Ovid, the Fasti *and the Stars*

This is a pre-print of an article accepted for publication in the *Bulletin of the Institute of Classical Studies*©, vol. 50 (2007)

Ovid, the Fasti *and the Stars*

Abstract: In the *Fasti*, Ovid provides dates for a number of astronomical phenomena. For many years these were dismissed by scholars as wildly inaccurate; and this assumption of inaccuracy has formed the basis for a number of literary approaches to the *Fasti*. Some recent studies have challenged this view of Ovid's accuracy, claiming that his dates are mostly accurate. This article examines the different conceptions of accuracy at work in these two positions, and explores the implication for literary approaches to the poem. By comparing Ovid's accuracy with those of other ancient authors, and providing the first detailed exploration in *Fasti* scholarship of the problems inherent in modern calculations, ancient observations, and the ancient sources, I conclude that a focus on accuracy is not the most helpful methodology, and that a focus on the choice of constellation is a more productive tool for literary criticism.

Ovid, the Fasti *and the Stars.*

> *nec si rationem siderum ignoret poetas [grammatice] intellegat, qui, ut alia mittam, totiens ortu occasuque signorum in declarandis temporibus utuntur...*
>
> Quintilian, *Inst. Orat.* 1.4.4

According to Quintilian, poetry cannot be fully understood without a good knowledge of the stars. As one example he cites the fact that poets frequently indicate the time of year by the rising and setting of stars and constellations, a device familiar to us from Hesiod onwards.[1] For Quintilian, who had the benefit of a stable civil calendar, there may have seemed little reason beyond a desire for poetic expression to specify the date in this manner: but before Caesar's calendar reforms in 45 BC, the appearance and disappearance of certain stars just before sunrise and just after sunset provided a much more regular guide to the year than the erratic calendars of Greece and Rome, which were often out of step with the solar year.[2] It is therefore not surprising to find the same method of specifying the date in prose authors too;[3] and lists of these stellar phenomena, arranged in various calendar-like formats, are found in both texts and inscriptions. These lists, known as *parapegmata*, can be traced back to fifth century Greece, but the tradition may be considerably older.[4]

Whatever our reaction to Quintilian's claim, it is certainly the case that a good knowledge of the stars is important for a full understanding of Ovid's calendar poem, the *Fasti*. To a large extent the poem presents itself as a poetic version of the Roman calendar: each book covers a different month, and as the year and the work progress, Ovid marks the dates of various religious festivals and historical events, as in the real *fasti*. However, unlike many of the extant *fasti*, Ovid combines this material with material from the parapegmatic tradition, giving dates for the rising and setting of various stars and constellations, and for the journey of the sun through the zodiac. The inclusion of the constellations – and of the aetiological tales explaining their presence in the sky – enables Ovid to introduce a variety of Greek myths into the Roman calendar, where they would otherwise have no place.

For generation after generation of scholars, these astronomical notices have excited little more than scorn and derision. From Bailey's 1921 commentary on Book 3 ("Ovid from time to time likes to intersperse a little astronomy with his religious lore; it is not infrequently incorrect") to Fantham's 1998 commentary on Book 4 ("Ovid is … wildly inaccurate"), the sentiments expressed are the same: Ovid's dates are wrong, and he has failed to grapple with the complexities of ancient astronomy.[5] In almost all cases, their assessment of Ovid's astronomical skills is based on the same source, namely a single article by a nineteenth-

---

[1] Cf. e.g. Hes. *Op.* 383-4, 564-69, 571-2, 614-7.

[2] Cf. e.g. Caes. *Bell. Civ.* 3.6.2 *ii Nonas Ianuarias naves solvit…*; 3.9.8 *iamque hiems adpropinquabat…;* 3.25.1 *multi iam menses erant et hiems praecipitaverat.…*

[3] Cf. e.g. Thuc. 2.78.2 *τάφρος δὲ ἐντός τε ἦν καὶ ἔξωθεν ἐξ ἧς ἐπλινθεύσαντο. καὶ ἐπειδὴ πᾶν ἐξείργαστο περὶ ἀρκτούρου ἐπιτολάς.…*

[4] Some of these texts are discussed in more detail below. For a brief introduction to *parapegmata*, cf. Evans (1998), pp. 199-204; Hannah (2005), ch. 3. For more detailed discussions, see Rehm (1941, 1949) and Lehoux (2000, 2007). It is thought by some that aspects of the Greek *parapegmata* originate from Babylonian astronomical works: cf. e.g. van der Waerden (1984); for a clear introduction to the kind of material in question, see Evans (1998), pp. 5-17.

[5] Cf. Bailey (1921), p. 112; Fantham (1998), p. 38. These examples can be multiplied: cf. e.g. Frazer (1929), p. xx: "my ignorance of astronomy is as profound as that of my author appears to have been"; Barsby (1978), p. 26: "There is nothing new to say on the astronomical side of the Fasti, where Ovid's errors of dating are frequent and notorious". For more examples, see Fox (2004), p. 93.

century German mathematician that is now nearly two hundred years old.[6] However, even those scholars who looked into the matter in a little more detail, such as Rehm, reached a similar conclusion: "[Ovid] used his models extremely carelessly and evidently never looked at a single star himself".[7]

Recently, however, some scholars have suggested that there might be more to these errors than mere incompetence or carelessness, and that they might serve a literary function: the argument is that Ovid positions his astronomical material in such a way as to comment upon or complicate our response to the surrounding text, or to draw attention to the text in some way. Precise methodologies differ: for example, Gee takes only those passages marked by their inaccuracy as eligible for such a reading: "Exploration of thematic links between the stars and the material with which they are juxtaposed becomes a possible methodology once it has becomes apparent that such juxtaposition … is a device achieved *at the expense of* chronological accuracy";[8] whereas Newlands makes the stronger claim that *any* of Ovid's stellar passages can be read in the fashion: "Ovid's seeming carelessness about the dates of the stars' appearances in the sky gives him the latitude to position Greek myths in his Roman poem where they best suit his poetic design".[9]

To complicate matters further, in the last few years a number of scholars have suggested that Ovid's astronomy is not as 'wildly inaccurate' as has been claimed.[10] Indeed, Ovid's most recent champion, Matthew Fox, claims that roughly three out of every four astronomical references in the *Fasti* meet his criteria for accuracy.[11] Whereas Rehm believed that Ovid 'used his models extremely carelessly and … never looked at a single star himself',[12] Fox concludes that Ovid is far from the bungling amateur he was thought to be (p. 131):

> It is clear … that Ovid took pains to be accurate when referring to the risings and settings of stars. Rather than seeking intentional purposes in Ovid's supposed errors, literary critics should feel fully justified in treating the *Fasti*'s references to star risings and settings as for the most part accurate astronomical observations, albeit subsumed to and shaped by Ovid's ever allusive-and elusive-poetic ends.

Fox argues that the current critical consensus regarding Ovid's inaccuracy "blocks avenues of literary interpretation that might wish to read Ovid's asterisms as meaningful on an astronomical level";[13] for example, on the assumption that Ovid does show an awareness of the night sky, Fox suggests that the figure of Hercules Musagete playing the lyre, which closes the *Fasti* at 6.812, corresponds to presence of both these constellations in the sky at the end of June;[14] similarly Hannah argues that the 'descent' of Mars to view his temple at *Fasti* 5.551 corresponds to the movement of the planet Mars at that time.[15]

---

[6] Cf. Ideler (1822-3). For a long time this article has been hard to obtain, but several years ago the *Proceedings of the Royal Academy of Sciences, Berlin* were digitised and made available over the web. Currently, only one page can be viewed at a time (the first page of Ideler's article can be found at http://bibliothek.bbaw.de/bibliothek-digital/digitalequellen/schriften/anzeige/index_html?band=07-abh/18221823&seite:int=572).

[7] Rehm (1949), p. 1309: "er seine Vorlagen höchst nachlässig benützt und augenscheinlich nie selbst nach einem Gestirn ausgeschaut hat".

[8] Gee (2002), p. 49.

[9] Newlands (1995), p. 31.

[10] Cf. Hannah (1997a and b); Robinson (2000), pp. 37-43; Fox (2004).

[11] Fox (2004), pp. 99, 126-127.

[12] See note 7.

[13] Fox (2004), p. 94.

[14] Fox (2004), pp. 124-5.

[15] Cf. Hannah (1997b).

What are we as literary critics to believe? If it is true that "Ovid took pains to be accurate" as Fox claims, then are we mistaken in looking for significance in his errors? An Ovid who struggles for accuracy would (on the face of it) be hard to reconcile with an Ovid who may have carefully positioned all of his astronomical passages for literary effect. On the other hand, although Fox hopes to put on the emphasis on Ovid's accuracy rather than his errors, his conclusion could in fact lend support to Gee's methodology: if Ovid is accurate most of the time, then his errors take on greater significance.

In fact, I believe that to base our literary approach to Ovid's astronomical passages primarily on the basis of their accuracy or inaccuracy – as these concepts are currently conceived – is both unhelpful and misleading, and leaves a number of important questions unanswered. For example, Fox's conclusion that 76% of Ovid's astronomical dates are correct may come as a shock to those who think that Ovid's dates are mostly incorrect: the figure seems high when compared to previous estimates of Ovid's accuracy.[16] But is this a high score when compared to other ancient authors? With no context, the figure does not tell us much in absolute terms. Why is Fox's figure so different to previous assessments of Ovid's accuracy? What criteria should we be using to judge levels of astronomical accuracy? Furthermore, to what extent is the figure a reflection of Ovid's accuracy, or a reflection of the accuracy of his sources? Are some of the errors more shocking than others?[17]

To illustrate the importance of these and other questions, I propose to take a single passage from the *Fasti* and show how our reading of this passage changes as we explore the various issues surrounding the concept of 'accuracy'. In the process, I hope a more helpful methodology for reading Ovid's astronomical material will emerge. Some of the material involved is quite technical, for which I make no apologies, as it essential for securing a solid foundation for subsequent discussion.

