescu (1937–1940, p. 198); Horedt (1973, No. 20).

11. Cugir

Type of site/find: Fortified hill top settlement ('dava').

Phases: Bronze age (Wietenburg-Sighişoara); early Dacian Iron Age (3rd–2nd c. BC); and Classic Dacian (1st c. BC–1st c. AD). Settlement possibly ends with Hadrianic invasion. [KL: could end earlier, in 1st century BC?]

Investigations: Excavations by Crişan, 1977–9.

Description: Large fortified hill top settlement with necropolis of tumuli to the SW. The accessible slopes defended by earthen bank which has two phases. Hill top extensively terraced. Excavation not fully published but traces of timber dwellings found. Also, 3–4 tumuli excavated. Tumulus II contained a 'princely' burial and was constructed of river boulders.

Finds:

Coins: Poorly known early finds including tetradrachms of Macedonia Prima, Thasos, and Roman Imperial; Hoard (1955) at foot of hill consisting of 8 tetradrachms of Macedonia Prima and one of Philip II.

Imports: In tumulus II, a bronze *situla* from Italy.

Special: In tumulus II, silver fragments, a funerary cart, three horses, unusually large *fructieră*, sword, shield.

Domestic: Hand and wheel made pottery.

References: Mărghitan (1970, p. 12); Crişan (1978a); Crişan & Medeleţ (1979); Crişan (1980); Daicoviciu *et al.* (1989, p. 224); Crişan (1994b). Awaiting full publication of the site.

12. Dobîrca

Type of site/find: Coin hoard

Phases: Closes with hybrid copy of Nerva.

Description: Hoard of 37 coins. Not uploaded in detail to CHRR database, hoard DBR.

References: Chirilă & Aldea (1968); Chiţescu (1981, no. 67).

13. Ghirbom

Type of site/find: Rural settlement and cemetary.

Phases: Neolithic, early Bronze Age, Bronze Age, La Tène, and prefeudal settlement; prefeudal cemetery. (Prefeudal settlement phase inferred from surface pottery finds.)

Investigations: Excavations on settlement 1967; later excavations of early medieval cemetery.

Description: The site is located at *La Ghezuini* 2km. west of village on the NE slope of a hill near a small stream. Site is on a terrace 200m by 70–80m. The cemetery is at *Gruiul Fierului*.

Five 1m wide trenches excavated across the terrace in 1967. One trench found a 'pavement' of river boulders with a pit next to it which may be part of a sunken-floored building (*bordei*). Site considered poor by excavators and 'not possessing anything other than that strictly necessary for life' (Aldea 1972, p. 13).

Finds:

Special: Bronze plaque, probably from a vase, and a fibula with a 'leg which returns underneath' (*cu piciorul întors pe dedesubt*). Two fragments of a blue glass bracelet.

Domestic: Mainly coarse hand-made pottery, including fragments of two very large jars. Fine pottery is wheel made and of high quality. It includes mainly triconical jars and bowls, fruit-bowls (*fructiere*) and small jars.

References: Aldea (1972, esp. pp. 13–16); Berciu & Moga (1972, p. 74); Aldea, Stoicovici & Blăjan (1980, p. 150).

14. Gura Ampoiţei

Type of site/find: ?Rural settlement.

Phases: Wietenburg, Coţofeni and late La Tène.

Investigations: Small excavations in 1948 at point *Pietrele Gomnuşei*.

Description: Thin layer of Dacian date.

Finds:

Domestic: Wheel-made Dacian pottery.

References: Details unpublished, records at Alba Iulia Museum; Berciu & Moga (1972, p. 74).

15. Inuri

Type of site/find: Hill-top settlement, coin hoard and silver collar.

Phases: Early Bronze age (Coţofeni), late Bronze Age and late La Tène.

Investigations: Surface visit by Floca.

Description: On hill "Piatra cu Stînjenu", terraces on which pottery was found. East side of hill coin hoard found during agricultural work. Silver collar found in village.

Finds:

Coins: Hoard of 37 Roman Republican *denarii* (hoard INU).

Special: Silver collar.

Domestic: Some pottery fragments.

References: Floca (1956b); Mărghitan (1970, p. 12); Takács (1982); Chiţescu (1981, No. 103).

16. Lopadea Nouă

Type of site/find: Finds from surface survey at point called 'Telek.'

Phases: Bronze Age, Iron Age, particularly 1st BC–1st AD, and feudal (X–XI centuries).

Investigations: Noted during field survey in 1969. Some early work on the site.

Description: Early work noted Bronze Age settlement and Iron Age burial. 1969 survey revealed cultural layer in bank of a stream containing pottery and animal bones dating to 1st century BC–1st century AD. Also thin layer of feudal material.

Finds:

Domestic: Hand and wheel made Dacian pottery dating including *vase borcan* and *fructiere*.

References: Ciugudean (1979, pp. 68 & 70).

17. Medveş

Type of site/find: Coin hoard (MDV).

Phases: Closes 68 BC

Investigations: Found early 20th century.

Description: Small hoard of Republican *denarii*. Mitrea lists coins from 11 families, Crawford lists 12 coins, Winkler and Chiţescu list 13 coins. . .

References: Mitrea (1945, p. 110, no. 82); Winkler (1967, p. 149, no. 89); Crawford (1969c, no. 324); Chiţescu (1981, no. 117).

18. Meşcreac

Type of site/find: Multiperiod site on the bank of the Mureş at the point 'În ţărmure, la pădure.' Possibly same as site reported in 19th century.

Phases: Work in 1972 revealed Halstatt, La Tène, 4th–5th century finds, and settlement evidence for 9th–10th and 14th–16th centuries.

Investigations: Surface survey (including bank of Mureş) in 1972.

Description: Various finds from surface and from pits revealed in bank of Mureş. Pits in the bank of the Mureş contained Halstatt pottery. Surface finds included Dacian, post-Roman and medieval pottery. Probably represents a multiperiod settlement.

Finds:

Domestic: Pottery of Halstatt–medieval periods. Dacian finds included a *fructieră* with a wide base of a type dated to the mid-second century BC by Crişan (1969a, pp. 126–9).

References: Ciugudean (1979, pp. 68–70 and Fig. 5/1).

19. Peţelca

Type of site/find: Finds in museum, perhaps from a burial.

Phases: La Tène B_2.

Description: Finds include: a large bronze brooch with a broken pin, six coil spring and nodes on arch; iron knife blade 22cm long. Thought by Crişan to be "celtic."

References: Crişan (1973, pp. 51–2 & plate 6).

20. Pianul de Jos

Type of site/find: Isolated find.

Phases: Late Iron Age or Roman?

Description: A *cremaiera*, or chain for hanging a pot over a fire. Only complete example from Dacia. Piatra Roşie (site no. 60, page 521) has a fragment of one.

References: Berciu (1965).

21. Piatra Craivii

Type of site/find: Mountain-top fortress and settlement.

Phases: Some traces of prehistoric activity (Coţofeni and Wietenberg cultures), major Dacian fortress of 2nd century BC–1st century AD, feudal period castle.

Investigations: Excavations from 1960–1971.

Description: The site lies about 20km. north of Alba Iulia on the east side of the Munţii Apuseni. The site consists of 11 long crescent shaped terraces arranged around the edge of a limestone outcrop at a height of 1083m. These man-made terraces range from 20×8m to 200×115m. in size, and are often partly cut into the rock. Terraces V and VII have supporting walls made of unfashioned rock. The medieval castle was situated on the summit of the limestone outcrop (almost nothing is now visible). The site commands superb views in all directions particularly towards Alba Iulia. It is extremely difficult to reach from most directions — from the valley floor to the summit via the circuitous mountain road is six hours on foot.

Excavations in the form of a series of long trenches were undertaken. These revealed that part of the mountain-top had been defended with a single-faced *murus dacicus* wall. This wall was unusual in having pillar-like uprights as well as the more usual courses of square blocks. The wall is now reconstructed in Alba Iulia museum. Most of the terraces lay outside this defended area. On three of the terraces were found circular stone bases similar to those used in the rectanuglar sanctuaries at Costeşti and Sarmizegetusa Regia. Of these, two terraces are too small for sanctuaries and it is suggested that they form foundations for buildings. The final group on Terrace V form six lines of stones similar to other sanctuaries. This terrace (V) had a particularly rich assemblage of artefacts, approximately 95% of all the finds, including all the sherds of painted pottery and the silver artefacts (Moga 1979). Stone for the walls and sanctuary probably came from about 7km. away, and evidence of stone working including chippings was found on terraces I and V.

No direct evidence of pottery manufacture found but presence of ceramic burnishers suggests that this took place here. Metal tools also attest to the working of wood. A small set of tools for the working of silver was also found (Moga 1979).

It is suggested that the site is the 'town' of *Apoulon* listed by Ptolomy (*Geography* III, 8, 1).

Finds:

Coins: Chance find at end of last century: 1 tetradrachm of Phillip II; excavated finds: 1 Geto-Dacian coin, 4 Roman Republican *denarii* [inc. 1 imitation?], 1 *as* of Augustus.

Imports: Sherds of Graeco-Roman amphorae and cups, La Tène graphite ware, possibly some of the painted vessels; Greek [?] tiles with a symbol of an anchor; Greek horse-trappings; ??Celtic jewelry.

Special: Painted vessels with geometric motifs found on terrace with sanctuary (Berciu & Moga 1974). Jewelry included fibulae, rings, arm-bands and collars made of iron, bronze or silver. Some appear ‘celtic’ in form leading Popa (1971, p. 276) to suggest that their might have been an “element of ethnic celts” both here and at Căpîlna. The silver objects consisted of four fibulae, a silver ring (diameter 4.3cm.), a silver plaque and two pendants.

Domestic: Large range of vessels both hand made and wheel made including ‘fruit-bowls’ (*fructiere*), dacian cups (*ceşti dacice*); jugs, jars *etc.* Other ceramic items included pottery burnishers, spindle whorls and loom weights, and Greek [?] tile. Agricultural evidence includes carbonised grains of wheat, barley, millet and hemp. There are also a surprising number of agricultural tools including sickles, scythes, plough-shares including “one of celtic manufacture”, hoes, querns, pitchforks *etc.* Animal bone evidence attests to the importance of both cattle and pig. Wide variety of iron and bronze tools and artefacts including woodworking tools, pins, shears, many knives, and crampons. Also, large selection of weapons including spearheads, arrowheads, short swords *etc.*

References: Berciu & Popa (1963); Berciu *et al.* (1965); Berciu & Popa (1971); Popa (1971); Berciu & Moga (1972, pp. 68–71); Berciu & Moga (1974); Moga (1975); Moga (1979); Moga (1981).

22. Poşaga de Sus

Type of site/find: Hoard of silver jewelry.

Phases: Late Iron Age.

Description: Two fibulae with nodes, a small chain and fragments of pendants.

References: Popescu (1937–1940, p. 201); Horedt (1973, No. 50).

23. Răhău — Budurăul Ciobanelului

Type of site/find: Dacian finds, Roman rural settlement.

Phases: Traces of eneolithic (Coţofeni), Dacian and Roman.

Investigations: Two trenches excavated in 1960 by Institute of History, Cluj.

Description: The site mainly revealed Roman period buildings which form part of a *pagus*, which may have had its origins in a *villa rustica*. In area A, at a depth of 45cm., some Dacian pottery found.

Finds:

Coins: Coin hoard found in 1853 contained some few hundred coins but details not now available.

Domestic: Only Dacian finds were sherds of coarse hand-made pottery with an alveolar band (*brîu alveolat*).

References: Horedt *et al.* (1967, pp. 18–19); Berciu & Moga (1972, p. 74); Chiţescu (1981, No. 163).

24. Săliştea (formerly Cioara)

Type of site/find: Hoard of silver jewelry.

Phases: 1st century AD?

Investigations: Found 1820.

Description: Many pieces lost, 31 now survive in Vienna. Surviving pieces include five fibulae, four bracelets, two collars, three spiral rings, a plaque with an anthropomorphic figurine, amongst other items.

References: Mărghitan (1969).

25. Sebeş

Type of site/find: Multiperiod site on the left bank of the Secaş, next to Podul Pripocului.

Phases: Surface finds include pottery from the following cultures: Turdaş (neolithic), Coţofeni (eneolithic, early bronze age), Bodrogkeresztúr (eneolithic), Basarabi (Halstatt C), and a flat headed Bronze Age pin. Pits and trenches revealed finds from second century BC ("celtic"), late La Tène, and 3rd–4th centuries AD.

Investigations: Excavations by Institute of History, Cluj, and Alba Iulia, Sibiu and Sebeş museums, 1960. Three trenches dug (see Horedt *et al.* 1967, Fig. 8) as well as features seen in the bank of the river.

Description: Site originally attracted attention due to the find of a Bronze Age pin. Features in the 4m high bank of the river Secaş included three pits and a sunken-floored dwelling with associated kiln with semicircular domed roof. One pit contained a large jug and other Dacian pottery, probably of the 1st century BC. The second pit contained "celtic" pottery including striated sherds made of a paste with graphite inclusions. This is dated to the mid-second century BC. The third pit contained pottery and a broach dated to the late third century AD. Similarities between the pottery in the last pit and the sunken floored dwelling suggest the latter is of a similar date. Trench A revealed a large pit of late La Tène date; trench B revealed late Bronze Age finds including a bronze pin and trench C had finds of the mid-second century BC.

Report considers this site extremely important and it was intended for further work to be undertaken.

Finds:

Special: Two Bronze Age pins; Roman broach.

Domestic: Pottery of various dates, hand and wheel made. Almost complete Dacian jug from pit 1, and "celtic" graphite-rich sherds particularly important.

References: Horedt *et al.* (1967, pp. 19–25).

26. Straja

Type of site/find: ?Rural settlement.

Phases: ‘Classical’ Dacian.

Investigations: Limited excavtions in 1948.

Description: Sondage excavated at point *Salca Barnei* revealed many cultural levels especially Dacian.

Finds:

Domestic: Hand and wheel made pottery including Dacian cups, dolia *etc.*

References: Berciu & Moga (1972, p. 75).

27. Tărtăria

Type of site/find: Burial.

Phases: 2nd–1st century BC.

Investigations: Found during fieldwalking of neolithic site.

Description: Finds discovered on surface after burial had been destroyed by agriculture. The finds were: part of a scabbard for a curved sword; an attachment (‘hanger’) for a scabbard; two fragments of a horse harness. All the objects were iron. The authors consider that these came from the burial of a warrior.

References: Ciugudean & Ciugudean (1993).

28. Teleac

Type of site/find: Burial.

Phases: 2nd–1st century BC.

Investigations: Found by chance and finds given to museum—no archaeological work undertaken.

Description: Finds recovered by chance from a burial near the earlier Halstatt fortified settlement. Unknown if they represent an isolated burial or part of a cemetery. The finds recovered consisted of two jugs, a bent spearhead and a curved knife.

References: Moga (1982).

29. Ţelna, Ighius

Type of site/find: Surface finds.

Phases: Many phases, including Neolithic, Bronze Age and Dacian.

Investigations: Small scale excavations in 1967.

Description: Dacian surface finds from three spots: Piatra Afinii, Rupturi, and Trăuaş—La Copaci. A possible Dacian dwelling observed at Rupturi. Authors consider that hill top site Piatra Afinii probably represents seasonal settlement.

Finds:

Domestic: Various types of pottery including a 'typical Dacian cup' from Trăuaş—La Copaci.

References: Berciu & Moga (1972, p. 75); Moga & Aldea (1975).

30. Tibru

Type of site/find: Coin hoard (TIB).

Phases: Augustan.

Investigations: Found 1938.

Description: Found west of village at point *La comoara*; at least 194 *denarii*.

References: Macrea & Berciu (1939–1942); Popa, Pavel & Berciu (1973); Pavel (1979); Chiţescu (1981, no. 200).

31. Turdaş

Type of site/find: Burial and chance finds, ?settlement.