It should also be noted from the outset that for many modern readers of Ovidian poetry, no specific invitation is required to press the text for hidden meaning, or to seek out destabilising narrative strategies: any juxtaposition in the text is there to be explored, whether the result of an error or not. However, it may still make a difference to our interpretation if we feel a passage is 'marked' in some way, or if it in some way draws attention to itself; and in any case, the process of reaching a conclusion will highlight problems inherent in traditional approaches to Ovid's astronomy, and an awareness of these problems is in many ways as important as the conclusion itself.

Before we begin, let us remind ourselves briefly of the phenomena that lie behind these astronomical passages, and of the accompanying terminology.[18] When Hesiod or Ovid talk of the rising and setting of stars, they refer not to 'rising' and 'setting' in the ordinary sense (that is, merely crossing the eastern or western horizon – many stars would do this every day); instead they refer to the rising and setting of the stars in a particular relation to the sun. These phenomena can be visible (termed 'apparent'), or invisible (termed 'true'); they can take place in the morning or the evening; and the star can rise or set. In the case of the 'true' phenomena, the sun and the star cross the horizon at the same time: as the sun still provides considerable

[16] Cf. Fox (2004), p. 126. I believe Fox to be mistaken in his interpretation of a number of Ovid's astronomical passages, and the figure I obtain by my own calculations is somewhat lower (see below).

[17] Fox (2004) does address some of these questions, but very briefly, and in some cases I disagree with his conclusions.

[18] The terminology for these phenomena is far from uniform, and at times we find the same terms used by different scholars to refer to different phenomena. To avoid complication, I avoid terms such as 'heliacal', 'first visibility' and the like.

light when at the horizon, the star cannot be seen, and these dates can only be reached by mathematical methods (such as calculation or use of a star-globe). The date of the apparent morning phenomena refers to the day on which the star is first visible rising or setting just before sunrise: on the day before, the star rose and set several minutes later, and was invisible in the light of the rising sun; on subsequent days, the star will rise and set several minutes earlier, and will be visible for longer. The opposite is the case with apparent evening phenomena, which refer to the last dates on which the star can be seen rising or setting just after sunset.[19]

VISIBLE PHENOMENA			INVISIBLE PHENOMENA		
PHENOMENA	ABBREVIATED	OTHER TERMS	PHENOMENA	ABBREVIATED	OTHER TERMS
Apparent Morning Rising	AMR	heliacal rising first visibility	True Morning Rising	TMR	(true) cosmical rising
Apparent Morning Setting	AMS	cosmical setting	True Morning Setting	TMS	(true) cosmical setting
Apparent Evening Rising	AER	acronychal rising	True Evening Rising	TER	(true) acronychal rising
Apparent Evening Setting	AES	heliacal setting last visibility	True Evening Setting	TES	(true) acronychal setting

Let us turn now to *Fasti* 2.145-6, where Ovid describes the rising of Aquarius:

> *iam puer Idaeus media tenus eminet aluo*
> *et liquidas mixto nectare fundit aquas.*

Ovid dates the rising of the middle of Aquarius to February 5th: this was also the date, Ovid tells us, on which Augustus received the title of *pater patriae*, and this astronomical notice follows the commemoration of that event. According to Ideler, the true morning rising of the star θ Aquarii, which he takes as the 'middle part of Aquarius', fell on January 22nd for Rome, and the apparent morning rising on February 25th.[20] Harries believes that Ovid's positioning of this passage here is deliberate:[21] Ovid's "placing of the rising of Aquarius at this point on the 5th February, mid-way between its 'true' morning rising on 22nd January and its 'apparent' morning rising on 22nd February, is an arbitrary compromise which cannot be traced back further than Ovid".[22] By placing the rising of Aquarius here, and by choosing to link Aquarius with Ganymede and his abduction by Jupiter rather than with any other of the figures with which Aquarius is associated, Harries suggests that Ovid complicates our response to the comparison of Augustus with Jupiter in the previous passage.[23]

Here an 'inaccurate' date is used as evidence to support the theory that Ovid is distorting astronomical facts for a particular literary purpose: Ovid's date is two weeks later than the true morning rising, two weeks earlier than the apparent morning rising, and so February 5th seems to be an invention on the part of the poet. If this is the case, then this passage satisfies Gee's criterion of chronological inaccuracy, and Harries would seem to have a strong argument.

However, there are two possible problems with this position. First, we find the same date for the same phenomenon in Columella's 'farming diary': *Non. Febr. mediae partes Aquarii*

[19] For more detailed discussion of these various terms, cf. e.g. Robinson (forthcoming); Gee (2000), pp. 205-8; West (1978), pp. 376-82; and Smith (1890), s.v. *astronomia*.
[20] Ideler (1822-3), p. 161.
[21] Harries (1989), pp. 166f.
[22] Ideler gives February 25th as the date for the AMR: tellingly Harries, Bömer and Frazer give February 22nd, suggesting that at least two of these scholars may not have consulted Ideler directly.
[23] Cf. e.g. 2.131-2 *hoc tu per terras, quod in aethere Iuppiter alto, / nomen habes: hominum tu pater, ille deum.*

oriuntur, uentosa tempestas.[24] Harries acknowledges this, but he is dismissive of the possibility that Ovid and Columella reflect a common source.[25] We will return to the problem of the sources later, so let us for the moment follow Harries and assume that Columella has taken this date from Ovid. However, we encounter a second problem when we turn to Fox's analysis of the astronomical passages in the *Fasti*: unlike Harries, Fox regards Ovid's dating here as accurate.[26] If Fox is correct, and this date is now to be thought of as 'accurate', Harries' position seems on the face of it to be considerably weakened.

So is this date accurate or not? And how is it that two scholars disagree on what might seem to be a straightforward issue? Analysis of the problem will reveal some important *caveats* about the use of modern calculations of which many scholars are unaware.

Like almost all scholars working on the *Fasti*, Harries relies for his astronomical information on an article by the mathematician Christian Ludwig Ideler, which was published in the early part of the nineteenth century.[27] In this article, Ideler calculates what he believes to be the 'correct' dates for the astronomical phenomena listed by Ovid. He does not specify an error margin for these calculations, but other scholars using a similar method often give a figure of ± 2 or 3 days for apparent phenomena.[28] True phenomena, by their nature, can in theory be calculated exactly. A list of all the astronomical passages in the *Fasti* can be found in Table One,[29] along with Ovid's and Ideler's dates. If we compare Ideler's calculations with Ovid's text, and allow a slightly more generous error margin of ± 4 days for both apparent and true phenomena, we find that of Ovid's dates, only six out of forty-five (13%) are within ± 4 days of Ideler's dates for apparent phenomena at Rome;[30] and only seven out of forty-five are within ± 4 days of Ideler's dates for true phenomena at Rome (16%):[31] in other words, even using an error margin slightly larger than the one traditionally associated with Ideler's method of calculation, we find that only thirteen out of forty-five dates (29%) are 'accurate'.[32]

Since the 1820s, the method used by Ideler has been refined, and the astronomical data required for the calculations has become more accurate. I have recalculated the dates using the latest computer software, and these dates are also presented in the table.[33] We find that now

---

[24] Col. *De Re Rus.* 11.2.14: "on the Nones of February (the 5th), the middle parts of Aquarius rise; the weather is windy".

[25] Harries (1989), p. 167, n. 18: "That Columella … follows Ovid in recording the rise of Aquarius at its mid-point is at least as likely as that both use some (unknown) independent source. Columella's 'mediae partes Aquarii oriuntur' is simply a prose version of *Fast.* 2.145".

[26] Fox (2004), p. 110.

[27] Ideler (1822-3), and see note 6. It may be the case, however, that Harries relies for his information not on Ideler directly, but on Ideler as filtered through the commentaries: though he refers to Ideler, the date he gives (February 22nd) is not the date found in Ideler, though it is the date found in the commentaries of Frazer and Bömer: see note 22.

[28] Cf. e.g. Neugebauer (1922), vol. 3, pp. xxxvii; Aveni (1972), p. 539.

[29] I have not included Ovid's notices of the sun's path through the zodiac, or his mention of the Kite, which appears to be a misunderstanding of the Greek parapegmata, which refer to the migratory appearance of the bird, not the constellation. For the argument that the Kite in question was once a constellation, see Hannah (1997a). The table also includes calculations made using modern computer software (see below).

[30] Nos. 12, 16, 21, 22, 34, 39.

[31] Nos. 8, 20, 30, 32, 35, 37, 40.

[32] As noted above, Ideler himself does not give any indication of what he feels is an acceptable error margin for a date to count as 'accurate'. Thus Fox is able to read Ideler's various comments on the various astronomical passages in such a way that he believes that Ideler counts about 60% of Ovid's dates as accurate: cf. Fox (2004), pp. 127-8.