Phases: Cremation: 4th century BC; chance finds: 2nd–1st centuries BC.

Investigations: Finds in 1962 and 1971.

Description: In 1962 a cremation found accidently at point *Coasta viilor*; fragments of vessel with bones and bronze objects recovered. In 1971 surface finds from point *Sub pădure* including pottery and a brooch which may represent a settlement.

Finds:

Special: From burial 4 bracelets, a collar (torque) and a pendant. From surface finds a bracelet with three lines of nodes.

Domestic: From surface finds pottery including a lamp and fragment of a rim of a *fructieră*.

References: (Blăjan 1972).

32. Uioara de Jos — Ciunga

Type of site/find: Surface finds, possible settlement.

Phases: Various including Dacian and Roman.

Investigations: No excavation on Dacian material.

Description: Variety of surface finds in and around village. Dacian finds from Gura Fînaţelor, Hotonfa and Orăzleci. Possibility of Dacian and Roman settlement in area.

Finds:

Domestic: Pottery, including wheel made wares with a fine slip, *fructiere*, *vase borcan*, and a foot of a Dacian cup (*ceaşca dacică*).

References: Lazarovici & Cristea (1979).

33. Vălişoara

Type of site/find: Multiperiod ?rural settlement.

Phases: Neolithic (Coţofeni) to Dacian.

Investigations: Excavations at end of last century, surface survey in 1968–1973.

Description: Various surface finds from neolithic to Dacian. Most common finds classic period Dacian, dated by surface decoration and forms.

Finds:

Domestic: Of Dacian period: pottery, some of which is decorated.

References: Ciugudean (1979, p. 85 & Figs. 10/5–8).

D.2.2 Hunedoara

34. Ardeu, Balşa

Type of site/find: Hill top settlement.

Phases: Bronze Age find, 2nd c. BC–1st c. AD.

Investigations: Small scale rescue excavations in advance of destruction by a quarry. Excavation consisted of four trenches excavated in 1973.

Description: Site to SW of village at site known as Cetăţeaua. Number of terraces visible. A 'dwelling' seen as destroyed by quarry. Excavations revealed a platform of river boulders. No defensive works observed.

Finds:

Special: Three sherds of painted pottery; silver plaque with animal motifs (Mărghitan 1970, p. 12).

Domestic: Iron sickle, key, slag, and domestic pottery.

References: Mărghitan (1970, p. 12); Nemoianu & Andriţoiu (1975); Crişan (1994a).

35. Baia de Criş

Type of site/find: Mixed hoard.

Phases: 1st century BC.

Description: Hoard of 70 coins including 11 *drachmae* of Apollonia, found with a silver chain and ring.

References: Mitrea (1945, pp. 93–4); Glodariu (1994a).

36. Băiţa

Type of site/find: Coin hoard.

Phases: Closes with Augustus.

Description: 16 Roman Republican and Augustan *denarii*—not yet uploaded to database.

References: Chiţescu (1981, No. 12).

37. Băniţa

Type of site/find: Mountain-top fortress.

Phases: 1st c. BC–1st c. AD.

Investigations: Excavations by O. Floca, 1960–1.

Description: Site on a 1000m high peak, cut into three terraces. Defensive wall of *murus dacicus* on north and south sides, the slopes on the west and east steep enough to obviate need. Inside defenses traces of Dacian sanctuary, wooden buildings and a wooden watch tower. A workshop for bronze working was also found with moulds made from clay or gritstone and a crucible.

Finds:

Coins: ?None.

Imports: ?None.

Special: Silver bracelet; clay and gritstone moulds for metal working.

Domestic: Pottery of different types, iron tools, broaches, arrowheads, spindle whorls, querns, crucibles.

References: Not yet properly published; Daicoviciu (1972, pp. 137–139); Rustoiu (1992); Preda (1994b).

38. Blidariu

Type of site/find: Fortress

Phases: ?1st century BC–106 AD

Investigations: Primary excavations during the 1950s

Description: This site is situated on a hill-top at 705m. above sea level, which lies slightly to the south of the site of Costeşti (site no. 46, page 512). The first phase of this site consists of an irregular quadrilateral enclosure, *c.* 65×56m., of *murus dacicus* with corner towers. The entrance to the enclosure was through the SW tower. In the centre of the enclosure was a square "dwelling-tower" made of *murus dacicus* and wood. A fifth isolated tower stands to the west and may perhaps belong to this phase. The second phase consists of an extension to the site to the west. The walls of this 'extension' butt-join to the isolated tower mentioned above. A sixth tower was part of the new walls and stood in the NE corner. The west and north walls of this extension were also part of a series of small rooms (casemates). The centre of the second enclosure probably had a further dwelling from which there was evidence of a hearth. Outside the fortress to the west was a water cistern sunk 5m. into the ground. Near the fortress, at 'Pietroasa lui Solomon', lies a rectangular sanctuary.

It is generally suggested that the first phase of construction dates to the period near or at the end of Burebista's reign (late 1st century BC), and second phase of construction dates before the two Dacian wars, and then some rapid reconstruction was undertaken between them.

As this site has not been fully published it is impossible to give a full finds list.

Finds:

Coins: 1 bronze coin of Trajan dating to AD 101–102.

Imports: Bottom of ?Roman amphora; various other fragments of imported vessels.

Special: Imitations of imported vessels one with a 'K' inscribed on it.

Domestic: Pottery, including a number of very large storage vessels (over 1m high and 1m in diameter) set into the ground within some of the towers. Some of these vessels had holes in their bases. Other ceramics included both flat and curved roofing tiles. Iron work included large numbers of nails.

References: Daicoviciu *et al.* (1955, pp. 219–227); Daicoviciu *et al.* (1957, pp. 263–270); Daicoviciu *et al.* (1962, pp. 463–466); Daicoviciu *et al.* (1973a, pp. 70–73); Daicoviciu *et al.* (1989, pp. 181–184); Preda (1994d).

39. Bozeş

Type of site/find: Coin hoard.

Phases: Dacian.

Description: Hoard of 39 Dacian coins of Răduleşti-Hunedoara type, found in a handled pot.

References: Bălan (1966)§; Preda (1973, p. 302).

40. Călanu Mic

Type of site/find: Coin hoard.

Phases: Roman hoard.

Description: 100 *denarii*, entirely lost.

References: Chiţescu (1981, No. 38).

41. Cerbăl

Type of site/find: Mixed coin and jewelry hoard.

Phases: Closes 43 BC.

Description: Hoard found in ceramic vessel and included a bronze vase, a spiral bracelet, a fibula and fragments of two further fibulae, three further bracelets, 7 spiral rings, three spirals made of thin silver plaques, 6 pendents; coins entirely lost, 447 *denarii* identifiable from early publication—not yet input to CHRR database.

References: Popescu (1937–1940, p. 198); Chiţescu (1981, No. 41).

42. Chitid

Type of site/find: Mixed coin and jewelry hoard.

Phases: Roman hoard.

Description: 70 *denarii*, 1 silver bar and 1 gold bracelet, entirely lost.

References: Chiţescu (1981, No. 46).

43. Cîmpuri-Surduc, 'La Mănăstire'

Type of site/find: Fortified promontory.

Phases: 1st. c. BC

Investigations: Excavations 1963–4 by Deva Museum.

Description: Small oval plateau, 37×22m. Defended with a wall of unfashioned local stone with a probable timber and adobe brick superstructure. No details of internal buildings except for traces of hearths. Site seems to have been destroyed by fire dated by excavators to the period of 'Burebista's assassination.'

Finds:

Special: Amongst other iron tools, a well preserved iron axe of type found on other Dacian sites including Sarmizegetusa Regia.

Domestic: Rich pottery assemblage of hand and wheel made vessels including a cup and various 'vases.' In centre of site *dolia* and bone fragments recovered.

References: Valea & Mărghitan (1966); Mărghitan (1970, p. 16); Dumitraşcu & Mărghitan (1971, p. 48).

44. Cîmpuri-Surduc, 'Cetăţeaua'

Type of site/find: Small settlement.

Phases: 1st c. BC.

Investigations: Excavations 1963–4 by Deva Museum.

Description: Traces of a small Dacian settlement only 25m. in diameter. Defended by a ditch, and possibly a wall. Largely destroyed during World War 1. Possibly related to La Mănăstire site. Site destroyed by intense fire dated by excavators to period of the assassination of Burebista.

Finds:

Coins: Two *drachmae* of Dyrrachium, and one of Apollonia.

Domestic: No tools but rich local pottery assemblage with cups and 'vases' with applied button decoration; knife blade and animal bones.

References: Valea & Mărghitan (1966); Mărghitan (1970, p. 17); Dumitraşcu & Mărghitan (1971, p. 53).

45. Cîrjiţi

Type of site/find: Coin finds.

Phases: Dacian (2nd–1st centuries BC)

Description: Hoard of imitations of Alexander the Great, found 1900 but now lost; lone bronze copy of a coin of Hunedoara-Răduleşti type.

References: Mărghitan (1970, p. 15); Preda (1973, pp. 302 & 333).

46. Costeşti–Cetăţuie

Type of site/find: Hill-top fortified settlment/fortress.

Phases: 2nd century BC–AD 106.

Investigations: Many excavations, primary investigations 1925–1929 (Teodorescu) and 1956–7 (Daicoviciu *et al.*).

Description: The site is situated on the left bank of the Apei Grădiştii, 2km south of the village of Costeşti on a hill at 561m. On the south and east slopes of the hill are man made terraces which culminate in a man-enhanced plateau which is 160×33m. The site has been studied almost in its entirety, although more work needs to be done on the bank which surrounds the entire hill-top. The defenses can be divided into three main phases, although absolute dating is difficult. The 1st phase consisted of a earth bank on top of which was constructed a timber and earth wall some 3.3m thick. Some of this defensive work has eroded down the hill. Details within this circuit have been destroyed by later phases.

In the 2nd phase a *murus dacicus* wall was constructed on the south and east sides of the site with three towers, of which the centre tower contained an entrance. Slightly later, short walls perpendicular to the main wall were constructed which may have formed a fighting platform or store rooms. At this period a number of isolated towers were also constructed including two to the north near the ancient road and one near the sanctuary on the east side. On the interior plateau two 'dwelling towers' were constructed, both of which had two phases of construction, one in this phase and the second in phase three. Both towers have stone foundations 2m thick, and then the superstructure consists of adobe brick walls. These towers were probably roofed with greek-style tiles. Next to the southern tower was a monumental staircase in limestone with flanking drainage channels. A further staircase leads down towards tower No. 1.

In phase three the so-called ‘red bank’ was constructed on the line of the phase 1 defenses which had been destroyed (?? in the first Dacian war). The phase one defenses were rebuilt using soil burnt red by the fire in the interior of the castle. Elsewhere, tower 1 at the north end of the wall was destroyed by a bank (or had already been destroyed and the subsequent bank built over it), and the intramural sanctuary was destroyed and the circular bases used to block the entrance to the site and reinforce one of the new banks.

There are also two unphased defenses on the upper plateau consisting of banks and palisades.

The site has evidence for four rectangular sanctuaries, one of which is the only sanctuary from any site to occur within the line of the fortifications. The interior sanctuary had 4 rows of 15 bases. The two sanctuaries on the eastern slopes were perhaps unfinished, one with 6 rows of plinths, the other with 5 lines of 7 plinths. The final sanctuary was found on the north-east slope of the hill with 4 rows of 12 plinths. On the west slope of the hill was a water cistern.

Daicoviciu *et al.* (1989) offer the following phasing: phase 1, end 2nd–start 1st century BC when the site formed the residence of a leader of a union of tribes; phase two, Burebista after his Pontic expedition (as the wall construction presupposes Greek help); phase 3, between the first and second Dacian Wars (*i.e.*, AD 102–106). The unphased banks on the upper plateau probably date between phases 2 and 3. Site finally destroyed by Trajan in AD 106.

Finds:

Coins: 1 ‘celtic’ silver coin, 1 copy of a *drachm* of Dyrrachium, 19 bronze coins of Histria, 1 other bronze Greek coin, 2 copies of Roman Republican *denarii*, 1 bronze of Claudius, and 1 bronze of Trajan dating to AD 103–111.

Imports: Three bronze buckets, two with iron handles, one fragmentary, one of Campanian origin and one of Italian origin; one complete bronze vase with hemispherical base from Campania; fragments of five further bronze vases probably of Italian origin; ten handles, or attachments for handles of Italian or Campanian origin, one has two female heads and is paralleled at Pompeii.

Special: Fragments of *mille fiore* glass; silver bracelet; bronze *fibulae* (not published); bronze rings, some with nodes.

Domestic: Wide range of pottery (not published in full) including dolia, *fructiere*, vases in the form of a bell with alveolar bands; various iron artefacts including hammers, anvils, files, spikes and nails, bits, buckles, hooks, knives, a plough, sickles *etc.*; animal bone and carbonized seeds.

References: Teodorescu (1930); Macrea (1933–5); Werner (1933–1935); Daicoviciu *et al.* (1959, pp. 331–335); Glodariu (1968, pp. 354–357); Mărghitan (1972); Daicoviciu (1979); Daicoviciu *et al.* (1989, pp. 178–180); Preda (1994e).

47. Cozia (Piatra Coziei)

Type of site/find: Hill-top ‘civil’ settlement.

Phases: Bronze Age (Wietenberg), early Iron Age, and late Iron Age (1st BC–1st AD).

Investigations: Excavations by Deva Museum 1967–8.

Description: Hill-top settlement at 686m. with five terraces each of which is 100–150m^2. No clear structural evidence but parts of hearths, and burnt clay with wattle impressions found. No defenses but location makes site inaccessible from three sides.

Finds:

Special: Painted Dacian pottery with floral motifs; iron spiral arm band; iron two-armed balance with chains.

Domestic: Much pottery including cups, & *fructiere*; ceramic spindle whorls, loom weights and pottery burnishers; iron knives, spear-points, two arrowheads and nails; bronze ring.

References: Mărghitan & Andriţoiu (1968, pp. 655–6); Mărghitan (1970, pp. 14–15); Dumitraşcu & Mărghitan (1971, pp. 48–49); László & Crişan (1994).

48. Deva — Cetatea

Type of site/find: Settlement?

Phases: Many periods represented.

Investigations: 1972.

Description: Small scale traces of Dacian settlement on the hill where the medieval castle now stands and in the town. Some blocks possibly from a *murus dacicus* wall have been used in the medieval fortifications. Some 'Dacian dwellings' observed, as well as a water cistern. Kiln site found in the town. Other chance finds found in the town including coin hoards.

Finds:

Coins: Two coin hoards (Chiţescu 1981, nos. 64–5) including *drachmae* of Apollonia and Dyrrachium, and Roman Republican *denarii*.

Special: Iron broach with *piciorul ajugat*, 1st c. BC, found in excavations south of the castle, parallels with finds from Bîtca Doamnei (Iaşi county, site 107, page 537) and Cozia (site no. 47, page 513).

Domestic: Various Dacian pottery forms including handled cups and *vase borcan*.

References: Floca (1969, pp. 18–25); Mărghitan (1970, pp. 13–14); Albu (1971a); Albu (1971b); Floca (1971); Andriţoiu (1973, pp. 11–21); Floca (1977, pp. 174–181).

49. Feţele Albe

Type of site/find: High status settlement?

Phases: Primarily 'classic Dacian' (100 BC–AD 106). Site ended with destruction by fire suggested to be at conclusion of second Dacian war.

Investigations: Excavations 1965–1972.

Description: 'Feţele Albe' covers a number of terraces on the mountainside overlooking Sarmizegetusa Regia. The best-examined area is known as *Şesului cu brînza*, a set of five terraces with *murus dacicus* sustaining walls.

Terrace I has two phases of construction. The lower is of unknown form, the upper consists of a large circular building with a possible colonnade with limestone block foundations. In the centre of this building were further blocks of limestone and andesite. Amongst the finds associated with this site is a handle of a bronze vessel from the workshop of Ansius Diodorus.