[33] I have used the software *Planetary, Lunar, and Stellar Visibility* (henceforth *PLSV*), at version 3.04, by Prof. Noel Swerdlow and Rainer Lange. The software can be downloaded from www.alcyone.de. In making the calculations, I have used the setting 'calculate *arcus visionis* from magnitude'; for critical altitude I have used

out of 45 entries, only five (11%) fall within ± 4 days of the dates calculated for the apparent phenomena, and only seven (16%) within ± 4 days of those calculated for the true phenomena, giving a total of twelve out of forty-five dates (27%) that are 'accurate'. These totals are similar to those based on Ideler's calculations, though in some cases different dates are found to be 'accurate'.[34]

At first glance, these results suggest that scholars have been right to criticise Ovid's astronomical skills: the fact that roughly seven out of every ten dates are wrong by modern reckoning does seem to support Fantham's claim that Ovid is 'wildly inaccurate'. Against this background of seemingly random dating, Harries' argument looks strong: Ovid's date of February 5th is wrong, and by a number of weeks, so it is quite possible that it – along with many others – has been deliberately positioned for literary effect.

However, before we lend our voices to the chorus of condemnations, we need to put this figure of 27% into some kind of context. For it to have any meaning, we need to know how other ancient authors fare when judged by the same criteria.

Now, many have sought to excuse or rather explain Ovid's inaccuracies on the grounds that the *Fasti* is after all a poem, and thus the astronomical passages it contains are not supposed to be practical sources of information.[35] However, whilst Ovid may not have included his astronomical information for this reason, there were other writers who did.

So let us turn now to Pliny and his *Natural History*. Pliny opens his huge encyclopaedic work with an account of the heavens and an introduction to basic astronomy, so we might expect him to be better informed about such matters than most. The most relevant section of his work for our purposes is the agricultural calendar, found in the eighteenth book, in which he gives dates for various stellar phenomena, together with instructions on the appropriate agricultural tasks to be carried out at those times. This appears to be a project that is important to Pliny,[36] and his research seems to have been careful and conscientious: he is aware of the problems inherent in his astronomical sources,[37] and he takes pains to specify the location for the phenomena he describes; he complains of the disagreements he finds between different astronomers;[38] and he even goes so far as to correct his sources (cf. 18.271).[39] Furthermore, his primary source for the dates concerning Italy is none other than Julius Caesar himself. It seems that Caesar wrote one or two works on astronomy (perhaps as the groundwork for or as

---

the magnitude of the star, using a value of 0.5 in those cases when the magnitude is 0.5 or less; for latitude I have used the default setting for Rome; and I have calculated the dates for 44BC. The dates for the true phenomena include corrections for refraction, which is arguably inappropriate for these more abstract calculations. However, the dates obtained without this correction usually differ only by a day or so. In the table I have marked the difference in days between the dates obtained by *PLSV* and Ovid. Where this is greater than ± 14, I have marked the 'error' column with an X.

[34] The apparent phenomena: nos. 11, 16, 21, 22, 41 (compare n. 30); the true phenomena: nos. 8, 20, 27, 30, 32, 37, 40 (compare n. 31).

[35] Cf. e.g. Newlands (1995), p. 28.

[36] Cf. *NH* 18.206 *spes ardua, inmensa, misceri posse caelestem divinitatem inperitiae rusticae, sed temptanda iam grandi vitae emolumento*.

[37] Cf. *NH* 18.210 *super omnia est mundi convexitatis terrarumque globi differentia, eodem sidere alio tempore aliis aperiente se gentibus, quo fit, ut causa eius non isdem diebus ubique valeat. addidere difficultatem et auctores diversis in locis observando, mox etiam in isdem diversa prodendo*.

[38] Cf. *NH* 18.212-4.

[39] Cf. *NH* 18.271. Interestingly, his correction is less accurate according to modern calculations: he corrects Caesar's date of 11th Aug. for the setting of the Lyre to 8th Aug. *PLSV* gives the date for the AMS of the Lyre as Aug 25th; the TMS as Aug 17th.

part of his new *Fasti*), which Pliny refers to throughout his astronomical section.[40] Surely we should expect a far better set of results for Pliny than for some dilettante poet like Ovid.

However, if we look at the dates for the phenomena that Pliny associates with Italy,[41] we may be surprised by the results. In Table Two I give the dates for risings and settings that Pliny links to Italy. I apply precisely the same set of criteria as I did for Ovid. By chance, both tables involve 45 phenomena, so the totals are directly comparable. We find that out of 45 dates, eight (18%) fall within ± 4 days of the dates calculated for the apparent phenomena, while ten (22%) fall within ± 4 days of the dates calculated for the true phenomena, giving a total of eighteen out of forty-five (40%).

Pliny fares slightly better than Ovid, but his accuracy – as judged by the above criteria – is still surprisingly poor. This is an important point, and it raises a number of important questions about the validity of the methodology employed thus far. The first is a technical point: if Ovid and Pliny are both so inaccurate according to the criteria we have used, namely that their dates should fall within ± 4 days of those reached by modern calculations, could it be that our criteria for accuracy are mistaken? Is ± 4 days an appropriate error margin for modern calculations? The second point is a more general one, and one we shall explore in some detail: if both Pliny and Ovid are inaccurate compared to modern calculations, are these comparisons telling us anything useful about Ovid as opposed to ancient astronomy in general? Is it Ovid that is inaccurate, or his sources?[42]

As regards the first point, it is important to realise that while the modern calculations give the illusion of precision, they are not without their uncertainties.[43] Let us take the first constellation that receives mention in the *Fasti*, namely the Crab. If we want to calculate the date for the rising or the setting of this constellation, which star should we take as the basis for our calculations? The first star to set (β Cancri), the middle star (δ Cancri), the 'alpha' star (usually but not always the brightest),[44] or the last star to set (ι Cancri)? Or some compromise? Ideler chooses γ Cancri, for reasons not entirely clear.[45] The table below illustrates the difference the choice of star can make to the date; the diagram illustrates the position of the stars of Cancer as it sets:[46]

Phenomena	β	α	δ	γ	ι
AMS	Jan 1	Jan 16	Jan 17	Jan 20	Jan 30
AES	May 23	Jun 1	Jun 3	Jun 2	Jun 11
AMR	Aug 5	Aug 11	Aug 2	Aug 1	Jul 23

[40] cf. Macrobius, *Sat.* 1.16.39; Pliny, *N.H.* 1.18B *Tuberone. L. Tarutio qui Graece de astris scripsit. Caesare dictatore qui item*; 18.214 *nos sequimur observationem Caesaris maxime*; 18.237 *Caesar cancri exortu id fieri observavit, maior pars auctorum vindemitoris emersu…Caesar et idus Mart. ferales sibi notavit scorpionis occasu*. Caesar is cited a total of 27 times, at 18.234, 237, 246–8, 255–6, 268, 270–71, 309–13.

[41] I assume that when Pliny does not specify a location, we should understand him to refer to Italy.

[42] This is an issue raised by Fox, but he does not go into detail: cf. Fox (2004), pp. 128-9.

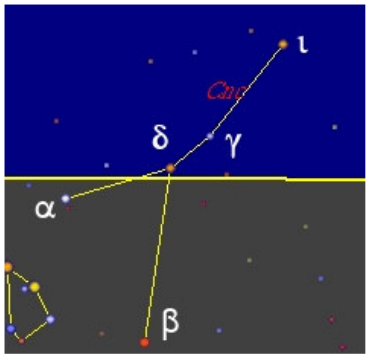
[43] These issues are explored in more detail in Robinson (forthcoming).

[44] The Greek lettering refers to labels introduced by Bayer in his seventeenth century star-atlas *Uranometria* (1603). He ordered the stars by order of magnitude as far as he was able, but within each order of magnitude the stars are not arranged in ascending order of brightness: for example, β Cancri is brighter than α Cancri.

[45] For other examples of seemingly arbitrary choices, cf. e.g. Ideler's choice of ϵ Centauri for his calculations for Centaurus (no. 27) – there are many other possibilities; and Fox (p. 118f.) attempts to defend Ovid's description of the setting of the Lyre (no. 28) by referring to γ Lyrae as opposed to α Lyrae. For further details on the problems involved in the choice of star, see Robinson (forthcoming).

[46] The picture is taken from SkyMap Light 2005, by Chris Marriott, available from www.skymap.com.

AER	Dec 24	Dec 29	Dec 20	Dec 16	Dec 6



Even when one agrees on the star in question, there are further uncertainties. One has to decide on the time and latitude of the observation;[47] and for the traditional method of calculating dates for the apparent phenomena one also has to estimate the minimum distances of a) the sun below the horizon and b) the star above the horizon, for the star to be visible. Various different rules of thumb have been used, and various attempts have been made to refine the calculations further,[48] with the result that even those using the same basic method can obtain different results for the same star: the table below illustrates the results for the star Asellus Borealis (γ Cancri) as obtained by Ideler and PLSV:[49]

Phenomena (γ Cancri)	Ideler	PLSV	Difference in days
AMS	Jan 29	Jan 20	-9
AES	Jun 9	Jun 2	-7

Furthermore, this method and the rules of thumb on which it relies have recently been called into question by the astrophysicist Bradley Schaefer, who argues that they are only valid for unusually clear viewing conditions.[50] He has devised a new method of calculating the dates of the apparent morning rising and evening setting, based on the limiting magnitude of the night sky and the atmospheric extinction factor (which can change with temperature, ambient light, dust in the atmosphere, etc.). Slight changes in the latter variable can produce significant changes in the results of the calculation.

For bright stars close to the ecliptic in theoretically ideal conditions, the methods give similar (though not identical results); but once we assume less than ideal conditions, they can diverge considerably. The table below illustrates this with two examples, giving dates for the AES of Asellus Borealis (γ Cancri), and the AMR of Capella (α Auriga: cf. Table One, no. 25) as calculated by various methods.[51] In both cases, Schaefer's method, using a limiting magnitude of 6 and an extinction factor of 0.2 (which corresponds to an extremely clear night), gives a result fairly close to PLSV; when using an extinction factor of 0.3 (which corresponds to a moderately clear night), the date for γ Cancri is still quite close to that of PLSV, while the

[47] For example, it may not be clear where or when exactly the observations took place. A change in latitude can have a much bigger impact on the result than a change in time: for details, see Robinson (forthcoming).
[48] For example, some calculations include corrections for refraction; some attempt to take into account the difference in azimuth (or horizontal position) between the sun and the star.
[49] The most significant difference between these two methods is that Ideler assumes that the star is visible as it crosses the horizon (a critical altitude of zero), whereas the calculations in *PLSV* assume that the star has to reach a specific altitude to be visible.
[50] cf. Schaefer [1985], [1986], [1987a], [1987b], [1993a], [1993b], [2000]. Schaefer (1985) provides the code for a computer program to calculate the AMR and AES of a particular star. It should be noted, however, that the program assumes a vernal equinox date of March 21st, so the result must be adjusted accordingly.
[51] Calculated for the latitude of Rome in 44BC.

date for Capella (April 21st) is quite different, and significantly closer to Ovid's date of May 1st.

Phenomenon	Ideler	PLSV	Schaefer 6/0.2	Schaefer 6/0.3	Ovid
AES γ Cancri	Jun 9	Jun 2	Jun 1	May 28	n/a
AMR Capella	Apr 7	Apr 7	Apr 11	Apr 21	May 1

This means that unless we are extremely confident in our choice of method and in the values we give to the variables involved, it is best to treat the results of these calculations as a rough guide to the date of the phenomena in question, and to allow an error margin substantially larger than the traditional ± 2 or 3 days. Even if we were absolutely confident of our method, there is still no guarantee that the apparent stellar phenomena would be visible on the date predicted – for example, low clouds could obscure any risings or settings for several days;[52] this is particularly the case with stars of low magnitude, whose risings and settings – as the great astronomer Ptolemy himself remarks – are hard to spot at the best of times;[53] the calculations also assume a flat horizon, but it is quite possible that aspects of the terrain such as a prominent hill may obscure the rising or setting of a star for several days.

It might be objected that many of these uncertainties apply only to calculation of the apparent phenomena: for in the case of the true phenomena, which are invisible and whose dates can only be reached by mathematical methods, as long we are confident that we have the right star and are making the calculations for the right latitude and right epoch, we can calculate the date exactly. However, in this case there are uncertainties of a different kind: namely, how accurate were these calculations in antiquity? We cannot expect ancient science to compete with modern astrometry and modern computational methods, so again it is necessary to allow a wide error margin, but for slightly different reasons than for the apparent phenomena. In this instance, modern calculations can tell us exactly when these phenomena occurred, but they cannot tell us the dates that would have been reached by the very best ancient calculations. It is to be hoped that they would roughly coincide, but once again the precision of the modern calculations is misleading.

If we re-assess the dates given by Ovid and Pliny with a larger error margin of ± 14 days, we obtain the following results:[54]

Author	Entries within ± 14 days of apparent phenomena (of 45)	Entries within ± 14 days of true phenomena (of 45)	Unique entries falling within ± 14 days of either apparent of true phenomena (of 45)
Ovid	18 (40%)	21 (47%)	28 (62%)
Pliny	21 (47%)	21 (47%)	29 (64%)

The increase in the number of dates that are 'accurate' according to our new criteria is striking. We note that with this larger error margin, the total number of 'accurate' dates in Ovid and Pliny is now almost identical.

[52] For some examples, see Robinson (forthcoming).
[53] Ptolemy, *Phaseis* vol. 2, p. 12. We shall discuss this passage in more detail below.
[54] With this larger error margin, some entries fall within ± 14 days of the dates calculated for both the true and apparent phenomena: the final total in the table counts such entries once only.

This helps to explain how Fox obtains his high figure for the percentage of accurate dates in Ovid. His method of testing Ovid's accuracy is very different to the approaches discussed above: he uses astronomical planetarium software to find the position of the star or constellation on the date specified by Ovid three-quarters of an hour before sunrise or after sunset, following a rule-of-thumb found in Pliny.[55] He marks a date as accurate if 'a star reference could be seen to represent an astronomical reality around the dates on which Ovid puts it'.[56] What counts as an 'astronomical reality' is rather vague, and it is a condition that seems to be satisfied as long as the constellation in question is approaching the correct horizon at the roughly the correct time of day.[57] This vagueness is equivalent to the use of a substantial error margin with the traditional method of calculation.[58] This vagueness has some appeal, as in the absence of further research into the matter, the specification of a precise number of days for the error margin (for example, fourteen rather than fifteen) seems somewhat arbitrary. However, there is a danger that this vagueness can allow too much flexibility, as at times Fox allows an error margin substantially larger than ± 14 days. This gives a period of over a month in which a date may be counted as 'accurate'. Indeed, the majority of dates that Fox marks as inaccurate are those that involve what I will term a 'mistaken phase': i.e. the specification of a rising rather than a setting, or a morning rather than an evening phenomenon – on these occasions the dates can be out by a number of months.[59]

Within reason, however, this broader approach to the concept of accuracy may have another advantage, in that it may more closely reflect the attitude of Ovid's audience to these dates: or at least, it encourages us to think what this attitude may have been. It is perhaps worth stressing that observation of these astronomical phenomena is quite demanding: one does not simply stick one's head out of the window and look up at the sky. To spot the first or last visibility would one have to get up not just three quarters of an hour before sunrise,[60] but still earlier to get to a suitable location and allow one's eyes to grow accustomed to the dark; and similarly one would have to interrupt one's evening's entertainment to observe the phenomena after sunset. However, while the Romans may not have had regular first-hand experience of the apparent phenomena, it would still be possible to notice that Aquarius was rising just before sunrise, and then infer from this that the morning rising would have taken place not many days before.

If we return to the rising of the middle of Aquarius, this broad conception of accuracy presents us with a variety of interpretative possibilities: on the one hand, we could argue that such a date corresponds closely enough to reality for this passage not to be marked by its inaccuracy, and so there is no invitation to investigate it further, and less impetus for a close reading; alternatively, one could argue that this broad conception of 'accuracy' is no longer helpful as a criterion for deciding such matters, as on this basis Ovid could have positioned the date almost anywhere in February and it would still be counted as 'accurate'.

---

[55] Fox (2004), p. 98, n. 14; pp. 104-5. The passage of Pliny in question is *NH* 18.219.
[56] Fox (2004), p. 98.
[57] This can obscure the difference made by the brightness or magnitude of the star: a bright star will be visible in the twilight much earlier than a dim one.
[58] In this I would disagree with Fox, p. 129, when he says "as anyone who cares to repeat my calculations will find, most of the time I have not had to give Ovid, or the comparanda texts, a very generous margin of error."
[59] Though the point here is that on these occasions, the date Ovid provides is roughly correct for one phenomenon of the star, just not the one that he specifies. This is a different kind of 'inaccuracy' to providing a date for a phenomenon that is roughly in the right area but still several weeks out.
[60] See n. 55.

Whatever we feel about dates that are 'accurate' on this broad conception of accuracy, one might argue that at least those that are 'inaccurate' are certainly marked by their inaccuracy and as such present a strong invitation to explore them further. For example, at *Fast.* 4.901-4 Ovid talks of the rising of the Dog-Star (Sirius) on April 25th. This is a long way out for both the apparent morning rising, which occurred at the end of July, and the apparent evening rising, which occurred at the beginning of January.[61] The event that did occur at this time was in fact the evening setting.[62] Gee has argued recently that this error was made deliberately, to draw attention to the passage and to emphasise the presence of the star whose martial connotations do not sit happily with the prayer for peace that follows.[63]

Sadly, matters are not quite that simple: we will return to the rising of Sirius later, but for the moment, let us take another example: Ovid records the rising of the Lyre on the morning of January 5th, even though the AMR took place about two months earlier, the TMR earlier still.[64] At first glance, this may seem like a very deliberate decision to place the Lyre as the second constellation in his poem, perhaps as a symbol of poetry. However, if we look elsewhere we find the same date for the same phenomenon not only in Columella but also in Pliny, who gives as his source no less an authority than Caesar himself.[65]

This underlines the fact that when investigating Ovid's accuracy we need to be clear about exactly whose accuracy we are trying to discover. In the case of the Lyre, it seems very likely that the mistake lies not with Ovid, but with his sources.[66] Indeed, when Ovid began writing the *Fasti*, it is extremely unlikely that he set about making his own list of observations. This is not to suggest that he had no familiarity with the night sky, or was incapable of identifying stars and constellations, which were no doubt much more a feature of everyday life in the days before street lighting and atmospheric pollution: but as mentioned above, the observation of these astronomical phenomena is very demanding. Ovid, like Columella and Pliny, will have been using dates found in earlier sources.[67] So any inaccuracy we find in Ovid may be the result of the careful use of an inaccurate source, or careless use of an accurate source.[68]

This is why judging Ovid's 'objective' accuracy, that is the accuracy of his dates as judged against modern calculations, is not sufficient: for example, Ovid may have followed an ancient source with great care, but that source may have been inaccurate. In which case, to say that 76% of Ovid's dates are accurate does not necessarily tells us anything about Ovid's astronomical skills or his literary intentions: it may only tell us about the accuracy of the ancient astronomers whose observations Ovid was using. To proceed any further we need to have some idea of the sources available to Ovid: how many were there? What did they look like? What information did they contain? What format were they in? How accurate were they? Were mistakes often made in the use of such sources?