Terrace II has three levels of construction. The upper level consisted of a large wooden structure with daub walls, which used limestone blocks as a foundation. Many nails were found in the destruction levels, along with an abundant ceramic assemblage. The middle phase consisted of a large 11m diameter circular building which again used limestone blocks as foundations. There was a possible entrance on the south side. The building was surrounded by a "porch" (*pridvor*) which had an earthern floor decorated with gooves in curving lines. The finds associated with this structure are less frequent than the following phase, but did include two graphite-ware vessels. These vessels, however, are of a form not paralleled elsewhere (*e.g.*, in the Manching corpus) and the excavators believe that these are local products and that the *inclusions* must have been imported. The lowest level is represented by a few finds only.

Terrace III was occupied by a circular sanctuary. The details of this sanctuary are not absolutely clear as it was destroyed by a powerful fire. As with Sarmizegetusa Regia, however, the outer edge consists of a series of stone bases, some long and flat and some narrower and higher, although the pattern of these cannot now be established. These bases are of limestone and appear to have been broken off at some point. They perhaps supported wooden walls as suggested by the large quantities of charcoal derived from the structure's destruction. Terrace IV had no traces of buildings.

Terrace V consisted of a single phase of construction with two buildings, one of which was supported on five lines of limestone blocks and may have been a granary.

There was also water management with ceramic water pipes and stone channels, along with a fragment of a large andesite basin.

The excavators believe that the terrace is almost entirely man-made. The first phase consisted of terraces I–II and walls B, D and E, and the earliest buildings, which were then replaced. In the second phase terraces III and V were built along with walls A, A_2, and C, and the buildings on those terraces including the circular sanctuary. These were then destroyed by fire. Finally, wall B was dismantled and the large circular building on Terrace I was built, which was in turn destroyed by fire. The excavators believe the destruction of the phase two buildings dates to the first Roman Invasion in AD 102, and the second to the second in AD 106.

Finds:

Coins: None.

Imports: Stamped handle of a bronze patera from the workshop of Ansius Diodorus, 1st century AD.

Special: Two graphite-ware vessels in an unusual form; a jug copying a bronze form painted with geometrical and zoomorphic designs; unique round vessel with a tubular spout.

Domestic: Finds not published in full but reports attest to a variety of domestic pottery, burnt daub, and a large selection of nails.

References: Daicoviciu & Glodariu (1969); Daicoviciu (1971); Daicoviciu *et al.* (1973b).

50. Grădiştea Muncelului (Sarmizegetusa Regia)

Type of site/find: Major settlement with defensive circuit, sacred precinct and civil settlement.

Phases: Probably second century BC to the Roman period (early second century AD).

Investigations: Excavations have continued on and off since the 18th century. Major excavations in the 1950s and 1960s by Constantine Daicoviciu and collaborators, and work connected with site conservation in the 1970s.

Description: It is impossible to provide a comprehensive description and discussion of this site as no major monograph has been published on this site of European importance. A large number of interim reports have been published, however, and the following is derived from them and from discussions in various works of synthesis. Space precludes too much detail being presented here.

The site is situated in the mountains to the south of the modern town of Orăştie and the fortresses at Costeşti and Blidariu, and lies east of the fortress of Piatra Roşie. The site is traditionally divided into three areas: the religious precinct, the defended area or fortress (*cetate*) and the civil zone. The site as a whole is situated on a long, rising, mountain ridge the summit of which is occupied by the *cetate*. Just below the *cetate* is the religious precinct with its astonishing collection of 'sanctuaries', both rectangular and circular. The civil precinct is arranged both around the *cetate* and the along the mountain ridge with terraces being recorded for over two kilometers from the *cetate*. The site is built on a series of terraces many of which have either been numbered, or given names (*e.g., terasa cu locuinţă rotundă*—the terrace with the round building). It is unfortunate that good quality detailed maps of the whole of this zone are not available making a detailed consideration of the spatial aspects of this site and the surrounding zone impossible.[1]

The religious precinct has attracted considerable attention for two centuries. The precinct is located on terraces X and XI and has provided evidence for 11 sanctuaries, 9 rectangular and 2 circular, although they are not all contemporary. Unfortunately, a great deal of the site has been disturbed by very early excavations and often relationships are difficult to ascertain. This is exacerbated by the forested nature of the site (now largely cleared) and the depth of the deposits. As an example of the complexity of the site, on terrace XI is situated the 'old limestone sanctuary' (*sanctuarul vechi de calcar*) which has four levels. The last dates to the Roman period after the Dacian wars; the second level is a sanctuary with andesite bases, below which was an earlier phase with a sanctuary with limestone bases, below which is evidence for an earlier sanctuary with limestone bases at a depth of 4.4m below the ground surface. The terrace on which this sanctuary is situated is sustained by walls of *murus dacicus* on three sides which are 2.5–2.9m thick. There is some evidence for a tower associated with the earliest phase, and on one side there is a double *murus dacicus* wall and a staircase of limestone blocks. Slightly above this structure, is another rectangular sanctuary with three rows of six bases—this is considered to have been built between phases two and three of the above discussed sanctuary.

On the same terrace lies the famous great circular sanctuary. This consists of an outer stone circle approximately 28m in diameter. This outer circle consists of two rows of andesite stones; the outer row consists of rectangular blocks 80–99cm×47–50cm×43–45cm, the inner row consists of a repeating pattern of six short, tall pillars interspersed with a single low flat pillar. Within this outer circle was an inner circle of 84 post-holes 35–40cm apart approximately 20m in diameter. This circle was interrupted on the NW, NE, SW and SE sides by flat paving slabs marking probable entrances. Within this circle was a further circuit of post-holes, although on this occasion they form an apsidal shape, with two further entrances

[1] For example, the maps in Daicoviciu *et al.* (1989) are split into many small parts and it is impossible to join them together to produce an overall plan. This situation was created by the fact the communist regime classified all detailed maps as state secrets, a situation which has not changed since the revolution.

on the SW and NE sides. The plan of this sanctuary is reflected in other structures thought to be *stîne* (sheep folds) from Meleia (site no. 55, page 520) and Rudele (site no. 64, page 524)—see main text for further discussion.

A few meters away from the great circular sanctury lies the small circular sanctuary which is 12.5m in diamter, and has an outer circle of short fat, and tall thin andesite pillars. These are mainly arranged in groups of 8+1, although there is also one group of 7+1 and one of 6+1. The interior had evidence for a hearth and further post-holes but was largely destroyed by a later Roman building.

To the west of the small circular sanctuary was the small rectangular sanctuary with columns and pilasters of andesite. This structure is 12×9.2m with the margins delimited by andesite posts, and the corners marked by larger posts. Within this is three rows of circular andesite bases, probably originally 18 in number of which 16 survive. There may have been an earlier phase with limestone bases. Next to this sanctuary is a similar one with an outer margin of andesite posts but a curious and poorly preserved interior plan.

Above terrace XI, upon which all the above sanctuaries were built, lies terrace X upon which two successive rectangular sanctuaries were built, the earlier with bases of limestone, and latter with andesite bases. In the case of the latter sanctuary (the great andesite sanctuary) the andesite discs are carefully worked and 2m in diameter. It has been suggested that these formed bases for andesite columns. It is also suggested that this structure was not completed prior to the arrival of the Romans. Terrace 11 was supported by double *murus dacicus* walls.

Returning to terrace XI, there is also the andesite ‘solar disc’ or altar. This consists of a central disc of andesite 1.46m in diameter, and then a series of ‘rays’ to form a larger disc 7m in diameter. This disc has limestone foundations, and a drainage channel runs under one edge of the disc. Finally, the precinct has a number of drainage channels and water pipes, and some poorly known rectangular structures to the north. The eastern edge of that part of terrace XI upon which the great circular sanctuary is built is supported by further *murus dacicus* walls including a poligonal tower. Finally, a paved road leads from the sacred zone to the fortified hill-top.

The hill-top, which comprises terraces I–V, is enclosed by a long and massive *murus dacicus* wall with several entrances. This appears to have been repaired at various times, sometimes seemingly in a hurry as some of the blocks have the grooves for the timber lacing on the external face, and some circular bases from the rectangular sanctuary have also been used. It is also suggested that the fortification was occupied for a time by the Romans as attested by the bath suite which lies down the slope on terrace VI, and by the names of military units carved on blocks in the wall. The various construction phases are often linked to historical events (the first Dacian war, the second Dacian war *etc.*). From an excavation near the southern stretch of wall was recovered coin dies (see main text). In addition to the main defensive circuit, a number of other ‘watch towers’ constructed mainly of timber, often on limestone block foundations, have been found in the area.

The so-called ‘civil zone’ of Sarmizegetusa Regia is visually less spectacular than the other remains at the site, but is of equal importance. The civil settlement is constructed on a series of terraces cut into the micaschist bedrock of the mountain ridge. The lower edge of these terraces is often supported by a crude wall or bank of rubble, and the platform itself constructed of layers of earth, clay and rock. The buildings constructed upon these terraces are of timber often using limestone blocks as foundations. These structures can have a single room (in only one example on the *teresa mică*), or multiple rooms (*e.g.,* building on the *teresa cu stînă,* or the *terasa de lingă turnul de veghe*), can be sub-rectangular, or poligonal. The poligonal structures often have special aspects—one was found with a medical kit and was 6m in diameter, and a second was associated with an extremely unusual and important vessel. This cone-shaped vessel had a base diameter of 9cm, a height of 70cm and a rim diameter of 125cm. Just below the rim were cartouches made by two stamps with the words "DECEBALVS PER SCORILO" (Crişan 1969a, pp. 189–190). Also found on these terraces were at least three large workshops, one for the reduction of iron ore and bronze, and two iron-working centres, as well as a number of smaller sites. No pottery or ceramic workshops have yet been discovered, although vast quantities of pottery including many Graeco-Roman imports have been recovered, along with all manner of other finds especially of iron. On the *terasa cu grîu* (terrace with grain) huge quantities of carbonised grain was recovered which is interpreted as evidence of a granary destroyed during the Roman invasion. A further structure identified as a granary was found on the *terasa cu depozitul de vase* (terrace with a deposit of vessels).

Unfortunately, it is extremely difficult to relate the various terraces to one another as no good large scale plan has been published, and many accounts such as that by Glodariu *et al.* (1988) rely on verbal descriptions of the various locations.

The catalogue of finds that follows cannot hope to be anywhere near complete and is provided more as a taste of the variety and quantity of material recovered from the site.

Finds:

Coins: Three tetradrachms of Thasos, 6 *drachmae* of Dyrrachium, four Roman Republican *denarii*, 1 bronze of Claudius and more than two coins of Trajan, one being a *denarius* without *Dacicus* (Mihăilescu-Bîrliba 1990, Table 6). Various other poorly recorded finds may have come from the site including early reports of large quantities of gold coins being found in the area. Imperial coin hoard dating to Marcus Aurelius found, contained 783 *denarii* (Winkler 1971).

Imports: From Glodariu (1976): a sherd of *terra sigillata*, two ceramic lamps, various fragments of other imported Roman vessels[2]; four imported bronze vessels, one with DIODORI stamped on the handle; fragments from four glass vessels; at least two iron tools (due to stamp of HERENNI on the handle)—there may be more imported tools but Dacian and Roman iron tools are very similar in form; two metal mirrors; medical kit (in casket: pincers of bronze, iron scalpel, five small vessels and a plate of volcanic tuff—the pincers have a parallel from Pompeii).

Special: Ceramics include: locally made amphorae, copies of imported vessel forms including painted vessels, painted vessels with geometric and zoomorphic designs (see especially Florea & Palkó 1991), the unique conical DECEBALVS PER SCORILO vessel, and a ceramic medallion copying a Roman coin, roofing tiles derived from Greek forms, ceramic water pipes; bronze work includes: copy[?] of Roman bronze jug; three coin dies; decorated and inscribed architectural fragments; highly ornamental iron nails *etc.*

Domestic: There are vast numbers of domestic finds from this site including many iron tools and implements including crampons, nails, tongs, anvils, sledge hammers, hammers, chisels, punches, plough shares and knives, knives, rakes, hoes, sickles, scythes, axes, *etc.* (see Glodariu & Iaroslavschi 1979); Crişan (1969a) collates ceramic evidence from the site up to the mid-1960s but this is presented in a typological fashion, not as a site catalogue—the vessels listed include dacian

[2]The quantity of imported pottery is relatively low compared to Poiana (site no. 112, page 541) or Popeşti (site no. 113, page 542) which may be partly due to the site's location.

cups, *fructiere*, jugs *etc.*; Florea (1989–1993, 1994) is publishing the pottery from C. Daicoviciu's excavations on terrace VIII which include bowls, cups, *fructiere etc.*—it is a great shame that no detailed quantified ceramic report exists from this site; Nandris (1981) provides a detailed archaeobotanical analysis of seed and bone evidence from the *terasa cu grîu*; other interim reports mention in passing other domestic artefacts as are found at contemporary Dacian sites.

References: Daicoviciu *et al.* (1950); Daicoviciu *et al.* (1951); Daicoviciu *et al.* (1955); Daicoviciu *et al.* (1957); Daicoviciu *et al.* (1959); Daicoviciu *et al.* (1962); Crişan (1965); Winkler (1971); Daicoviciu *et al.* (1973a); Daicoviciu *et al.* (1979); Daicoviciu (1980); Daicoviciu *et al.* (1980); Strîmbu & Glodariu (1981); Nandris (1981); Daicoviciu *et al.* (1986); Glodariu *et al.* (1988); Florea & Palkó (1991); Glodariu *et al.* (1992); Florea (1993); Florea (1994).

51. Haţeg

Type of site/find: Coin hoard.

Phases: Known coins close with Titus.

Description: At least 10 *denarii*—not uploaded to CHRR database.

References: Chiţescu (1981, No. 92).

52. Hunedoara

Type of site/find: Traces of a settlement; chance finds.

Phases: Many periods represented including classic 'Dacian' period (1st BC–1st AD).

Investigations: None?

Description: Variety of chance finds including a handle of a Graeco-Roman vessel, a silver bracelet (Mărghitan 1970), and a number of coin hoards including four with Roman Republican coins.

Finds:

Coins: Four coin hoards with Roman Republican coins, *drachmae* of Apollonia and Dyrrachium, and Roman Imperial coins (Chiţescu 1981, nos. 97–100).

Imports: Handle of Graeco-Roman vessel.

Special: Silver bracelet.

Domestic: Pottery.

References: Winkler (1958, pp. 403–4); Mărghitan (1970, p. 13); Rusu (1974–5).

53. Jeledinţi

Type of site/find: Coin hoard.

Phases: Surviving coins close with Septimus Severus.

Description: Of 58 *denarii*, 13 recovered—not uploaded to CHRR database.

References: Chiţescu (1981, No. 107).

54. Ludeşti

Type of site/find: Isolated find of a coin die.

Investigations: Metallographic investigation by Stoicovici.

Description: A die for striking a reverse of a coin of L. Marius C.f. Capito. The design is 'die-linked' to a coin in Paris. The die consists of an iron shank with a copper die-face. It must have been made by some form of hubbing.

References: Stoicovici & Winkler (1971, pp. 478–79).

55. Meleia

Type of site/find: Upland settlement.

Phases: Classic Dacian (1st c. BC–1st c. AD).

Investigations: Surface surveys from 19th century on. Excavations 1957–1959 by H. Daicoviciu and 1972 by H. Daicoviciu & I. Glodariu.

Description: On summit of hill (1419m.) eight mounds of which 7 have been studied. On slopes below summit a settlement with seven or eight terraces comprising three–four buildings and some annexes (stores?). The building excavated in 1957 had a plan which is extremely reminiscent of the great circular sanctuary at Gradiştea Muncelului (site no. 50, page 515). Site very similar to Rudele (site no. 64, page 524). Nearly all the buildings are oval and appear to consist of wooden structures resting on stone blocks—in one case on non-local limestone blocks. The settlement on the plateau appears to have had two phases and was abandoned. The lower settlement on the terraces was burnt.