---

[61] The AMR occurred in Rome on July 30th, the AER on January 5th, according to *PLSV*.
[62] The AES occurred on May 2nd, according to *PLSV*.
[63] Cf. Gee (2002).
[64] The AMR occurred on Nov 5th, the TMR on Oct 24th according to PLSV.
[65] Col. *RR* 11.2.97 *fidis exoritur mane*; Plin. *NH* 18.234 *pridie nonas Ian. Caesari delphinus matutino exoritur et postero die fidicula*.
[66] Le Boeuffle (1964), pp. 329-330, argues that in fact this is not a mistake, and that there are two constellations known as the Lyre. If he is right, then the 'mistake' lies with modern scholars.
[67] Furthermore, in the case of true phenomena he is unlikely to have calculated these dates himself, though if he had access to a sky-globe it may have been an easier task than watching the night-sky every morning and evening.
[68] Fox, p. 128f., makes a similar point, but does not pursue it.

We know from Pliny that many literary parapegmata existed: for example, in addition to the observations of Caesar, he was able to compare dates as observed by Philippus, Callippus, Dositheus, Parmeniscus, Conon, Criton, Democritus, and Eudoxus;[69] he also made use of a astronomical text attributed to Hesiod;[70] and we find a long list of astronomers cited among his sources for Book 18.[71] Presumably some or all of these would have been available to Ovid.[72]

This large variety of sources means that there would have been a large variety of dates from which Ovid could choose: Pliny comments a number of times on the lack of agreement between different astronomers:[73] and while we might expect to find disagreements among astronomers from different latitudes, he notes that we also find them among astronomers from the same latitude: cf. *NH* 18.210 *addidere difficultatem et auctores diversis in locis observando, mox etiam in isdem diversa prodendo*;[74] 212 *minus hoc in reliquis mirum, quos diversi excusaverint tractus; eorum qui in eadem regione dissedere, unam discordiam ponemus exempli gratia...*[75].

Furthermore, it seems that one could also find disagreements between the observations ascribed to the same astronomer. For example, in his *Phaseis*, Ptolemy records meteorological predictions taken from various ancient authorities (dated according to the Alexandrian calendar), among whom are Eudoxus, Euctemon and Callippus.[76] If we compare these predictions with those ascribed to the same authorities in the Geminus parapegma (on which see below), we find that some dates are the same,[77] some dates are not; and that Ptolemy records a number of predictions not found in Geminus and vice versa.[78] However we explain these differences, they underline the wide variety of dates that would have been presented by the sources.[79]

Turning now to some specifics, let us look at Table 3, which contains the dates of stellar phenomena in the month of March, taken from Ovid,[80] Columella,[81] and Pliny,[82] and also

---

[69] Cf. *NH* 18.312.
[70] Cf. *NH* 18.213.
[71] Cf. *NH* 1.18b and c.
[72] Rehm (1941, 1949) assumes that Ovid was using two sources, namely Caesar and the 'Roman Rustic calendar', a Roman version of some Greek parapegmata whose existence was hypothesised by Mommsen. Merkel (1841), pp. lxv-lxxiv believed that Ovid was following Clodius Tuscus. However, there is no good reason to believe that Ovid (or any other Roman for that matter) did not consult Greek sources directly. Of course, the observations in many of the Greek sources would have been made in latitudes other than that of Rome, and so would not necessarily be 'accurate' for Roman skies.
[73] Cf. *NH* 18.212 [of various astrologers] *raro ullius sententia cum alio congruente*, 312.
[74] The context here seems to suggest that Pliny is referring to observations of meteorological phenomena and their relation to the stars, but this is a common feature of parapegmata and the dating of these observations would be linked to the dating of stellar phenomena.
[75] He proceeds to give different dates for the morning rising of the Pleiades from Greek authors. It should be noted however, that they are not all from the same latitude, though the slight differences in latitude would not explain the substantial difference in dates Pliny records. The difference in time would also have little effect.
[76] I assume that Ptolemy's method is to ignore the stellar phenomena in the parapegma (the dates for which he calculates), but to preserve the meteorological information and their dates.
[77] On the conversion of Geminus' zodiacal dates to the Julian calendar, see below.
[78] Another example can be found in the fragments of the inscribed calendar from Miletus (frag. 456A Diels-Rehm), which seem to contain an attribution to Euctemon not found in either Ptolemy or Geminus.
[79] The attempts of scholars such as Rehm (1913, 1941, 1949) to show that all these differences can be reconciled are extremely unconvincing. For similar scepticism regarding the unification of our various sources, see Lehoux (2000), pp. 108-110; and his forthcoming article cited in n. 94.
[80] The references are: *Fast.* 3.339-402 Pisces; 403-7 Bootes and Vindemitor; 449-50 Equus; 459-516 Corona; 711-12 Scorpius.

from the parapegma attached to Geminus' *Elementa Astronomiae*;[83] and from the calendar of 'Clodius Tuscus' found at the end of Lydus' *De Ostentis*.[84] Lydus' text dates from the 6th century, though the date of the calendar attributed to Tuscus is uncertain. I have not included meteorological notices, nor do I attempt to discern any distinctions in the language used in the Geminus parapegma.

The first to point to make is that the dates in the Geminus parapegma are given according to a zodiacal scheme: for example, the date of the evening rising of the Crown is given as Pisces 21, that is, on the 21st day of the sun's journey through Pisces. It is not certain, however, that the Geminus parapegma preserves the original format of its sources: some scholars believe that Euctemon used a zodiacal calendar, but one in which the zodiacal 'months' had different lengths, a fact which was ignored by the compiler of the Geminus parapegma;[85] some believe that Euctemon may have originally recorded his observations using day-counts, later converted into the zodiacal calendar.[86] The zodiacal calendar brings with it its own problems: how were they converted into local calendrical systems, such as the Julian calendar (in the case of Pliny), or the Alexandrian calendar (in the case of Ptolemy)?[87] Some orientation for the dating is given at the start of the calendar, where it is stated that the calendar begins on the summer solstice, with the first day of Cancer: but this may have caused added confusion in Rome, where the system in common use identified the summer solstice not with the first degree of Cancer but rather the eighth.[88] The specification of dates has also proved problematic for modern scholars: the date-equivalences we find in Aujac's 1975 edition of Geminus are taken from Manitius (1898), who takes them from Wachsmuth's 1897 second edition of Lydus *De Ostentis*, which gives different dates to his first edition of 1863.[89] The upshot of this all is that when we convert the zodiacal calendar dates into Julian calendar dates, we cannot be certain that these are the same dates that Ovid or Pliny would have found in their sources (or reached by their own calculations).

From the table we can see that in the Geminus parapegma, more often than not, no time for the rising or setting of a phenomenon is specified (seven out of nine entries not specified). So

---

[81] The references are: 11.2.24 Vindemitor, Equus, Pisces, Argo; 2.30 Scorpius; 2.31 Scorpius, Sun, Equus, Aries, Equinox.

[82] The references are: *NH* 18.237 Cancer, Vindemitor, Pisces, Orion, Scorpius, Equus; 246 Equinox.

[83] The text used is that of Aujac (1975). The date of the *Elementa Astronomiae* is uncertain: Neugebauer (1975), vol. 2, pp. 579-81 argued for a date in the first century AD, against the commonly held view that he was writing in the first century BC (cf. Manitius [1898], p. 213; Aujac [1975], pp. xix-xx). Recently Jones (1999) has restated the case for a date in the first century BC. There is similar disagreement regarding the authenticity of the calendar, some believing it to be the work of Geminus (cf. e.g. Aujac [1975], p. 157), others not (cf. e.g. Böckh [1863], pp. 22ff.; Neugebauer [1975], pp. 580-81; Jones [1999], p. 257). Geminus' parapegma refers to a variety of astronomers, including Eudoxus, Euctemon, Callippus, Democritus, Dositheus, and Meton, though only the first three are cited with any regularity: according to Aujac [1975], p. 157, Eudoxus is cited 60 times, Euctemon 47 and Callippus 33. Chronologically, the latest author to be cited is Dositheus (fl. 240-230).

[84] For discussion of the parapegmatic tradition, see Rehm (1941, 1949) and Lehoux (2000 and 2007).

[85] Cf. Pritchett and van der Waerden (1961), pp. 31f.; van der Waerden (1984), pp. 103-6, following Rehm (1913). The idea is that the compiler of the parapegma was using a zodiacal calendar based on that of Callippus, and that he transferred Euctemon's dates directly over with no adjustment: so Taurus 13 in Euctemon's calendar was marked as Taurus 13 in the Geminus parapegma, even though the date of the former in the Julian calendar would be May 8, while the date of the latter would be May 5.

[86] Cf. Hannah (2002).

[87] Ptolemy records the meteorological information from various ancient calendars in his *Phaseis*, dated according to the Alexandrian calendar. He also records stellar phenomena for a number of bright stars, but these are for the most part reached by calculation rather than by observation or by use of earlier sources.

[88] Cf. e.g. Plin. *NH* 18.264 *solstitium peragi in octava parte cancri et VIII kal. Iul. diximus*; for further details cf. Neugebauer (1975), vol. 2, pp. 593-98.

[89] In the 1863 he begins the calendar on June 27th, following Böckh (1863). In the 1897 second edition, he begins the calendar on June 26th, following Unger (1892), pp. 746-7.

too in Columella (six out of eight not specified) and Pliny (five out of six not specified). Ovid, however, specifies the time on all but one occasion (six out of seven specified). This striking difference suggests a possible explanation for some of Ovid's errors of phase that does not involve Ovid carelessly miscopying his source, or slyly changing time in order to draw attention to the phenomenon in question: namely that confronted with the poetic challenge of turning over forty notices of rising and settings into verse, and doing so in sufficiently varied and interesting ways, Ovid may well have been tempted to specify the evening or morning even when his sources did not. This could be evidence of his lack of awareness of the position of the constellations in the heavens, but it is not necessarily evidence of deliberate tampering with the date.

We may think we see an example of this with the rising of the Horse: Euctemon appears to date its rising to Pisces 14, without specifying whether the rising took place in the morning or the evening. Ovid specifies the evening – unfortunately, it is the morning rising that takes place at this time of year. In fact, Euctemon does not date the rising of the Horse to Pisces 14: although *Εὐκτήμονι δὲ Ἵππος ἐπιτέλλει* is the text printed in the latest edition of Geminus, it is in fact an emendation of Manitius for the transmitted text *Εὐκτήμονι δὲ Ἵππος ἑῷος δύνει* ('for Euctemon the Horse sets in the evening'). What has happened here is that Manitius has 'corrected' the text to replace the erroneous 'morning setting' – which did not take place until September - with a more accurate 'rising'.[90]

The importance of this 'correction' becomes clear when we look at the only stellar phenomenon that Columella and Pliny share in March,[91] and one of the few for which they specify a time, namely the morning setting of the Horse on March 21st.[92] It is not the case that Pliny is following a mistake he found in Columella,[93] for here he explicitly informs us that his source for this date is Caesar (*NH* 18.237) *Caesar notavit ... xii kal. Equum occidere matutino*.

So we find that both Pliny and Columella preserve a mistake which seems to have been in Caesar's calendar; and it is not inconceivable that Caesar's calendar preserved a mistake that was already found in Euctemon's parapegma. If this is the case, then not only did Pliny and Columella not notice that there was a mistake, but neither did Caesar or his ghost-astronomer Sosigenes. This underlines two very important points: first, that when investigating these matters, we need to look at what the manuscripts actually say, rather than what various editors think they should have said;[94] and second, that even those well-versed in astronomy may not have been particularly sensitive to an error of phase.

Turning away from the table for a moment, we find another very telling example of the ease with which one can make such a mistake in Pliny: at one point in his agricultural calendar, he is so struck by the fact that all his sources are for once in agreement that he notes that fact with a lengthy authorial comment: *dein consentiunt, quod est rarum, Philippus, Callippus, Dositheus, Parmeniscus, Conon, Criton, Democritus, Eudoxus IV kal. Oct. capellam matutino*

[90] It should be noted that the evening setting of Pegasus also took place at about this time, and so some scholars have proposed to emend 'morning' to 'evening' rather than delete the time reference and emend 'set' to 'rise'.
[91] Their entries for March 15th are slightly different, in that for Columella, the setting 'begins' on the 15th (he has just an ordinary setting on the following day): cf. Col. 11.2.30 *id. Mart. Nepa incipit occidere*; Plin. *NH* 18.237 *Caesar et idus Mart. ... notavit scorpionis occasu.*
[92] Cf. Col. 11.2.31 *xii calen. April Equus occidit mane*; Plin. *NH* 18.237.
[93] Pliny lists Columella among his sources for Book 18 (cf. *NH* 1.18b).
[94] The parapegmatic tradition is particularly vulnerable to such 'corrections': for more on this topic, see Lehoux, 'Image, Text, and Pattern: Reconstructing Parapegmata' in A. Jones, ed., *Reconstructing Ancient Texts* (Toronto, forthcoming).

exoriri et III kal. Haedos.[95] Pliny refers to the morning rising of Capella on September 28th, and of the Kids on September 29th. Alas, it was the *evening* rising of Capella and the Kids that fell around this time.[96] We find other such errors of phase in Pliny, not just mistakes involving a confusion between morning and evening but also those involving confusion between rising and setting.[97] Such mistaken phases are also not uncommon in Columella.[98] These errors may of course be the result of corruptions introduced in transmission of the texts of Pliny and Columella, but then again these corruptions may have already existed in the sources they were using.

If we look now at the 'calendar of Clodius Tuscus', we see just how garbled the tradition can become, and how insensitive authors, compilers or scribes could be to astronomical errors: we find Arcturus' evening rising on the day after its morning rising (it actually occurred about five months later); repeated references to the morning setting of the Horse (see above); the morning setting rather than the evening rising of the Crown; the setting rather than the rising of Vindemiatrix,[99] etc..

Finally, for the sake of comparison, let us see how well Euctemon performs according to modern calculations, applying the same criteria as we did for Ovid and Pliny.

CONSTELLATION	EUCTEMON	PLSV (432BC, ATHENS)			
Arcturus	ER Mar 4	AER Feb 23	-9	TER Mar 3	-1
Vindemitor	R Mar 4	AER Feb 14	-18	TER Feb 22	-7
Equus	MS Mar 6	AMS α Sep 6	+184	TMS Aug 27	+174
		AMR α Feb 14	-20	TMR Jan 18	-47
		AES α Feb 2	-32	TES Feb 19	-15
Scorpius	S Mar 21	AMS ζ Apr 17	+27	TMS Apr 2	+12

While we should certainly bear in mind both the uncertainty involved in the modern calculations,[100] and the uncertainty involved in turning zodiacal dates into dates in the Julian calendar, Euctemon's dates do not correspond particularly well with those reached by modern calculations for apparent phenomena. There is a better match with the true phenomena, but some scholars do not believe that astronomy was at a sufficient stage in Euctemon's time for these dates to be calculated.[101] Obviously this is just a tiny sample, but it does remind us that we should not expect too much from ancient astronomical sources (or modern calculations?) in terms of precision, and that some of Ovid's 'inaccuracies' may have been taken directly from his sources. Indeed, the great astronomer Ptolemy, writing about a century after Ovid, complains about the standards of the observations made by his predecessors. In defending his decision to deal only with stars of the first and second magnitude in his list of risings and settings in the *Phaseis*, he has this to say:

---

[95] Cf. *NH* 18.312.
[96] PLSV gives the date for the AER of Capella as Sept 24; of Haedi as Sept 26 for Athens in 432BC.
[97] Cf. e.g. 18.237 MR of Pisces rather than ES; 256 S rather than MR of Orion's sword; 312 MS rather than ER of Auriga.
[98] Cf. e.g. 11.2.58, where Columella gives Arcturus' setting rather than his rising; or 11.2.93 where he gives the setting rather than the rising of the middle of Sagittarius. For an assessment of Columella's accuracy (relative to other sources), see Le Boeuffle (1964). He claims that Columella's accuracy is 87% (p. 333), though it is not clear exactly what his criteria for accuracy were. My preliminary investigations suggest that applying the same criteria as we have to Ovid and Pliny gives a considerably lower figure.
[99] The AMS of Vindemiatrix took place on May 7th, according to PLSV; the AES on Sep 1st.
[100] In this instance, we are also uncertain about the time and place of the observations: according to Ptolemy, *Phas*. vol. 2, p. 67 H, Euctemon observed in Athens, the Cyclades, Macedonia and Thrace.
[101] Cf. e.g. Bowen and Goldstein (1988), p. 54.

> But one should pardon the fact that we have not incorporated some of the dimmer stars that are named by the more ancient [authorities] either in the treatise on this subject itself or here, e.g. Sagitta, the Pleiades, the Haedi, Vindemiatrix, Delphinus, and any other such [constellation], since the fault is not grave, especially since the last and first appearances of such small stars are absolutely difficult to judge and observe, and one might remark that our predecessors handled them more by guesswork than by observation of the actual phenomena.[102]

What can we conclude from all of this? It is clear that when Ovid was composing the astronomical parts of his *Fasti* a wide variety of sources would have been available to him. He would have found different dates in each source, and perhaps even different dates in sources attributed to the same astronomer. These sources may not have been 'accurate' according to modern calculations using a narrow margin of error. Some sources would not have specified the time of all the phenomena. Some of these sources contained errors, either errors in observation, errors arising from textual transmission, or errors that were the result of simple mistakes. We see that other authors preserve these errors, which may suggest an insensitivity to such errors; it certainly underlines the ease with which such errors are made.