The function of these settlements and buildings is disputed. Originally, thought to be a pastoral settlement with sheepfolds (*stîne*) but later scholars have suggested that they have a productive (?iron working) function. Sanie suggests a relgious function for at least one of the buildings. Certainly, the presence of iron slag and painted vessels seems unusual finds for a purely pastoral settlement.

Finds:

Special: Two painted vases with zoomorphic designs and two painted lids. See Daicoviciu (1972, plates V & VII) for colour photographs. Some buildings contained iron slag.

Domestic: Mainly pottery but also iron objects including iron spikes (nails), knives, iron rings, and an end of a spear *etc.*

References: Daicoviciu *et al.* (1959, pp. 346–349); Daicoviciu *et al.* (1961, pp. 308–315)§; Daicoviciu *et al.* (1962, pp. 467–473); Daicoviciu (1964, pp. 121–122); Nandris (1981, pp. 249–253); Vulpe (1986); Daicoviciu *et al.* (1989, pp. 214–6); Sanie (1995, pp. 21, 23, 27, 274).

56. Ohaba-Ponor

Type of site/find: Cave.

Phases: Some later finds including Dacian from a primarily Palaeolithic site.

Investigations: Excavations 1955.

Description: Some finds in the upper strata of the cave site interpreted as being used as a refuge.

Finds:

Special: Silver fibula.

Domestic: Some sherds of Dacian pottery.

References: Nicolăescu-Plopşor *et al.* (1957, Fig. 5 and p. 47).

57. Orăştie

Type of site/find: Single find.

Description: Silver spiral bracelet with serpent head terminals.

References: Popescu (1937–1940, p. 200); Mărghitan (1970, p. 13); Horedt (1973, No. 40).

58. Pădurea Bejan

Type of site/find: Coin hoard.

Phases: 1st century BC.

Description: Hoard of *drachmae* of Apollonia and Dyrrachium, and Roman Republican *denarii*.

References: Mărghitan (1970, p. 14); Chiţescu (1981, no. 140).

59. Petroşeni

Type of site/find: Various coin finds.

Phases: Dacian coinage.

Description: One coin of Banat type, one of Aninoasa-Dobreşti type, and a lost hoard of 200 "barbarous tetradrachms."

References: Stanca (1972); Preda (1973, pp. 57, 282, 393 & 435).

60. Piatra Roşie

Type of site/find: Hill-top 'fortress'.

Phases: 1st century BC–1st century AD.

Investigations: Large scale excavations in 1949.

Description: The 'fortress' is situated on a mountain-top at 823m. The site consists of a rectangular fortified enclosure on the hill-top. This enclosure is 90×40m. with 5 towers constructed of *murus dacicus*, and a entrance way with a staircase in the NE tower. To the east, running down the slope, is a larger less-well fortified rectangular enclosure with a rubble-construction wall (120×150m.). This latter wall connects to two further *murus dacicus* towers at its eastern corners; further isolated towers of this construction lie 80m to the east of the second enclosure, and *c*. 110m. to the north of the first enclosure. Within the main enclosure is a large apsidal building with two square central rooms. Just to the north of the main enclosure lies two further rectangular buildings and traces of a rectangular sanctuary represented by 6 circular stone bases in two lines, one of two bases and one of four. Recently, a coin hoard has been recovered from the footslopes of the hill.

Finds:

Coins: 1 imitation of a tetradrachm of Thasos, 1 bronze of Histria, 3 Roman Republican *denarii* and 1 imitation of a Roman Republican *denarii*. Mihăilescu-Bîrliba (1990, Table 6) also lists one silver coin of Histra. The Piatra Roşie (PIA) hoard was found near the foot of the hill on which the site lies. It closes in 43 BC and contained 277 *denarii*.

Imports: Alabaster plate, possibly imported; four fragments of glass vessels, probably imports; various bronze vessels and lamps including one possibily Campanian lamp, and one three-spouted 'candelabra' lamp with suspension chain; bronze decorative plaque; decorative bronze plaque for ?horse harness; fragments from two amber beads.

Special: Small bronze plate in the shape of an oak leaf; 96cm long iron fork with three prongs found in watch tower B along with a *c.* 75cm long iron chain with links of a figure-of-eight form; a long iron sword of "celtic type"; various decorative bronze plaques; small bronze phallus; bronze fibula; fragment of a silver fibula; iron, bronze and glass vessels; bronze bust of "a god" with lugs for attaching it to a ?wooden surface; decorated fragments of a bronze shield (would have been attached to surface of a wooden shield).

Domestic: Wide range of iron tools and weapons including woodworking tools, sickles, knife blades, a hoe, arrowheads, *etc.*; other iron objects include horse bits, crampons, iron spikes (nails), *etc.*; bronze objects include a hinge, pins and a spoon; ceramics include pottery burnishers, a wide range of vessels including vases, Dacian cups, dolia, plates, *fructiere*; stone objects include whetstones and rotary querns.

References: Daicoviciu (1954); Glodariu (1968, pp. 357–362); Pavel & Andriţoiu (1994).

61. Ponorici

Type of site/find: Defensive system of ditches, towers *etc.*

Phases: Late Iron Age.

Investigations: 1949 by C. Daicoviciu who cut a section; Ferenczi, surface visits 1972–5 and 1977; ?Tatu and Moraru, late 70s, early 80s.

Description: This site consists of a series of earthern banks which are poorly dated. A single coin of Domitian was found in the earlier part of this century, and most authors regard these works as Dacian, probably of the time of Decebalus. There is also a Roman marching camp at the site which uses one of the banks for one of its defenses. The main feature is a bank some 1.5km. long which cuts right across the valley at this point. This bank has, however, a large series of shorter banks at right angles to the main bank, and also a series of "bastions". To the south-west of this feature are three more complexes of banks — firstly, a simple oval enclosing the top of Dealul Feţei; secondly, a more complicated quadrilateral enclosure some 300m. to the north of the first enclosure, and finally a complicated enclosure and bank system about 300m. to the west on Dealul Măguliciului. There is then a further fortification at Dealul Bradului (also known as Dealul Troianului) 1.5 km to the north of Dealul Măguliciului (which is probably also called Dealul Robului).

References: Tatu & Moraru (1982–83); Moraru (1984–5); Moraru & Tatu (1984–5).

62. Pustiosu

Type of site/find: Circular 'dwelling' or sanctuary? Part of possibly larger settlement.

Phases: Little found which was extremely diagnostic but certainly dates to 'classic Dacian'.

Investigations: Main excavation 1955.

Description: This site is on the slopes of the hill Pustiosu (or Pustîiosu) and consists of many terraces (unplanned) with traces of a Dacian settlement. One terrace was excavated in 1955 and a poligonal building with concentric rooms was found. The site could not be fully excavated due to trees. The building is a maximum of 19m. in diameter and has an outer foundation of widely spaced rectangular blocks of andesite, each with a slot cut in its upper suface. Within this is a second circle of limestone blocks, within which is a ?square building with a central hearth. Thought by some (*e.g.,* Daicoviciu 1972, p. 162) to be a 'luxury' house, and others (*e.g.,* Sanie 1995) to be a circular sanctuary. In favour of the former interpretation is the lack of special artefacts, and the preponderance of more ordinary finds; in favour of the latter is the form which is similar to the circular sanctuaries at Sarmizegetusa Regia (site no. 50, page 515), and the presence of andesite in the foundations. This building replaced a smaller one on the same site.

Finds:

Imports: One sherd of Roman pottery.

Domestic: Main find pottery, both hand and wheel made vessels including the usual jars and bowls, and a Dacian cup with two cordons; iron objects included small knife blades, a chisel, a drill, a shaft-end of a spear, many spikes (large nails), nails, crampons *etc.*

References: Daicoviciu, Gostar & Crişan (1957, pp. 270–276); Sanie (1995, pp. 22, 27–9).

63. Răduleşti

Type of site/find: Coin hoard found in 1944.

Phases: Dacian.

Description: Hoard of 245 coins of the Răduleşti-Hunedoara type.

References: Preda (1973, p. 303).

64. Rudele

Type of site/find: Upland settlement.

Phases: Classic Dacian (1st c. BC–1st c. AD).

Investigations: Excavations in 1956–7.

Description: Surface finds led to excavation of this site which is on a mountain which reaches 1366m., in a clearing which is known as *Preluca Brînduşiţa*. The site consisted of five mounds of which four have been excavated. These structures thought originally to be *stîne*, or sheep-folds. They are wooden structures which use stone bases (*cf.* Meleia, site no. 55) and consist of two circles of bases one within the other, and a square, apsidal or oval building in the centre. In plan, they are extremely reminiscent of the great circular sanctuary at Sarmizegetusa Regia (site no. 50, page 515) and Sanie argues for a religious function. Others have argued that the site was associated with iron exploitation—tongs and hammers have been found in the area subsequent to the excavations.

Finds:

Domestic: Pottery vessels including some miniature vases; a few iron objects including rings, a pruning knife and a file as well as formless lumps of iron. Later find of hammer and tongs.

References: Daicoviciu & Crişan (1959, pp. 386–391); Daicoviciu *et al.* (1959, pp. 341–346); Daicoviciu (1964, p. 121); Glodariu & Iaroslavschi (1979, pp. 17–19, 48, 91, 112); Nandris (1981, pp. 249–253); Vulpe (1986); Daicoviciu *et al.* (1989, pp. 213–4); Sanie (1995, pp. 22, 23, 27, 274).

65. Sălaşu de Sus

Type of site/find: Coin hoard found 1935.

Description: Hoard of *c*. 100 Geto-Dacian coins of the Răduleşti-Hunedoara type. Only two examples survive in Cluj.

References: Floca (1945–7)§; Preda (1973, pp. 300–307).

66. Sălaşu de Sus

Type of site/find: Coin hoard found 1958.

Description: Hoard of 106 Roman Republican *denarii* and 5 imitations. See hoard SDS.

References: Floca (1960); Chiţescu (1981, No. 177); Pavel-Popa (1982–1983).

67. Sărăcsău

Type of site/find: Hoard of silver jewelry found 1950.

Phases: 1st centuries BC–AD.

Description: Hoard of silver jewelry found with a vase within which they were probably buried. Hoard included 4 large fibulae, 4 small fibulae, an arch of another fibula, three collars, four bracelets and six rings.

References: Floca (1956a, pp. 7–18); Mărghitan (1970, p. 12).

68. Sîrbi—Măgura

Type of site/find: Possible major settlement. Thought by Gostar (1958, p. 417) to be Singidava but Floca (1977) places that *dava* at Deva (site 48).

Phases: Coţofeni and late Iron Age (Dacian).

Investigations: Excavations by Floca (unpublished).

Description: Site was on a hill top on the right bank of the Mureş. Now destroyed by a stone quarry. On plateau, single level of settlement with hearths and pottery fragments.

Finds:

Special: Locals found fragment of bronze statue.

Domestic: Dacian pottery, including fragments of *fructiere*, Dacian cups, storage vases *etc.*

References: Gostar (1958, p. 417, especially footnote 1); Mărghitan (1970, pp. 15–16); Dumitraşcu & Mărghitan (1971, no. 20, p. 50); Floca (1977, p. 173).

69. Tisa, Burjuc

Type of site/find: Coin hoard.

Description: Hoard found in 1872 or 1873 containing tetradrachms of Thasos, drachms of Apollonia and Dyrrachium, 808 Roman Republican *denarii*, and 13 Imperial *denarii* up to Severus Alexander. It seems highly likely that the later issues are extraneous. This hoard has not been input to the CHRR database.

References: Winkler (1970)§; Chiţescu (1981, No. 201).

70. Turmaş

Type of site/find: Coin hoard.

Phases: Roman Republican period hoard.

Description: 103 Roman Republican *denarii*, ?now in Deva Museum, not published in detail.

References: Chiţescu (1981, No. 208).

71. Vaidei

Type of site/find: Single find.

Description: Silver spiral bracelet with serpent head terminals.

References: Popescu (1937–1940, p. 202); Mărghitan (1970, p. 12).

72. Vărmaga

Type of site/find: Coin hoard.

Phases: Mixed hoard.

Description: Tetradrachms of Thasos and Macedonia Prima, 1 Roman Republican *denarius*.

References: Chiţescu (1981, No. 211).

D.2.3 Sibiu

73. Agîrbiciu

Type of site/find: Mixed hoard.

Phases: 2nd–1st century BC.

Description: Mixed hoard of silver ornaments including fibulae, 5 *drachmae* of Dyrrachium and uncertain bronze.

References: Horedt (1973, Find no. 1); Glodariu (1976, p. 233).

74. Amnaş

Type of site/find: Coin hoard.

Phases: Closes 56 BC.

Description: 157 *denarii*, hoard AMN.

75. Apoldu de Sus

Type of site/find: Coin hoard.

Phases: Closes 42 BC.

Description: 500 coins, mainly Roman Republican *denarii*, hoard not yet uploaded.

References: Chiţescu (1981, no. 6).

76. Arpaşu de Sus, Cîrtişoara

Type of site/find: Defended promontory settlement.

Phases: 1st BC–1st AD.

Investigations: Excavations in 1954–5 and 1974.

Description: On a promontory between two streams in the foothills. Streams converge to north. Exposed southern approach defended by single ditch and bank. Defences of two phases in the second of which the bank was strengthened by earth filled timber wall. Internal buildings consists of surface or sunken floored timber dwellings. Large numbers of pits.

This site is important as it is one of the few that reports pottery by closed contexts.

Finds:

Imports: Possibly one pottery sherd.

Special: A badly corroded iron broach, silver arm ring, glass bead.

Domestic: Pottery, pottery burnishers; some iron tools, iron nails, a very small bronze plaque; evidence for spinning and weaving (spindle whorls and weights); a little ?iron slag; faunal evidence included cow, pig and ovicaprid bones.

References: Macrea & Berciu (1955, pp. 615–626); Glodariu (1974–5a); Macrea (1957, pp. 145–154); Macrea & Glodariu (1976); Glodariu (1981b); Preda (1994a).

77. Axente Sever (Frauendorf)

Type of site/find: Coin hoard (FND).

Phases: Closes 56 BC

Investigations: Found 1875.

Description: Hoard of 563 *denarii*.

References: Bahrfeldt (1877); Chirilă, Gudea & Moldovan (1972, pp. 9–11); Chiţescu (1981, no. 10).

78. Bratei

Type of site/find: Rural settlement? Later cemeteries and settlement.

Phases: 3rd–2nd centuries BC, 4th–8th centuries AD.

Investigations: Major excavations 1959–1972.

Description: Of Dacian period, 18 pits, and finds from a possible 19th pit, found in area of later (5th–7th century) settlement. The later cemeteries and settlement important as often claimed as first evidence for continuity of settlement after the Aurelianic withdrawal from Dacia.

Finds:

Special: Bronze ‘celtic’ fibula.

Domestic: Pottery, mainly hand-made and primarily jars; a spindle whorl.

References: Dacian period references: Nestor & Zaharia (1973, p. 199); Bârzu (1976).

79. Copşa Mică

Type of site/find: Hill-top settlement.

Phases: Excavators argue for continuous settlement from 3rd century BC–early 4th century AD.

Investigations: Chance finds led to excavation in 1974.

Description: The site occupies the artificially flattened hill-top and a terrace on a hill known as 'Cetate.' Various chance finds in area including a 3rd century AD cremation with a coin of Gordian III. Defoliation of the hill led to severe erosion by sub-surface water and thus to excavation. Eleven sections excavated; two on plateau, two on ditch and seven on the terrace. The trenches revealed pits, sunken-floored biuldings (*bordei*) and finds. No real differences between Roman period buildings and earlier Dacian, dated by finds only. Main period of occupation during Roman period. Difficult working conditions prevented complete buildings being uncovered. Hearths are simple, round or oval, and built direct on the ground. Impossible to say "if settlement was military or civil." Excavators also see mixed Roman and Dacian pottery assemblage indicating native and Roman people at this site.