Let us now return to Harries and the rising of the middle of Aquarius. How does an examination of the sources affect our reading of the passage? As mentioned above, Harries dismissed the possibility that Ovid and Columella reflect a common source (p. 167, n. 18): "That Columella … follows Ovid in recording the rise of Aquarius at its mid-point is at least as likely as that both use some (unknown) independent source. Columella's 'mediae partes Aquarii oriuntur' is simply a prose version of *Fast.* 2.145". However, the fact that Columella includes another phenomenon involving Aquarius' mid-point later in his agricultural calendar suggests that he was not merely rephrasing Ovid,[103] and makes the possibility that they were using a common source more likely. Indeed, we find a very similar dating for the rising of the middle of Aquarius in two ancient sources: according to the Geminus parapegma, Callippus dated this phenomenon to Aquarius 17 (Καλλίππῳ Ὑδροχόος μέσος ἀνατέλλει), or February 7th following the conversion system commonly used; we also find the same phase recorded in the Miletus parapegma for Aquarius 18 (fr. 456b Diels-Rehm), or February 8th.

The fact that Ovid and Columella both give same date for this phenomenon strongly suggests that they used a common source, and that source specified the date of the rising of the mid-point of Aquarius as February 5th. It could be argued that Ovid changed the date from say February 7th to February 5th for literary purposes, to ensure that the astronomical passage was juxtaposed to preceding passage on Augustus' title of *pater patriae*, but closer inspection of the *Fasti* makes this unlikely. The next entry in the *Fasti* after February 5th is dated to February 9th, so it makes no difference whether the passage is dated to February 5th, 6th, 7th or 8th: in all cases, the astronomical passage still follows on immediately from the *pater patriae* passage that precedes it.

So let us review the situation: the date of February 5th does not closely correspond to – that is to say, it does not fall within ±4 days of – the date reached by modern calculations for Rome for either the apparent or the true morning rising. However, we have seen that this is also true of many dates in Pliny. This suggests that we would be unwise to expect a close correspondence between ancient and modern dates: partly because of the uncertainties

---

[102] Ptol. *Phas.* vol. 2, p. 12 H: *τὸ μέντοι τινὰς τῶν παρὰ τοῖς παλαιοτέροις κατωνομασμένων ἀμαυροτέρων ἀστέρων μὴ προσεντετάχθαι παρ' ἡμῖν μήτε ἐν αὐτῇ τῇ τῆς πραγματείας συντάξει μήτε νῦν, οἷον Ὀιστόν, Πλειάδας, Ἐρίφους, Προτρυγη τῆρα, Δελφῖνα, καὶ εἴ τις τοιοῦτος, συγχωρητέον, εἰ μὴ βαρὺ τὸ αἴτημα, μάλιστα μὲν διὰ τὸ δυσδιακρίτους καὶ δυσκατανοήτους εἶναι παντάπασιν τὰς τῶν οὕτω σμικρῶν ἀστέρων ἐσχάτας καὶ πρώτας φαντασίας, κεχρῆσθαί τε τοὺς πρὸ ἡμῶν αὐταῖς ἀπὸ στοχασμοῦ τινος μᾶλλον ἢ τηρήσεως ἐξ αὐτῶν τῶν φαινομένων ἄν τις κατανοήσειεν*. The translation is that of Jones.

[103] In August, outside the range of the *Fasti* (which only covers January to June): cf. Col. 11.2.57.

involved in making the modern calculations, and partly because of the difficult and inexact nature of the phenomena in question.[104] Modern calculations can however tell us if a date is roughly correct, that is to say, if it roughly corresponds to what can be observed in the night sky. If so, then one might assume that such a date would not strike Ovid's readers as particularly odd or puzzling, and thus would not draw attention to itself.[105] On this approach, Ovid's date of February 5th seems unexceptional. Finally, we can now plausibly argue that Ovid found the date of February 5th in one of his sources. While the observation may have been made in a latitude different to that of Rome, and while its use in Rome may be not be astronomically sound, it is still roughly correct. If Ovid has made this methodological error, it is one shared by Columella, and according to Ideler, by Caesar on a number of occasions.

So we have a date that comes from an ancient source, that we also find in Columella, and which is accurate enough not to draw attention to itself. It is hard to argue that Gee's criterion of 'juxtaposition at the expense of chronological accuracy' is satisfied here. Does Harries' hypothesis – that Ovid has deliberately juxtaposed the rising of Aquarius with the granting of the title *pater patriae* to Augustus – fall down as a result?

I would argue that it does not, and that in this case, as in many others, focus on Ovid's 'accuracy' or otherwise is unhelpful. First, for almost all the stellar phenomena listed in the *Fasti* Ovid would have found a variety of dates in his sources. He would have had a range of options from which to choose,[106] and the existence of choice is always an invitation to examine the choice made for significance.

However, there is a more important point to make here: even if all sources and regular observations and modern calculations were in agreement that the rising of the middle part of Aquarius took place on February 5th, Harries' hypothesis still stands. Literary criticism of the *Fasti* has thus far been focused on the accuracy or otherwise of the *dates* of the stellar phenomena; however, a glance at Tables Two and Three, and through the sources in general, remind us that on every occasion Ovid has a choice of *which constellation* to mention, and whether to mention a particular constellation or not. To further illustrate the point, the table below lists the constellations mentioned during February in Ovid, Columella, and the Miletus Parapegma (fr. 456b Diels-Rehm, Miletus II).

CONSTELLATION	MILETUS PARAPEGMA	OVID	COLUMELLA
Andromeda	Andromeda MR begins		
Aquarius	Aquarius middle R	Aquarius middle R	Aquarius middle R
Acrturus		Arcturus R	Arcturus ER
Centaurus	Centaur MS all		
Cetus	Cetus ES begins		
Crater		Crater, Corvus, Hydra R	Crater ER
Cygnus	Cygnus ES all		
Delphinus		Delphinus	
Hydra	Hydra MS all		
Lyra		Lyre ES	Lyre S (all)
Leo		Leo (back) ES	Leo middle S
Pegasus	Pegasus MR begins		
Sagitta	Sagitta S. Zephyrs		Sagitta ER begins
Sagittarius			Sagittarius ES

[104] This is particularly true of θ Aquarius, which is a very dim star (magnitude 4.17): as such, its first and last risings and settings are very hard to see clearly. Compare the passage of Ptolemy quoted above.
[105] It should be noted when confronting the barrage of criticism levelled at Ovid by modern scholars that Pliny was happy to use Ovid as a source (cf. Plin. *NH* 1.18b).
[106] It is of course possible that the extensive variety of dates in his sources may well have encouraged him to some of his own.

So again, even if it could be shown that every single source available to Ovid gave February 5th as the date for the rising of the middle parts of Aquarius, it is still highly significant that he chose to include this phenomenon in his calendar: he could have chosen another one, such as the morning rising of Andromeda, which occurs at about this time according to the Miletus parapegma, or he could have not mentioned Aquarius at all. Indeed in the last half of February he chooses not to include *any* stellar phenomena after he has described the sun moving into Pisces.[107]

This is an important point to stress, as it is very easy when reading the *Fasti* to assume that Ovid had no choice regarding the events to write about, be they terrestrial or celestial – and when Ovid writes such things as *exigit ipse locus raptus ut uirginis edam*,[108] this is a view he himself encourages.[109] We find different anniversaries recorded in different *Fasti*, and different constellations marked in different *parapegmata*. In each case Ovid has made a choice, and in each case we may feel justified in examining that choice for significance.

Let us take two more examples: the first involves a passage where Ovid's date is accurate on the narrow error margin of ± 4 days with which we began, namely the evening setting of the Dolphin, which Ovid dates to February 3rd, just before the *pater patriae* passage.[110] This is close to the date of the TES (Jan 31st),[111] and close to the date in Columella (Jan 30). As such it is reasonably 'accurate' and unremarkable. Neither Gee (who looks for juxtaposition 'at the expense of chronological accuracy') nor Fox (who believes that Ovid 'took pains to be accurate') would mark this passage as one suitable for investigation. However, as I have argued above, even if Ovid's dates are accurate, or correspond to those found in another source, we are still justified in a close examination of the text. Ovid has chosen to mention the Dolphin constellation at this point, and he has made other choices too: he chooses to explain how the Dolphin was raised to the heavens,[112] and he chooses one of a number of possible stories: in this case, he hints at one possible story (the tale of Poseidon and Amphitrite) only to narrate an other, which turns out to be an unusual version of the Arion tale. In Ovid's version of the story, the *gubernator* of Arion's ship plays a striking and otherwise unattested role in throwing the poet overboard.[113] Immediately after this narrative there follows the celebration of Augustus as *pater patriae*. The fact that Ovid has made these choices should encourage us to explore how the unexpected violence of the helmsman of Arion's ship affects our reading of Ovid's praise of the helmsman of the Roman state. Whatever we conclude about the juxtaposition of these passages, the approach is methodologically sound.

Our final example involves a passage where there is a clear error, namely the error of phase at 4.901-4, where Ovid describes the rising rather than the setting of Sirius. Gee takes this inaccuracy as the basis for her literary interpretation of the text.[114] Now it may be possible

---

[107] Ovid also had a choice regarding the identity of Aquarius. Harries argues that Ovid's choice of Ganymede is not the most obvious, but it is the identification we find in Eratosthenes, who is the main source for Ovid's catasterism myths: see Robinson (2000), pp. 43-5.
[108] Ov. *Fast.* 4.417 (introducing the story of the rape of Persephone).
[109] Cf. Barchiesi (1997), pp. 74-78.
[110] Cf. *Fast.* 2.79-118.
[111] According to *PLSV*.
[112] He does not always include a catasterism myth – indeed, this is the first extended catasterism narrative in the *Fasti*.
[113] When mentioned, the *gubernator* is usually on the side of the victim. For details see Robinson (2000), on 79-118.
[114] Cf. Gee (2002).

that this error in phase was deliberate, to draw attention to the passage (see below); however, even if it were an honest mix-up, such as we see elsewhere, Gee's argument still stands: the fact that Ovid has chosen to mention the star at all is sufficient invitation to press the text further. The question of accuracy or otherwise is no longer so important.