Finds:

Coins: Earlier burial contained a Republican *denarius* and a coin of Gordian III; excavations uncovered an antoninianus of Philip (AD 247–249).

Special: Iron spearheads, a blue glass bead and a perforated boar's tooth.

Domestic: Wide variety of pottery, both hand and wheel made. Forms including *vase borcan*, *fructiere*, plates, lamps and jugs; four fragments of querns and two fragments of whetstones; cow, sheep, goat and pig bones; iron knife blades, 2 chisels, nails, unidentified iron bars.

References: Winkler & Blăjan (1979).

80. Curciu "La Fîntini", Dîrlos

Type of site/find: Rural settlement

Phases: Main phases 3rd c. BC–4th c. AD.

Investigations: Survey and small scale excavation 1969–1970.

Description: Site on a low rounded hill in valley near two springs. Various chance discoveries from site by agricultural workers. Excavation of a 1.8×0.9m had 1m of stratigraphy. Possible kiln or hearth found.

Finds:

Domestic: Many types of hand and wheel made pottery including cups, a *fructieră*, various 'vases', strainer sherd and one small sherd considered by authors to be 'celtic.'

References: Radu (1971).

81. Guşteriţa–Sibiu

Type of site/find: Two deposits of vessels.

Phases: 1st century AD.

Description: First deposit found in 1840 consisted of three vessels and a bronze handle. The vessels were: a bronze 'tureen' with leaf-decoration applique handle-mounts, Roman import dated by Horedt to 1st century AD; bronze cauldron with iron handles, again probably of Roman origin and the same date; iron vessel with tripod base, probably of same date. Second deposit consisted of five ceramic vessels in a pit (found in 1950s?), of similar date to metal vessels. Horedt suggests local rite involving burial of vessels as neither deposit had evidence for cremated bone.

References: Rusu (1955)§; Horedt (1965).

82. Ighişu Vechi

Type of site/find: Coin hoard.

Phases: Roman hoard.

Description: 40 *denarii*, entirely lost.

References: Chiţescu (1981, No. 101).

83. Mediaş — Baia de Nisip

Type of site/find: Rural settlement.

Phases: Wietenberg (Bronze Age), Halstatt, "Celtic" and Dacian.

Investigations: Excavations 1953 and 1955, surface survey 1968–71.

Description: A large mound of sand 120×70m and 3m high. Contained various archaeological finds. 1953 excavation revealed a sunken-floored building with a hearth and fragments of pottery, and an inhumation. Excavations of 1955 revealed a layer 30cm thick including Iron Age (3rd–2nd century BC) finds and two semi-sunken floored buildings. In area a Dacian coin copying Philip II was found. Survey found large quantities of pottery, a Dacian dwelling, a bronze bracelet and a bronze fibula.

Finds:

Coins: One copy of Philip II.

Special: Bronze bracelet of common type, 2nd century BC–4th century AD; bronze fibula with broken pin, 2nd–1st centuries BC.

Domestic: Large quantities of pottery. Material from excavations by Crişan *not* similar to that from Munţii Orăştie. Crişan thinks it earlier, and "celtic". Pottery from surface survey included lamps, *fructiere*, various jars and jugs. Dated to 2nd century BC–1st century AD.

References: Crişan (1955–1956, pp. 27–45); Blăjan & Togan (1978, pp. 42–44).

84. Mediaş — various

Type of site/find: Isolated finds around town.

Phases: Most.

Description: Various chance finds at various places: (a) *Podei*, two "celtic" burials, one found 1860, the other 1938, two "celtic" vessels found 1958, vessels date to La Tène B_2 or C; (b) 'Glass Factory" chance find of pot; (c) *Dealul Cucului*, quern of volcanic tuff; (d) *Teba*, semi-sunken floored building observed with fragments of daub, an oven and pottery inc. 11 Halstatt sherds, 54 Dacian sherds and $>$12 celtic sherds; (e) in "incinta Autobazei" two complete vessels and other fragments; (f) *Rora mică*, 1968–71, hand-made Halstatt and La Tène pottery; (g) *Gura Cîmpului*, 1969–70, found during foundation works, an iron scythe, hand-made pottery and wheel made *fructieră*; (h) *Hientz*, 1969–70, pottery of various periods including Dacian *vase borcan*; (i) *pădurii "Dumbrava"*, 1975, Dacian sunken-floored building with 16 pottery sherds, many of a single thick walled vessel.

References: Crişan & Szuchy (1955–1956, pp. 13–16); Blăjan & Togan (1978, pp. 39–46).

85. Mediaş — hoard

Type of site/find: Hoard of silver jewelry.

Phases: Classic Dacian?

Investigations: Found 1829.

Description: Hoard was found in a pottery vessel. Part of hoard was sent to Vienna, rest to Mediaş school. Orignally contained 53 silver objects including at least 2 fibulae, a collar (torque) and a chain with three pendants.

References: Popescu (1937–1940, p. 200); Horedt (1973, No. 33); Mărghitan (1976).

86. Roşia

Type of site/find: Low lying settlement.

Phases: Early Halstatt, Dacian, Roman and medieval.

Investigations: Chance finds and a single 15×1m. trench excavated by Lupu in 1958.

Description: Settlement probably occupies an area of 100×160m. It was discovered by accident due to plough damage. Trench revealed 80cm of cultural layers which included many fragments of pottery. Lupu argues for continuity between Dacian and Roman phases.

Finds:

Domestic: Pottery including *fructiere*, a *vas borcan* and a possible *ceaşca dacică*. Also found, an iron sickle of "common La Tène type," iron chisel and a bronze plaque.

References: Lupu (1968).

87. Şeica Mică, Mediaş

Type of site/find: Multi-period fortified settlement; hoard of silver jewelry and coins; at point *La troci* on Copşa Mică–Blaj road; finds from a ?burial.

Phases: Bronze Age to 6th century AD.

Investigations: Ten trenches excavated by Horedt in 1962. Hoard *not* found at settlement.

Description: Settlement lies half way between Şeica Mică and Copşa Mică on a promontory known as 'cetate'. Plateau on promontory 25m.×650m. Promontory has six lines of defenses but these appear to be Halstatt and/or feudal. Dacian evidence only found in trench 5 and it appears that settlement was confined to northern part of the plateau.

Hoard of silver jewelry found elsewhere (see map in Floca 1956a).

Burial was found during surfacing of the road and a jug, a massive bronze bracelet, and a iron necklace or collar recovered. Thought by Crişan to be celtic dating to end 4th century BC.

Finds:

Coins: Major hoard of 348 *denarii* (SEI).

Special: Hoard contained the following items of silver jewelry: three torques, five bracelets, a chain and a silver fibula; burial contained an iron necklace or collar, and a bronze bracelet.

Domestic: Dacian pottery from excavation; jug from burial.

References: Floca (1956a); Horedt (1964); Crişan (1973, pp. 52–54, 63–4).

88. Slimnic

Type of site/find: Rural settlement.

Phases: Dacian and Roman.

Investigations: First recorded finds published by Gooss in 1870. Some excavation by M. v. Kimakowicz in 1900s, main excavation by Glodariu 1970–3.

Description: The site lies 16km north of Sibiu just to the south of the present village. There are two sites, one Dacian and Daco-Roman at *Şarba-Stempen*, and the second Daco-Roman only at *Şarba-La Saivane*. The sites lie in a region of gently rolling hills with good agricultural land. Glodariu exacavated 11 trenches on the western, better preserved edge of Şarba-Stempen, and this site only will be discussed from here on. These trenches constitute a very small fraction of the site, surface finds from which spread over a wide area 2km long and up to some "hundreds of meters wide." These trenches revealed a series of sunken-floored and semisunken-floored buildings (*bordei şi semibordei*), an occasional surface-built building, and pits. There were seven definitely Dacian period buildings and 22 pits. One of the *bordei* had a floor of river boulders, three of the *semibordei* did not have a hearth. There was also a kiln made of stone slabs with a vault of unfashioned stone. This kiln is unique in Dacia being of a form more common in the prefeudal period, although there are a couple of stone-built kilns from Cernat and Boarta. All the *bordei* contained archaeological finds although *bordei* 11 was extremely rich. The 22 pits are of two forms: bucket-shaped and funnel-shaped. The latter are storage pits as found at Arpasu de Sus (site no. 76, page 526) and Şura Mică (site no. 89, page 532), the former could be clay-pits. The date of the structures appears to go from 2nd century BC (bldg. 12—because it only contains hand-made pottery and because of a brooch) to the Roman Invasion (bldg. 11—contains pottery for which the only parallel is in buildings in the Munţii Orăştie, thought to be destroyed by the Romans), into the Roman period.

Finds:

Special: Fragment of a copy of a delian bowl and an iron fibula from bldg. 12; a iron stand which is only paralled by the die-stands from Tilişca (site no. 91, page 533) from bldg. 11. Earlier find of silver hoard containing two spiral bracelets, another bracelet and a torque.

Domestic: A wide range of ceramic forms both hand and wheel made including vases, handled jugs, dacian cups, fruit-bowls (*fructiere*), stoarge vases *etc.* Some forms are extremely rare or unique. This assemblage is important as it has a moderate number of closed assemblages.

References: Popescu (1937–1940, p. 201); Glodariu (1972, 1981a, 1981b).

89. Şura Mică

Type of site/find: Rural settlement.

Phases: Neolithic, Bronze Age, La Tène, Roman and post-Roman.

Investigations: Excavations 1976–8.

Description: The site lies 10km west of Sibiu on the edge of the Sibiu basin. Excavations at *Rîşloave* ('Reichsgraben') which lies to the NW of the town in the Valea Rîşloavelor at the confluence of the pîrîiele Rîşoavelor and Rocoteciului. This site is surrounded by hills on three sides. The Dacian and Daco-Roman settlement appears to have its origins on the west branch of the Rocoteciului and then spread south towards the confluence of the two streams. The buildings found were both sunken-floored buildings (*bordei*) and surface-built. They are 3–3.7×3.7–4m and 0.30–0.45cm deep. They had beaten earth floors and wattle and daub walls, and presumably thatched roofs. Only hut 16 had a hearth which was of burnt white clay on the short side of the hut. Near this semisunken-floored building was another hearth in a surface-building. In section II was also found a pottery kiln of a type not previous found in Dacia. It had a lower combustion chamber and two upper stories for vessels, and a domed roof. The kiln dates to 2nd–1st centuries BC due to pot and the pit it partly overlies. As well as the buildings, there were many pits, either of a 'cauldron' shape, or funnel-shaped. These were storage pits later reused as rubbish pits, *cf.* Arpasu de Sus (site no. 76, page 526). The Roman period had very similar structures but no rubbish pits. Argued to illustrate continuity of settlement. Some evidence of exploitation of iron ore in Roman period.

Finds:

Coins: One Roman Republican *denarius* dating to 68 BC; from Roman period a bronze coin of Hadrian dating to AD 123–8.

Special: Some iron fibulae (earliest dating to 200 BC); iron tools rare; fragment of a glass bracelet and glass 'gems.'

Domestic: Usual range of Dacian pottery which continues into Roman period when Roman forms are introduced.

References: Paul *et al.* (1981).

90. Ţara Făgăraşului

Type of site/find: Various finds from sites in area.

Phases: 3rd century BC to 1st century AD.

Investigations: Field survey 1978.

Description: Settlement at Beclean "La Canton" (3rd–2nd centuries BC, no details given); settlement at Voila (1st BC–1st AD, few details), complete vessels and a brooch from the settlement at Cuciulata "Stogul lui Cotofan" (2nd–1st centuries BC); unprovenenced jug (classic period).

Finds:

Special: Bronze bracelet from Cuciulata.

Domestic: From Voila: pottery and a rotary quern; from Cuciulata: *ceaşcă dacică* and a bowl; unprovenced: a jug.

References: Costea & Ciupea (1979–1980).

91. Tilişca

Type of site/find: Large hill-top defended settlement.

Phases: Halstatt and late Iron Age (2nd BC–AD 106?).

Investigations: Major excavations by Lupu from 1959–1965.

Description: The site lies on an elongated hill at the nothern edge of the southern Carpathians overlooking the plain of the Sibiu depression. The hill (712m) has steep slopes to the south, but more gentle slopes to the north and west. There are two lines of fortifications: an exterior earthern bank on the west, and the north-western half of the northern slope some 800m long, and a second bank some 400m long which surrounds part of the upper plateau. The first bank has an interior ditch from which the soil from the bank was quarried, and in places a layer of stones to act as a foundation. The upper bank has stone reinforcement on both the interior and exterior slopes.

There in an entrance mid-way along the upper bank at which point there is a "dwelling tower" of *murus dacicus*. The lower portion of the tower is sat directly onto the bedrock. The upper portion of the tower is of adobe brick. The construction technique of this wall is unusual in that some blocks are transversal and project into the emplection of the wall. This method is more similar to the Greek construction technique from which *murus dacicus* was derived, than the other sites with walls of this type. Traces were found of a second dwelling tower to the east of the first. In the modern village, many buildings have reused the blocks from *murus dacicus* walls.

The plateau and terraces of this site were densely occupied with a large number of buildings which used blocks or post-holes as foundations. Evidence for forty-one buildings recovered, some of which were identified as workshops. There were 11 pits recovered, the stone subsurface precluding the easy excavation of pits for storage or rubbish disposal. There was also a water cistern on the western slope.

On the far western foot-slopes of the hill two cremations were found. These consisted of two burial platforms on which the cremation appears to have taken place. The remains of which were then placed into two pits along with a selction of grave goods. The first grave contained a selection of silver objects which had been cut into pieces with a chisel. The second grave had a poorer assemblage with some silver objects, iron objects and pottery all of which had again been deliberately destroyed. Grave 1 was dated to the 1st century BC, and Grave 2 dated to the 2nd century BC.

Finds:

Coins: Three Roman Republican *denarii*, two imitations of *denarii* and one badly damaged coin which might be a *drachm* of Apollonia or Dyrrachium.

Imports: A bronze situla, a situla handle, another handle, a fragmentary bronze bucket, a bronze fibula (from Picenum), sherd of a glass vase, two ceramic vessels, a lamp, a mirror and imported foodstuffs.

Special: An earthernware vessel with 14 coin dies and three mounts (see page 403); Grave 1: silver chain necklace with pendants, silver fibulae, fragments of silver bracelets, silver rings, and some unidentified silver objects; Grave 2: iron objects including a ring (?bracelet), bronze rings, a silver bar and glass beads; other finds include iron, bronze and silver fibulae, a silver bracelet, iron and bronze bracelets and beads.

Domestic: Wide variety of ceramic forms both hand and wheel made including fruit-bowls (*fructiere*), jugs, bowls, lids, *vase borcan*, Dacian cups, strainers and storage vessels; other ceramics include loom weights and spindle whorls; stone objects included querns and whetstones; various iron tools including knives, scythes, mattocks, shears, chisels, hammers, anvils, a punch, chains and so on; a few bronze tools including a chisel; various pieces of horse-harness; weapons included spear-heads, part of a sword, two *umbo*s and an arrowhead.

References: Lupu (1962a, 1962b, 1967, 1981, 1989).

92. Ungurei

Type of site/find: Coin hoard.

Phases: Roman period hoard.

Description: Entirely lost.

References: Chiţescu (1981, No. 209).

D.2.4 Other minor findspots in Munţii Orăştiei

In the area immediately around Sarmizegetusa Regia, Costeşti and the other fortresses, there are a huge number of find spots and sites known. This is partly a reflection of the extraordinary concentration of sites in this area, but also a reflection of the immense concentration of archaeological work there. To balance the picture somewhat, these findspots have not been listed in the main survey above, and a selection are listed below. The decision to include a site in the main survey, here, or not at all, is entirely subjective. All references given here are to the survey of Daicoviciu *et al.* (1989) where further references, usually to the earlier surveys of Daicoviciu & Ferenczi (1951) and Daicoviciu (1964) can be found.

93. Cetăţuia Înaltă
Possibly a small fortress, or two towers, on a hill-top near Costeşti. Some evidence for iron-working (p. 181).

94. Ciocuţa
Eight metre square tower of *murus dacicus* to the SW of Costeşti (p. 180).

95. Cucuiş—Golu
This site consists of a plateau 94×25m and a terace which is 60×20m. The former is cut off from the rest of the hill by a 90m long ditch and bank which is 7–8m high (from base of ditch to summit of bank). Within this many sherds of Dacian pottery recovered from surface (p. 209).

96. Faţa Cetei
This site lies lies to the north-east of Vîrful lui Hulpe (site 104) and consists of 40–50 man-made terraces, some as long as 100–200m. From the surface of these terraces burnt daub, pottery, an iron tripod and a quern stone found. This is a civil settlement with, perhaps, a rôle in the exploitation of iron (p. 208).

97. Gura Tîmpului
During construction of forest railway, evidence for iron working including two 40kg iron blooms (p. 191).

98. Muchea Chişetoarei
Four *murus dacicus* towers on a terrace (p. 185).

99. Pietroasa lui Solomon
Large cultivated field from which many architectural fragments, a hemispherical tin ingot, a silver statue of a lion and other artefacts were recovered. Possible site for a rectangular sanctuary? (p. 197).

100. Pîrîul Chişetoarei
Dacian water cistern with complete vessels inside (p. 186).

101. Platoul Faeragului
Plateau at 558m above datum on which was built a line of three towers of *murus dacicus* which are 11.5×11.5m square. Water supplied to towers via a ceramic pipe. Nearby, a further 6 terraces (p. 184).

102. Sub Cununi
SE slope of Vîrtoape (see below no 105) on which has been found Dacian and Roman evidence some of which suggests iron smelting here in both periods. Also found, an Imperial hoard of 500 *denarii* dating to Trajan, walls, bricks, tiles, and two inscriptions (of Roman date). This site could be *Ranisstorum* (pp. 206–7).

103. Valea lui Brad
On hill near confluence of Văii lui Brad and Apa Godeanului, a structure with two rooms with stone foundations and walls of wood. Probably a watch tower although it could be a granary (pp. 190–1).

104. Vîrful lui Hulpe
This hill, rising to 902m, presents much evidence for a large defended site with *murus dacicus* walls, a tower on the west slope, *etc.*, and may represent an as yet unexplored fortress of similar importance to others discussed above (p. 208). See also site 96.

105. Vîrtoape

Stone 'massive' to the right of the Apei Grădiştii on which numerous Dacian finds made and on the peak of which exist mounds which may indicate ancient constructions, *cf.* Meleia *etc.* (p. 206).

D.3 Other sites of interest outside the three counties

This sectiona lists sites which are of interest outside of the three counties.

106. Barboşi, jud. Galaţi

Type of site/find: Promontory settlement and later Roman fort.

Phases: Bronze Age (Monteoru culture), late Halstatt (6th–5h c. BC), Dacian (2nd century BC–start 2nd century AD); Roman and medieval.

Investigations: Various from 19th century onwards.

Description: The site is situated at the end of a promontory of the hill *Tirighina* and rises 44m above the watermeadows of the Siret and dominates the area. The promontory has steep slopes on all sides except the north where it is cut off from the rest of the hill by a wide and deep ditch.

The multiperiod site has 3m of stratigraphy dating to the Dacian period, which is divided into three main periods. The site was defended by a bank and palisade. The earliest level has not produced any evidence that need be earlier than the end of the second century BC. The second level closes with *sestertius* of Domitian, and the last, very thin level, closes with the Roman invasion. All the buildings discovered so far, with a single exception, have been surface-built structures; some appear to have used 'greek' tiles for roofing but most probably used reeds. The hearths were generally oval. As is usual, a large number of pits were also discovered.

In 1963, on the south edge of Area I, the excavators found evidence for a structure which they interpret as a rectangular sanctuary. This consists of a burnt clay floor on which were 'stains' (*pete*) for six bases of timber forming two alinments of three bases [the alinments do not appear very convincing— see Sanie 1988, Fig. G].

The Dacian levels as a whole have been badly damaged by the later Roman fort as well as medieval and modern structures.

Finds:

Coins: Coin hoards in local area: (a) poorly known hoard, possibly of 3,700 Imperial coins; (b) hoard of 517 *denarii* closing with Augustus (usually known by the original name of Gherghina, hoard GHE, RRCH 531, Chiţescu 1981, no. 84). Site finds (Dacian levels): 1 bronze of Histria, 3 bronzes of Tomis, 1 Thracian bronze, 7 Roman Imperial bronzes, 2 Roman Imperial *denarii*, 1 barbarous bronze (Sanie & Sanie 1991).

Imports: Handle of a bronze vessel stamped P.CIPPI POLYBI indicating a south Italian origin; amphorae, both anepigraphic and inscribed; fragments from 3 glazed [*sic.*] vessels, probably *skyphoi*; terra sigillata (samian) vessels and fragments; other imported vessels, mainly Greek; ceramic lamps; glass vessels and beads.

Special: Iron and bronze shield fragments; bronze, iron and silver fibulae—the silver fibula is of the Nauheim type; a plain bronze ring and a larger bronze ring with nodes; a coin die for an unidentifiable coin type.

Domestic: Other metal artefacts included arrow heads, spear heads, and various tools; wide range of pottery including both hand and wheel made forms such as *fructiere*, Dacian cups. jugs, bowls, copies of Greek vessels. *etc.*

References: Ştefan & Gostar (1962); Sanie (1987, 1988); Sanie and Sanie (1991, 1992); Sanie (1994, 1995).

107. Bîtca Doamnei, jud. Piatra Neamţ

Type of site/find: Hill-top fortress (*cetate*).

Phases: Some Neolthic and Bronze Age finds, classic period Dacian 'fortress', medieval castle.

Investigations: Excavations 1928, 1957, 1962–1985.

Description: Site occupies a elliptical plateau on the hill-top 170×110m.

Finds:

Coins: 1 *drachm* of Dyrrachium and 1 *denarius* dating to 91 BC.

Imports: An imported bronze vase.

Special: Fibulae of bronze and silver, rings of bronze, and a gold ring with snake-head terminals.

Domestic: Wheel and hand made pottery.

References: Not yet published in detail; Preda (1994c).

108. Brad, jud. Bacău

Type of site/find: Major defended settlement ('dava').

Phases: Many phases represented from the neolithic to the feudal period but of the 3m thick stratigraphy 2m dates to the second Iron Age (La Tène).

Investigations: 1963, 1965–1986.

Description: The site is situated on a promontory in the Siret valley, 35m above the valley floor, and dominates the valley at this point. The site is divided into two by a large ditch which is originally of Bronze Age date, but was widened by the Dacians. It is now a maximum of 56m wide. The defended area of the site (the 'acropolis') covers 7,000m^2, the undefended part is approximately 25,000m^2. Some 500m to the east was a cemetary but this had now been destroyed by agricultural work. A second ditch was also constructed in the Bronze Age some 500m from the first.

The stratigraphy from the acropolis can be summarised thus: the lowest level is Bronze Age and is associated with the first defenses; next follows a thin layer from the first Iron Age; there then follows four main Dacian phases: 1. 4th–3rd centuries BC, few finds, some hearths *etc.*; 2. 3rd–2nd centuries BC, more finds especially bone and pottery, one surface building and four oval/round sunken featured buildings (*bordei*); 3. 2nd century BC, many more dwellings, hearths, carbonised beams, pottery, bone and other finds; 4. 1.1m thick deposit dating from 1st century BC–1st century AD with extremely rich finds and structural evidence.

The open settlement has fewer phases, the lowest of which was Bronze Age which contained many dwellings, finds *etc.* and was delimited by the edge of the terrace and the two ditches of this period. The next level is Dacian dating to 2nd–1st centuries BC and stretches 30–35m from the ditch. The third level (equivalent to the third Dacian level in the acropolis) spreads to 100m from the ditch, and a further ditch and palisade was built. The last phase (equivalent to the first phase of the third Dacian level in the acropolis) spreads up to 400m from the ditch. The open settlement is missing the lower and upper Dacian phases, the probably because of later agricultural work.

The Dacian levels revealed evidence for some 400 surface or sunken-floored dwellings, and 430 pits. There were over 200 hearths in the acropolis, and 18 kilns for bread or heating — no pottery kilns were identified. There was evidence for a large apsidal building in phase two covering an area of 430m^2 which was interpreted by the excavator as a palace. Next to the 'palace' was a pavement of river boulders. Next to this was a 'circular sanctuary'. This consisted of a platform of beaten burnt daub (derived from the previous building) which was surrounded by a circle of 46 post-holes some 16m in diameter. This substantial circular structure is exceptional and interpreted as a sanctuary. This interpretation is reinforced by the building which preceeded this phase. The first phase of this building was a rectangular post-hole and timber-slot construction from which some carbonised beams were preserved. This building was then partially rebuilt with an apsidal end.[3] This area of the site was never occupied by the more usual buildings found at the site.

At some 500m east of the settlement was a group of tumuli which have now been completely destroyed. Three were excavated the first of which contained three cremations, the second was a cenotaph and the last 2 inhumations. On the edge of the open settlement was found a cremation in a simple pit with a jug, a *kantharos*, a pedestal cup, a glass, a whet stone, a plate (*platou*) and some calcinated bone. In the open settlement were a further 16 inhumations in cylindrical or bell-shaped pits. In some pits where the remains of 2, 3 or even 4 skeletons.

Finds:

Coins: 1 Macedonian coin, 4 Geto-Dacian coins, 11 Roman Republican and 2 Augustan *denarii*; a bronze coin of Nero–Vitellius.

Imports: Fragments of bronze vessels including a "cassarole" (*caserolă*) which may be a Roman import; fragments of a shield only paralleled in Hungary; Greek and Roman amphorae; various imported jugs, bowls, *kantharoi*, *etc.*

Special: Stone and ceramic metal working moulds; fragments of a cart or chariot (found in the area of the apsidal 'palace'); ceramic figurines, 8 anthropomorphic, 1 zoomorphic; minature versions of common vessel types; painted pottery, although this seems to be Hellenic inspired and much dates to an earlier date than the Transylvanian material; over 100 broaches and 34 bracelets and well as rings, beads, mirrors, pendants, applique items *etc.*

Domestic: Iron objects included agricultural tools such as plough shares and knives, sickles, scythes *etc.*, wood working tools such as chisels and drills, metal working tools such as hammers and anvils, construction materials including rings, hinges, keys, nails *etc.*, other tools mainly knives; stone artefacts mainly consist of querns but also include moulds, whetstones, spindle whorls, burnishers and hammer stones; bone artefacts (not well preserved due to soil conditions) included pins, hair pins, rings, knives, spindle whorls, spatulae, points

[3] Ursachi (1980–1982) provides three plans of the three phases (Figs. 1–3) but the captions of Figs. 2 and 3 have been transposed.

(*străpungătoare*), skates *etc.*; ceramic artefacts included spindle whorls, weights (for fishing or perhaps burnishers), pyramidal weights [for looms? or thatch?], bungs, counters (*rondelele*), sling shot (*ghiulelele de praştie*) and fire dogs (*căţeii de vatră*); weapons included arrowheads, spears and lance points, and iron sword pummels; pottery included an enormous range of forms and types with 28 hand made and 32 wheel made forms indentified (these were being studied further), these included the usual range of Dacian cups, fruit-bowls (*fructiere*), vases, bowls *etc.*

References: Ursachi (1969, 1980–1982, 1987, 1992); Ursachi & Mihăilescu-Bîrliba (1992); Vulpe & Glodariu (1994); Sanie (1995).

109. Cîrlomăneşti, jud. Buzău

Type of site/find: Large settlement ('dava') on plateau near confluence of two rivers.

Phases: Bronze Age and La Tène (pre-classic and classic Dacian).

Investigations: Site known since 1871. Systematic excavations 1967, 1972–1981.

Description: This site is situated on an oval plateau with natural defenses formed by ravines. No artificial defences have been found. The lower levels represent a Bronze Age settlement of the Monteoru culture. There is some evidence of a small short-lived pre-classic Dacian settlement (3rd century BC). The upper levels form the Dacian settlement (dava) of the 2nd–1st centuries BC. The earliest dwellings of this phase appear to be built on the surface from wood and clay but their exact form is difficult to ascertain due to later disturbance. The latest phase prior to abandonment of the site has some large timber buildings including a square construction with an altar-hearth (*vatră-altar*) and another with a rectangular 'nave' and an apsidal end thought by Sanie (1995, pp. 24–26) to be a temple. The site also has numerous pits. The site has also produced a unique collection of ceramic statuettes mounted on conical supports and including wolves, wild boar, deer and birds. It seems likely that these were made on the site (see Babeş 1977). Faunal investigations revealed a mixture of cattle (19% of total MNI), sheep/goat (34%) and pig (22%); the assemblage also included bear (*Ursus arctos*; Udrescu 1977). Plant remains contained evidence for wheat, barley and rye (Cârciumaru 1977).

Finds:

Coins: 132 Dacian coins of the Vîrteju-Bucureşti type, one coin each of Thasos, Dyrrachium, copy of Philip III Arridhaeus and Inteşti-Răcoasa. Some peculiarities in the Vîrteju-Bucureşti type coins has led to the suggestion that they were minted at the site.

Imports: Early Dacian phase: leg of an Attic *kantharos*. Classic Dacian phase: amphorae from Rhodes and Kos, *kantharoi*.

Special: Early Dacian phase: La Tène C_1 fibula. Classic Dacian phase: Bronze mirrors, fragments of bronze vessels, silver, bronze and iron fibulae, gold pendant, bronze bracelets, some weapons and armour and a unique series of ceramic statuettes.

Domestic: Large assemblage of iron tools (knives, sickles, *etc.*), stone querns, bone handles, clay weights and spindle whorls. Large pottery assemblage including hand and wheel made vessels with decoration in relief or painted.

References: Babeş (1975); Cârciumaru (1977); Babeş (1977); Udrescu (1977); Babeş & Constantinescu (1981); Babeş (1994).

110. Dolinean, Ukraine

Type of site/find: Circular sanctuary.

Phases: Dacian (late La Tène).

Investigations: 1972–3.

Description: Excavations in 1972–3 by Leningrad on a mound, thought originally to be a Scythian tumulus, revealed an unusual circular structure. This consisted a ring of yellow clay approximately 16m. in exterior diameter, 2–2.8m. wide, and 10–15cm. deep. There were two ‘entrances’ in the east and the west, and the surface of the ring had some small stones impressed into the surface. Immediately outside the clay ring was a circle of 36 post-holes, 35 of which were 50–70cm. in diameter at the surface, 15–20cm. at the base and 1m. deep. They contained evidence for burnt posts, and some had well-preserved stone packing. The four largest post-holes, including the largest which was 1$\times$1.15m. at the surface, were found either side of the entrances. The excavators thought the posts formed an exterior colonade with entrances. Outside the post-holes was a ring of stone slabs laid in rows. although this was badly preserved except along the southern edge. The whole of the structure was covered in a layer of burnt wood which included planks and poles. In the centre of the structure was a square pit, 2.8$\times$7.5m., dug into the natural, which was probably the source of the yellow clay ring. The reason for the location and the function of this pit is an “enigmă”.

Sherds from the surface of the structure are small and of Scythian type similar to that found at a local settlement. The central pit, however, produced quite different forms and fabrics which led the excavators to conclude that the surface finds are intrusive. The excavators believe that this structure cannot be assigned to the Scythian period. Unfortunately, the sherds from the central pit did not enable the excavators to assign this site to an exact period. They differ from the pottery found at a La Tène settlement 200m down the hill.

The form of the structure leads the excavators to conclude that this structure is not domestic or a workshop. By analogy with the structures from western Transylvania, they conclude that this building is a circular sanctuary, probably dating to the the 1st century AD.

Finds:

Domestic: Iron point; ceramic spindle whorls; various ceramic vessels.

References: Smirnova (1976); Sanie (1995, pp. 21, 23–4, 27, 36, 38–9, 273–4).

111. Pecica, jud. Arad

Type of site/find: Major settlement (? Ziridava), with circular sanctuary.

Phases: Bronze Age and Dacian (2nd century BC–AD 106).

Investigations: Excavations 1898–1902, 1910–1911, 1923–24, 1943, 1960–??.

Description: The primary publication for this site (Crişan 1978b) was not available and therefore this entry concentrates on the circular sanctuary. The site is situated on a 'tell' with a large natural ditch which may have been enlarged. Excavations on the site revealed many square buildings as well as an apsidal building and a circular structure which were built close to each other on the north-west side of the plateau.

The circular building consists of a smooth beaten earth platform some 15cm high and 7m in diameter, in the centre of which is an oval hearth with a thick burnt crust delimited by a border of river boulders. The edge of the platform was marked by post-holes some 30–35cm in diameter and 40–50cm deep. The distance between them varied from 10–40cm and they were packed with stone. Crişan does not believe that the posts were higher than 1m or supported a roof. Only half of the building was well preserved.

Finds:

Coins: 2 Roman Republican *denarii*, 1 *denarius* of Trajan dated to AD 108–110 (from Mihăilescu-Bîrliba 1990).

Special: Gold ring found near the central hearth.

Domestic: Pottery and bone, presumably many other artefacts but primary publication not available. No domestic objects found on the site of the circular sanctuary.

References: Crişan (1966); Crişan (1978b)§; Sanie (1995, pp. 21, 23, 25–6, 36, 40, 42 & 274).

112. Poiana

Type of site/find: Major settlement.

Phases: Bronze Age through middle Halstatt; Dacian 4th century BC–1st century AD.

Investigations: Many excavations including those by Pârvan (1913), Ştefan (1926), Vulpe and Vulpe (1927–1951).

Description: NB Many of the publications for this site were not available for consultation.

This site is situated on a plateau at 300m commanding the valley of the Siret. The site is surrounded by steep slopes reinforced by an earth bank 3m high with a ditch and a strong timber palisade upon the top.

This site dominates movement, including that of goods up the Siret Valley[4] from the Black Sea zone—the distribution of imports in Moldavia, especially coinage, is dominated by this site. According to Vulpe, the site is also on the boundary between good agricultural land and forest.

Excavations have revealed large numbers of pits and dwellings, as well as a large burnt area 2×3.9m which might be the remains of part of a building. No particularly unusual building have been published (Sanie 1995 does not list any religious buildings at the site, for example).

Vulpe divides the site into four main periods: I Bronze Age; II early Geto-Dacian (4th–3rd c. BC); III middle to late Geto-Dacian (2nd c. BC–1st c. AD); IV Roman (1st–2nd c. AD).

Nearby, there is a a group of about 30 tumuli, probably of Dacian date, of which three have had some investigation.

[4]This is emphasised by the fact that there are World War 1 trenches on the site.

Finds:

Coins: 1 imitation of a coin of Macedonia, 2 bronze and 11 silver Geto-Dacian coins, 1 imitation of a tetradrachm of Thasos, 1 imitation each of *drachmae* of Apollonia and Dyrrachium, 5 silver coins of Histria, 35 bronze coins of Callatis, 644 Roman Republican *denarii* and 8 bronze Republican coins, coins of Augustus–Vespasian (from Mihăilescu-Bîrliba 1990). Six coin hoards with Roman Republican *denarii* (Chiţescu 1981, nos. 148–153).

Imports: From Glodariu (1976): large quantities of Greek and Roman amphorae including stamped vessels from Thasos and over 200 anepigraphic amphorae many of which have now been lost—vessels date to 4th c. BC–1st c. AD; large quantities of imported other Greek and Roman ceramics including lamps and samian (G. lists 79 pieces); imported bronze vessels and fragments thereof including one handle with swan's head terminals dating to the 1st c. BC (G. lists 20 pieces); amulets of glass and cornelian; rings with semi-precious stones; cylindrical bones boxes; mirrors; fragments of pincers, 2 marble plates and the base of a terracotta statue. Glass includes *balsamarii* (ointment or perfume bottles), bowls, jugs, glass vessels with inscriptions from Syria/Palaestine, beads, and many others—see Teodor & Chiriac (1994).

Special: Hoard of 20 silver pieces including a brooch, rings and six fibulae (Mărghitan 1976); copies of imported amphorae forms (G. lists 5 examples); copies of other imported ceramic forms (G. lists 59 pieces); large numbers of iron, bronze and silver fibulae (the 1927 excavations alone found 31 examples); bronze bracelets; bronze and silver pendants; weapons include arrow-heads, spear fragments and sword fragments; a "surgeon's kit", crude ceramic figurines.

Domestic: Large quantities of ceramics including hand and wheel made forms including Dacian cups (*cestile dacice*); fruit-bowls (*fructiere*); bowls, jugs, storage jars (emphvase borcan), lids, lamps , bowls, strainers, jars; other ceramics include spindle whorls, weights, large triangular weights [thatch weights?], a fire-dog, pottery burnishers, and burnt daub; stone artefacts include querns (flat and rotary); bone artefacts include pins and needles; other metal artefacts include iron and bronze pins, tweezers, razors, knives, scissors, awls, keys, locks, hooks, crampons amongst other tools; large quantities of bone.

References: Vulpe & Vulpe (1927–1932); Mitrea (1957); Vulpe (1957); Mărghitan (1976); Vulpe (1976, pp. 208–210); Crişan (1978a, pp. 161–162); Chiţescu (1981, nos. 148–153); Teodor & Mihăilescu-Bîrliba (1993); Teodor & Chiriac (1994).

113. Popeşti

Type of site/find: Major Iron Age settlement.

Phases: Bronze Age to late Iron Age.

Investigations: Excavations 1932–1947 (not published); 1954–63; 1976–1979

Description: The site lies 25km SW of Bucureşti and is situated on a triangular promontory some 1200m long and 600m wide at the base. The promontory has been divided into three sections by two large transverse ditches. The largest, southernmost area is now occupied by the modern village, the middle area is occupied by a 17th century church and cemetary, the northernmost area contains the main Iron Age settlement and is known as 'Nucet.' This last segment is 160m long by 120m across its base, and has steep slopes on all sides falling some 15m towards the river Argeş. The archaeological strata are approximately 1.8m deep with levels from the Bronze Age, the first and the second Iron Ages. The early Iron Age levels are well represented by hearths and burnt wattle.

The later Iron levels levels are well represented by pits, mainly of cylindrical shape. These pits contained a variety of finds including charcoal, hearth fragments, bone, pottery, stone artefacts *etc.* Some of the pits appear to be ritual, although the vast majority are undoubtably for grain. There are also a large number of hearths, many overlain representing the long occupation in the late Iron Age. At one point, there are 6 hearths superimposed, under which was a ritual pit containing various complete and fragmentary vessels including a Rhodian amphora, a biconical jug, a strainer *etc.*, as well as an imported rotary quern, an arrowhead, bronze rings, a knife blade and other artefacts. In sector X six *dolia* were found *in situ*. There are also 'ritual' hearths which consist of a burnt clay surface with decoration.

The northernmost transverse ditch and bank is Halstatt in date, and was originally reinforced with a bank with appears to have been created by deliberate burning of timbers to form a earthern version of the vitrified defenses known from elsewhere. The defenses included a series of baked earthern *turte* (lit. flat cakes) which have been found at other Halstatt period sites such as Bucovăţ, near Craiova. The defenses were reused in the Geto-Dacian period.

The excavations in the 1950s revealed a large building with wattle walls which although constructed using local building techniques the excavator (Radu Vulpe) considered to be Hellenistic in plan. This building had suffered a number of fires and been rebuilt. Vulpe considered this building to be the palace of a tribal leader. Within this building were hearths of burnt clay, square in plan and with a decorated surface. A pottery kiln was found near the building.

Excavations by Al. Vulpe in 1976–7 concentrated on the central area around the modern church. These revealed some inhumation burials of unusual form with multiple crouched inhumations, in one case of two adolescents arranged in a cross pattern. These are dated by Vulpe to the Geto-Dacian period on stratigraphic grounds as they were poor in finds. These finds led Vulpe to question the dating of a similar burial found in the Nucet area by R. Vulpe and dated by him to the Halstatt period (Vulpe *et al.* 1959a). This earlier find was also lacking grave goods and was not very securely stratified. Vulpe also found pits and buildings in this area as well as a rich finds assemblage which was, however, lacking in luxury goods leading Vulpe to suggest that this area, occupied when the population grew beyond the capacity of the Nucet, was of a lower status than the acropolis which occupied the Nucet.

In 1978–9 Al. Vulpe re-examined the early unpublished trenches excavated by Rosetti. To do this he cut the trenches back anything up to 2m. The sections revealed anything up to 6 Dacian levels as well as earlier phases. All the levels except the last were destroyed by fire [!]. Eleven pits were excavated of which Pit B was extremely rich. All the pits contained large quantities of animal bone.

Some 1.5km SSW of the Nucet there are 9 tumuli of which four have been excavated (Vulpe 1976). Of these tumuli, one was particularly rich with the remains of a warrior including a fragmentary helmet, spear handle *etc.* The tumuli also contained pottery including *fructiere*.

Finds:

Coins: 5 coins of Alexander the Great, 1 of Callatis, 3 *drachmae* of Dyrrachium and 1 of Apollonia, 15 tetradrachms of Thasos, 1 coin each of Maroneia, Thessalonica, Mesembria and Amissos, 2 coins of Odessa, 28 Geto-Dacian coins, 17 Roman Republican *denarii* and 6 illegible Greek coins (from Cojocărescu 1981).[5]

Imports: From Glodariu (1976): imported Greek and Roman amphorae including stamped vessels from Rhodes, Cos *etc.*, amphorae with painted inscriptions, and unstamped amphorae; large quantities of imported pottery (G. lists 50 pieces) including Greek and Roman vessels dating from 3rd c. BC–1st c. AD; 11 bronze vessels or fragments thereof including lamps, paterae, and a Hellenistic figurine, *etc.* dating from 2nd c. BC–1st c. AD; 22 glass vessels, objects or fragments thereof including a vessel from Alexandria and a millefiore vessel; chain with a gold Medusa's head amulet; five complete or fragmentary metal mirrors; a fragment of a marble vessel and a fragment of a marble mortar; Vulpe *et al.* (1959b) list an Egyptian glass amulet.

Special: Various brooches including a bronze 6th century BC (Halstatt) example, and silver, bronze and iron La Tène fibulae including fibulae with 'bilateral springs' and Nauheim-type fibulae including their Dacian derivative the spoon-brooch (*fibulă-linguriţă*); other jewelry, including a massive bronze bracelet, silver finger rings including a sprial ring; decorated sword pummel; clay mould for metal-work; Glodariu (1976) lists 52 imitations of Greek and Roman amphorae and 32 imitations of other Greek and Roman vessels—the site had many cups with relief decoration which have been subject to a detailed study by Vulpe & Gheorghiţă (1976a), finds included moulds for the manufacture of these vessels; clay figurines. From the tumuli, a helmet, fragments of chain-mail *etc.*

Domestic: Large variety of both hand and wheel made pottery including urns, triconical urns, lamps, minature conical lids, jugs, *fructiere*, cylindrical cups, bowls, pitchers, a *kantharos*, minature amphorae, strainers, bowls, tall lamps, and candlesticks; large quantities of animal bone; iron work included shears, spurs, knife blades (including a curved 'pruning knife'), arrowheads, a key, nails and spikes; querns including one square example.

References: Vulpe *et al.* (1955); Vulpe *et al.* (1957); Vulpe *et al.* (1959a); Vulpe *et al.* (1959b); Vulpe *et al.* (1962); Turcu (1967, 1969); Vulpe (1976); Vulpe & Gheorghiţă (1976a); Vulpe & Gheorghiţă (1976b); Vulpe & Gheorghiţă (1979); Cojocărescu (1981); Gheorghiţă (1981); Vulpe & Gheorghiţă (1981).

114. Racoş, jud. Braşov

Type of site/find: Defended hill-top settlement with circular sanctuary.

Phases: 1st Iron Age (the Halstatt culture Basarabi), late Iron Age (1st BC–1st AD); 13th century.

Investigations: Excavations in 1980s by Cluj.

Description: Only part of the work relating to the circular sanctuary has been published. The site lies at the end of the 17km long Racoş gorge on a hill known as *Tepeiul Ormenişului*. This hill, with an absolute height of 756m, rises 200m above the valley floor and dominates the end of the gorge. It has steep sides with only the southern side providing a more gentle approach. The river Olt flows along its northern edge and the Pîrîul Racilor flows along its southern and western sides.

[5] Mihăilescu-Bîrliba (1990) gives a quite different list, see Table 14.4b, page 398.

The hill-top plateau has a rocky precipice to the north, and walls on the three remaining sides.[6] The southern slope of the hill has been terraced in places. These terraces may have originally been constructed in the Halstatt period but where substantially enlarged in the Dacian period. They have sustaining walls along their down-slope edge constructed of roughly fashioned stone and earth.

On the third terrace was found a circular sanctuary. This was best preserved on the NE side, and was partly destroyed by a medieval pavement. The sanctuary consisted of three concentric foundations. The outermost of these consisted of limestone and *ofiolit* stones, roughly fashioned and set on the surface of the terrace. This foundation had a diameter of 19.2m. Some of the stones had traces of burning and occasionally charcoal upon their upper surfaces and probably supported a timber wall. Within this was a second circular foundation made of blocks of white tuf. These blocks were 20–23cm thick and 45–90cm long and would probably have originally formed a continuous circle. Above the ancient surface, these blocks had been carefully cut; below the surface they were less well carved. These slabs are very friable and the excavators feel that they could not have supported a wooden wall. Two of them have evidence for later hammering. Within this foundation was a further structure with two rooms: a rectangular room 7×6.5m and an apsidal room 6.5×2.3m maximum. The foundations were again of limestone and *ofiolit* although this time of much larger pieces than the outer circle. In two corners of the square room were post-holes. Part of the wattle and daub wall of the dividing wall was preserved. The floor was of finely smoothed clay and had been preserved in places due to the fire which eventually destroyed the site. There were two outside doors to the square room as shown by the finds of hinges and bolts. A further entrance between the two rooms was indicated by a carbonised beam.

No other details of the site are currently available although indications of the presence of a rectangular sanctuary in the form of circular plinths not *in situ* was indicated (Glodariu & Costea 1991, ftn. 18).

Finds:

Special: Five iron hinges with a catch and a ring; two late Iron Age type fibulae; 'swan headed' nails of which 18 were found in a carbonised beam—it is suggested that they were used for hanging items from.

Domestic: Pottery including *vase borcan, fructiere* and a Dacian cup (*cească dacică*); many large nails.

References: Glodariu & Costea (1991); Sanie (1995, pp. 22–3, 26–7 & 274).

D.4 Sites of special interest

This section lists sites with special types of buildings, or sites of particular importance. They are cross-referenced with the fuller descriptions in sections D.2 and D.3.

D.4.1 Rectangular sanctuaries

Barboşi, Galaţi. See site 106, page 536.

Băniţa, Hunedoara. See site 37, page 509.

[6]Unfortunately, the publication does not state the form of these walls.

Bîtca Doamnei, Piatra Neamţ. Originally thought to have two rectangular scantuaries but later found to be two phases of a single sanctuary—see site 107, page 537.

Blidariu, Hunedoara. See site 38, page 509.

Căpîlna, Alba. See site 5, page 497.

Costeşti, Hunedoara. See site 46, page 512.

Grădiştea Muncelului, Hunedoara. See site 50, page 515.

Piatra Craivii, Alba. See site 21, page 503.

Piatra Roşie, Hunedoara. See site 60, page 521.

D.4.2 Circular Sanctuaries

Brad, jud. Bacău. See site 108, page 537.

Butuceni. Unpublished and no details available (Glodariu & Costea 1991, p. 38 & ftn. 13).

Dolinean, Ukraine. See site 110, page 540.

Feţele Albe, Hunedoara. See site 49, page 514.

Gradiştea Muncelului, Hunedoara. See site 50, page 515.

Meleia, Hunedoara. See site 55, page 520. Usually considered a *stîna* (upland sheep fold) but listed as a circular sanctuary by Sanie (1995, p. 21 & p. 27).

Pecica, Arad. See site 111, page 540.

Pustiosu, Hunedoara. See site 62, page 523.

Racoş, Braşov. See site 114, page 544.

Rudele, Hunedoara. See site No. 64. Usually considered a *stîna* (upland sheep fold) but listed as a circular sanctuary by Sanie (1995, p. 21 & p. 27).

D.4.3 *Murus dacicus* wall construction

Băniţa, Hunedoara. See site No. 37, page 509.

Bîtca Doamnei, Piatra Neamţ. This site was thought to have stone-built walls although not of *murus dacicus* construction. Further excavation by Mihăilescu-Bîrliba (*pers. comm.*) revealed that these walls were actually supporting terraces and were not defensive. See site 107, page 537 for further details.

Blidariu, Hunedoara. See site 38, page 509.

Căpîlna, Alba. See site 5, page 497.

Costeşti, Hunedoara. See site 46, page 512.

Deva, Hunedoara. See site 48, page 514. No wall found, but a block from such a wall found on the castle hill.

Feţele Albe, Hunedoara. See site 49, page 514.

Grădiştea Muncelului, Hunedoara. See site 50, page 515.

Piatra Craivii, Alba. See site 21, page 503 above. The wall was dismantled and is now in Alba Iulia museum.

Piatra Roşie, Hunedoara See site 60, page 521 above.

Tilişca, Sibiu. See site 91, page 533 above. The site had a 'dwelling-tower' with a base of *murus dacicus* and upper levels constructed of adobe.

Many of the minor sites in the Munţii Orăştiei have evidence for *murus dacicus* wall construction but are not listed here.

Appendix E

Metallurgical data and analyses

E.1 Introduction

E.2 Pre-processing of the data

It is usual for the archaeometallurgist in a project to supply the data to the statistical analyst only in the form of a table of percentages (Ponting, *pers. comm.*). In the case of the current project, however, the problem of highly variable sample sizes, extremely low elemental concentrations, and variable detection limits was a cause for concern, and in close collaboration with Dr. Ponting I obtained the sample weights, detection limits, and PPM values, in addition to the percentages as calculated by Dr. Ponting. This allowed me to use my 'dual mode' method of calculating estimated values for those measurements below the detection limit. All the data available to me was stored in a relational database structure which will be described below. This method of storage proved far superior to the use of multiple spreadsheets — the form in which the data was originally stored — and is to be much recommended.

During the project a number of problems and errors were encountered which is to be expected in a project of this size. The problems and their solutions were:

- Samples 9, 11, 25 rejected at the drilling stage as the coins were too brittle.
- Sample 27 rejected in Romania as it was a plated coin.
- Samples 17, 24, 26, 30, 33 and 37 rejected in Britain as the sample weight was too low.
- Sample 191 was of a surface chip of a brittle coin, the results are regarded as highly unreliable.
- PPM values for the pilot study not now available.
- Sample weights not now available for 74, 75, 77, 78, 79, 82, 98, 99, 111, 122, 123, and 141. These were calculated from the PPM readings and the percentages, and then input to the SAMPWTS table. They were not used in the analysis of sample weights, but were used to determine the method of estimation.
- High acid solution sample weights provided were impossible for 31, 35, 36, 38, 57, 58, 59, 60, 61, 62, 63, 64, 65, 76, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177 and 178, although the percentages provided were prefectly acceptable. New weights were calculated from the PPM readings and the percentages, and then input to the SAMPWTS table. The rejected weights have been stored in a separate table, REJWTS.
- Measurements were not available for the following:

- Sample 19: Zn
- Sample 141: Cu
- Sample 167: Fe
- Sample 182: Au
- Sample 182: Sn
- Sample 191: Au
- Sample 191: Sn

In each case the value was replaced by the median of the element.

From my experience of this project I would argue that it is *absolutely essential* that the statistical analyst is provided with *all* the relevant data including the batch numbers, detection limits for each batch/element, sample weights and PPM readings. This data should then be analysed in close collaboration with the original analyst. If the statistician also has computing and database skills, it would also be advisable to set up a well-designed and constructed relational database at the start of the project which would help prevent losses of data and errors, and would save enormous amounts of time at the data pre-processing stage. This last lesson was learnt too late for this project, and pre-processing took some considerable time.

E.3 The availability of the METAL database

The following section outlines the structure of the METAL database. This database is available by anonymous ftp from `ftp://avebury.arch.soton.ac.uk/database/metal` in three file formats. `Metaldbf.zip` contains the data in dBASE III+ format, along with a small number of programs to perform common tasks on the data. `Metalacc.zip` contains the same data in Microsoft Access 2 format, and `Metalasc.zip` contains the data as a series of comma delimited files. This directory will also contain a `read.me` file and a `http` version of this appendix for persons using a World Wide Web browser such as NETSCAPE or MOSAIC. If no Internet access is available, the files can be obtained on disc from the author.

E.4 Database structure

The database has a relational structure. There are five main tables. In the following description the fields which constitute the unique keys are marked with a §.

SAMPLES This table contains information regarding the individual samples such as date, hoard *etc.*

- **`sample`** § The sample number. A sequential number given to each sample. Used as link to many other tables.
- **`hoard`** Three letter code for samples from hoards. The codes are those used in the main CHRR database. For unprovenanced samples, `---` has been used.
- **`refno`** The museum, hoard publication or other reference number.
- **`cointype`** The cointype according to RRC or RIC 1[(2)].
- **`ctype`** The `ctype` reference number to allow linkage to the main CHRR database.
- **`query`** The query code as defined on page 124.

`date` The date of the issue. This field is included so that this database can be distributed without having to have the CHRR database as well. If the CHRR database is available, the date is included in the COINTYPE table.

`coin_wt` The weight of the coin.

`diameter` The diameter of the coin.

`comment` A comment about the coin either from the sampling or analysis stage of the project.

COMPOSIT This contains the results of the analyses. As some samples were analysed twice in seperate batches a second unique key is required for each sample.

`sample` § The sample number.

`batch` § The batch number.

`solution` § The solution used for that analysis (*i.e.,* high acid, nitric acid or single acid). Needed for calculation of percentages, and for the cases where an element was measured using both solutions.

`big` Is the sample 'large'? For single and nitric acid solutions, sample weight >3mg is 'large', and <3mg 'small', for high acid solutions the cut-off is 1.3mg. Values are: **b** big; **s** small; **u** unavailable.

`element` § The element, *e.g.,* Au.

`ppm` The parts per million reading.

`perc_mp` The percentage as provided by the analyst.

`perc_ml` The percentage where the maximium (worst) dectection limit has been used as the cut-off point. Readings below this limit were calculated using half the detection limit.

`perc_bl` The percentage where the batch dectection limit has been used as the cut-off point. Readings below this limit were calculated using half the batch detection.

`perc_mix` The percentages used in the analyses. In this case, percentages were calculated using the worst detection limit. For small samples with levels below the detection limit the values were replaced with the median value for that element. For high acid samples, this was samples below 1.3mg, for nitric acid samples this was samples below 3mg. In these cases Ag was replaced with 95.48%, Cu with 1.36%, Pb with 0.58%, Au with 0.3%, Bi with 0.154%. Other elements were not affected as there was too little information for analysis.

`status` The status of the PPM value, *i.e.,* above the worst detection limit, below all dectection limits *etc.*—see table STATUSCD.

`diff` A 'working' field used to detect differences between values in fields `perc_mp`, `perc_ml`, `perc_bl` and `perc_mix` used in the data cleaning process (not part of the strict relational schema).

`select` A logical field to allow easier selection of samples for analysis with having to reissue complex retrieval commands (not part of the strict relational schema).

VOLUME The volume of the solution used in calculation of the percentages from the PPM values.

solution § Solution type: high, single or nitric.

volume The volume: 25ml. or 10ml.

SAMPWTS The sample weights. Again these are used in the calculation of the percentages from the PPM values. They are also used in assessing which form of estimate should be used for readings below the detection limit.

sample § The sample number.

batch § The batch number.

solution § The solution type.

weight The sample weight.

LIMITS This table records the dectection limit for each element for each batch. The detection limit varies from one batch to another due to a variety of factors.

batch § The batch number.

element § The element, *e.g.*, Au.

limit The detection limit in PPM.

STATUSCD The meaning of the status codes in table COMPOSIT.

status § The status code.

meaning The meaning of the status code.

In addition to these core tables, additional ones were created for various purposes. They are provided on the CD-ROM 'as is'.

MAXLIMIT The maximum (worst) detection limit for an element over all batches. This table was created solely for the purpose of speeding up the dBASE program and is derived from the LIMITS table.

element § The element, *e.g.*, Au.

maxlimit The maximum (worst) detection limit.

REJWTS The weights rejected from the main database during the preprocessing stage because they are impossible as noted above on page 549.

sample § The sample number.

batch § The batch number.

solution § The type of solution.

weight The value of the rejected weight.

BYDATES A derived table which combines the date of the issues (taken from the COINTYPE table of the main CHRR database) and other pieces of information to enable the comparison of various factors with the date of the coin.

samplea § A variant of the sample number where samples analysed twice have 'a' suffixed to the number.

sample The sample number.

site The hoard code (from the CHRR database) with the following additions: IMI: imitations; MUS: UK Museums.

origin A single letter variant of the site field for plotting in simple packages such as MV-ARCH. Values are: **b** Breaza; **i** imitation; **m** Şeica Mică; **o** Poiana; **p** Poroschia; **s** Stăncuţa; **u** UK museums; **v** Voineşti; **z** Zătreni.

type Type of object. Values are: **b** bar from Stăncuţa; **c** known cast copy from Breaza; **d** *denarius*; **i** imitation; **s** probable struck copy from Poroschia; **t** tetradrachm.

Cu Copper value from COMPOSIT.`perc_mix`.

Pb Lead value from COMPOSIT.`perc_mix`.

Au Gold value from COMPOSIT.`perc_mix`.

Bi Bismuth value from COMPOSIT.`perc_mix`.

copycon Logical field.

date Date of coin (or of original for copies).

coin_wt Weight of the coin.

diameter Diameter of the coin.

RESULTS Another derived table with additional information on the results of the PCA.

samplea § As for table BYDATES, above.

sample As for table BYDATES, above.

pca1 The object score for the first principal component from the analyses reported in section 14.4.6, page 429.

pca2 The object score for the second principal component.

pca3 The object score for the first third component.

pca4 The object score for the first fourth component.

site The hoard code as for table BYDATES.

origin A single letter code as for table BYDATES.

type Type of object as for table BYDATES.

Cu Copper value from COMPOSIT.`perc_mix`.

Pb Lead value from COMPOSIT.`perc_mix`.

Au Gold value from COMPOSIT.`perc_mix`.

Bi Bismuth value from COMPOSIT.`perc_mix`.

copycon Logical field.

copyopt Logical field.

multstat What category the sample is in (see Table 14.13, page 438). Values are: **c** core sample; **p** penumbra sample; **o** outside sample; **f** far-out sample1.

TESTWTS Weights used for Fig. 14.5, page 413.

sample § The simulated sample weight.

estimate The estimated percentage.

TESTWTS2 Weights used for Fig. 14.7, page 414.

sample § The simulated sample weight.

estimate The estimated percentage.

E.5 dBASE programs and other files

The CD-ROM contains several dBASE III+ programs which are provided ‘as is.’ The programs and what they do are now listed:

back Calculates sample weight from user-supplied PPM figures and percentage for *nitric acid* samples only.

backhigh Calculates sample weight from user-supplied PPM figures and percentage for *high acid* samples only.

big Created data in field `big` of the COMPOSIT table.

chkstat Checks the status code entries in table COMPOSIT.

doests The program which created the figures in table TESTWTS.

estimate Calculates the values for field `perc_ml` in table COMPOSIT.

estimat2 Calculates the values for field `perc_bl` in table COMPOSIT.

findmax Finds the maximum value in a field.

findmin Finds the minimum value in a field.

medians Calculates the values for field `perc_mix` in table COMPOSIT.

maxlimit Created table MAXLIMIT.

newsamp Outputs data from table `results` to create Table 14.13.

output Created basic data table which forms core of `metpca.dat` for PCA analysis. [select] Sets field `select` in table COMPOSIT to tue for specified samples.

In addition to these files there are also a large number of other derived and output files. Of these `metpca.dat` is the most important, being the compositional data in the form required by CANOCO. The `.sav` files are from SPSS, the `.mtw` MINITAB files, `.xls` EXCEL files (including the original data files), `.cht` chart files from SPSS.

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Description of plates

Plate I: Nos. 1–10: the Tilişca dies; Nos. 26–51: cast coins from the Breaza hoard (BRZ); No. 96 coin from Breaza hoard with possible casting flanges (Breaza coin numbers from Poenaru Bordea & Ştirbu 1971).

Plate II: Obverses of die-linked coins from the Poroschia hoard (PRS; coin numbers from Chiţescu 1980). Nos. 397–420 L. PROCILI F (RRC 379/2), nos. 397, 399–400, 402–419 completely die linked, coins 398, 401 & 420 not die linked. Nos. 317–324 anonymous *denarii* (RRC 350A/2), 317–320 die-linked, 321–324 not die linked. Nos. 523–530 P. Clodius (RRC 494/23), all die-linked.

Plate III: Reverses of die-linked coins from the Poroschia hoard—see previous plate for details.

Plate IV: Obverses of die-linked coins from the Poroschia hoard. Nos. 476–492 C. PISO FRVGI, nos. 476, 482–492 die-linked, nos. 477–481 not die-linked. Nos. 543–548, 178–181 L. SATVRN (RRC 317/3a), nos. 543–548 die-linked, nos. 178–181 not die-linked.

Plate V: Reverses of die-linked coins from the Poroschia hoard—see previous plate for details.

Plate VI: Top two rows: obverses and reverses of five coins from the Nicolae Bălcescu hoard (NB2); bottom six rows, coins from the Coin Cabinet, Institutul de Arheologie, Bucureşti. No die-links within the collections or with Poroschia.

Plate VII: Sampling the coins. Lower picture shows coins on edge in vice with unfilled sampling hole.

Plate VIII: Samples 1–20 (1–6 from Zătreni; 7–20 Poiana).

Plate IX: Samples 21–39 (21–28 Poiana; 29–34 copies; 35–7 tetradrachms from Popeşti; 38–39 Breaza).

Plate X: Samples 40–59 (40–56 Breaza; 57–59 Stăncuţa).

Plate XI: Samples 61–2 (Silver bars from Stăncuţa, much larger than life).

Plate XII: Samples 60, 63–80 (60, 63–5 Stăncuţa; 66–8 Voineşti; 69–80 Poroschia).

Plate XIII: Samples 81–100 (Poroschia).

Plate XIV: Samples 101–120 (Poroschia).

Plate XV: Samples 121–140 (121–134 Poroschia; 135–140 Şeica Mică).

Plate XVI: Samples 141–160 (141–160 Şeica Mică).

Plate XVII: Samples 161–180 (161–178 Şeica Mică; 179–180 Ashmolean).

Plate XVIII: Samples 181–203 (181–187 Ashmolean; 188–203 British Museum).