The end result of this approach may seem similar to that of Newlands' position: she argues that Ovid's 'seeming carelessness about the dates' allow him to position the astronomical passages where 'they best suit his poetic design'.[115] However, the fundamental difference is that with the approach argued for above, the concept of 'accuracy' does not come into play at all: Ovid may well have been very careful about the dates (as argued by Fox), but he still would have had flexibility as to when and where to place his stellar narratives.

Although I have argued that Ovid's accuracy or lack of it should not play an important role in our approach to the literary criticism of the *Fasti*, there are two areas where I would make an exception. The first concerns the arguments of scholars such as Hannah and Fox, who argue that Ovid's astronomy is good enough that we should feel justified in seeing the night sky as another text to which Ovid can allude. Focus on Ovid's inaccuracy has discouraged scholars from such a position, but the fact that Ovid's astronomy is of a similar standard to that of Pliny, and (perhaps more importantly) that observation of the apparent phenomena is a very different activity to ordinary star-gazing, should encourage us to follow their lead.

The second area lies beyond the scope of this article, and it concerns the extent to which Ovid's audience would have been sensitive to those dates which are significantly inaccurate, most commonly those involving mistakes of phase: would they have marked out the astronomical passages in question for particular attention? The frequency with which these errors seem to have occurred in the calendars of Pliny and Caesar might suggest that an ancient audience would not be particularly sensitive to such things, but it may be that some errors may have been more striking than others. Ovid's specification of the rising rather than the setting of Sirius could be regarded as the kind of mix-up exampled many times in the sources, but the strong association with the rising of Sirius and the heat of summer makes this error particularly surprising.[116] We should also note in this regard an example recorded by Plutarch of the hostility of Caesar's enemies to his new calendar: he relates how in response to someone's remark 'The Lyre will rise tomorrow', Cicero replied 'Yes, in accordance with the edict'.[117] Some see this as an ironic response by Cicero to the error in Caesar's calendar regarding the rising of the Lyre in January (see discussion above),[118] though for Plutarch it is rather a comment by Cicero on the extent of Caesar's control. If the story is true, then does it suggest that discussion about these astronomical phenomena was more common than one might expect?

With a better understanding of such issues, we may be able to take a more nuanced approach to Ovid's astronomy. In the meantime, however, whatever we may feel about Ovid's skill as an astronomer, we do more justice to Ovid's skill as a poet if we open up avenues of interpretation, rather than attempt to close them down.

---

[115] Newlands (1995), p. 31

[116] One could argue, however, that while Ovid was fully aware that one astronomical rising of Sirius was connected with the heat of summer (as it happens, this is the morning rising), for neither him nor his contemporaries was there a strong association between the other phenomena (AER, AMS, AES) and the seasons. It should be noted, however, that Vergil seems to get the timing of this phenomenon right (cf. *Georg.* 1.218), and its presence in an esteemed literary text might give it prominence.

[117] Plut. *Caes.* 59.6.

[118] cf. Holleman (1978).

Bibliography

Aveni, A.F. (1972) 'Astronomical Tables Intended for Use in Astro-Archaeological Studies', *American Antiquity* 37, pp. 531-40.

Aujac, G. (1975) *Géminos. Introduction aux Phénomes*. Paris: Les Belles Lettres.

Bailey, C., ed. (1921) *P. Ovidi Nasonis Fastorum Liber III*. Oxford: Clarendon Press.

Barchiesi, A. (1997) *The Poet and the Prince. Ovid and Augustan Discourse*. Berkeley and Los Angeles: University of California Press

Barsby, J. (1978) *Ovid*. Greece and Rome Surveys in the Classics, vol. 12. Oxford: Clarendon Press

Böckh, A. (1863) *Über die vierjährigen Sonnenkreise der Alten, vorzueglich den Eudoxischen*. Berlin: G. Raimer.

Bömer, F. (1957-8) *P. Ovidius Naso: Die Fasten*. 2 vols. Heidelberg: C. Winter.

Bowen, A. and Goldstein, B. (1988) 'Meton of Athens and Astronomy in the Late Fifth Century B.C.' in *A Scientific humanist : studies in memory of Abraham Sachs*, ed. E. Leichty, M. de J. Ellis, and P. Gerardi. Philadelphia: University Museum.

Degrassi, A. (1963) *Inscriptiones Italiae*. Rome: Istituto Poligrafico dello Stato

Diels, H., and Rehm, A. (1904) 'Parapegmenfragmente aus Milet' *Sitzungsberichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin (phil.-hist.)* 23: 92-111.

Evans, J. (1998) *The History and Practice of Ancient Astronomy*. New York: Oxford University Press.

Fantham, R. E., ed. (1998) *Ovid. Fasti. Book 4*. Cambridge: Cambridge University Press.

Fox, M. (2004) 'Stars in the *Fasti*: Ideler (1825) and Ovid's Astronomy Revisited' *American Journal of Philology* 125: 91-133.

Frazer, J. G., ed. (1929) *Publii Ovidii Nasonis Fastorum Libri Sex,* edited with translation and commentary. 5 vols. London: Macmillan.

Gee, E. (2000) *Ovid, Aratus and Augustus*. Cambridge: Cambridge University Press.

——— (2002) "*Vaga signa*: Orion and Sirius in Ovid's *Fasti*." In *Ovid's Fasti. Historical Readings at its Bimillennium*, edited by G. Herbert-Brown, 47-70. Oxford: Oxford University Press, 2002.

Green, S. J. (2004) *Ovid, Fasti 1. A commentary*. Leiden: Brill.

Hannah, R. (1997a) 'Is it a Bird? Is it a Star? Ovid's Kite - and the First Swallow of Spring' *Latomus* 56: 327-42.

——— (1997b) 'The Temple of Mars Ultor and 12 May' *Mitteilungen des Deutschen Archäologischen Instituts, Römische Abteilung* 104: 527-535.

——— (2002) 'Euctemon's Parapegma' in *Science and Mathematics in Ancient Greek Culture* edited by T. E. Rihll and C. J. Tuplin, 112-32. Oxford: Oxford University Press.

——— (2005) *Greek and Roman Calendars. Constructions of Time in the Classical World*. London: Duckworth.

Harries, B. (1989) 'Causation and the Authority of the Poet in Ovid's Fasti' *Classical Quarterly* 39: 164-85.

Holleman, A. W. J. (1978) 'Cicero's reaction to the Julian calendar (Plut., Caes. 59)' *Historia* 27: 496-8.

Ideler, C. L. (1822-3) 'Uber den astronomischen Theil der Fasti des Ovid' *Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin* (1822-3): 137-69.

Jones, A. R. (1999) 'Geminus and the Isia' *Harvard Studies in Classical Philology* 99: 255-267.

Le Boeuffle, A. (1964) 'Quelques erreurs ou difficultés astronomiques chez columelle' *Revue des Études Latines* 42 : 324-333.

Lehoux, D. R. (2000) *Parapegmata*. PhD Thesis: University of Toronto. Available on-line at http://www.collectionscanada.ca/obj/s4/f2/dsk2/ftp03/NQ53766.pdf.

——— (2007) *Astronomy, Weather, and Calendars in the Ancient World: Parapegmata and Related Texts in Classical and Near-eastern Societies*. Cambridge: Cambridge University Press.

Manitius (1898) *Geminus. Elementa Astronomiae*. Leipzig: Teubner.

Meeus, J. (1998) *Astronomical Algorithms*. 2nd ed. Richmond: Willman-Bell, Inc.

Merkel, R. (1841) *P. Ovidii Nasonis. Fastorum Libri Sex*. Berlin.

Neugebauer, O. (1975) *A History of Ancient Mathematical Astronomy*. 3 vols. Berlin: Springer-Verlag.

Neugebauer, P. V. (1922) *Tafeln zur astronomischen Chronologie. Teil 3. Hilfstafeln zur Berechnung von Himmelserscheinungen*. 1st ed. Leipzig: J.C. Hinrichs.

Newlands, C. E. (1995) *Playing with Time: Ovid and the Fasti*. Ithaca and London: Cornell University Press.

Pedersen, O. (1986) "Some Astronomical Topics in Pliny." In *Science in the early Roman Empire : Pliny the Elder : his sources and influence*, edited by R. French and F. Greenaway.

London: Croom Helm, 1986.
Pritchett, W. K., and Van Der Waerden, B. L. (1961) 'Thucydidean time Reckoning and Euctemon's Seasonal Calendar' *Bulletin de correspondance hellénique* 8 : 17-52.
Rehm, A. (1913) 'Griechische Kalender III. Das Parapegma des Euktemon' *Sitzungsberichte Heidelberger Akademie (phil.-hist.)* 3 (1913).
——— (1941) *Parapegmastudien : mit einem Anhang Euktemon und das Buch De signis*. Munich: Bayerische Akademie der Wissenschaften.
——— (1949) "Parapegma." *RE* 18.4, 1295-1366.
Robinson, M. (2000) "Prolegomena to the Study of Ovid's *Fasti*, with a commentary on Book 2, 1-532." DPhil thesis, Oxford University.
——— (forthcoming) 'Ardua et Astra – On the Calculation of the Dates of the Rising and Setting of Stars' *Classical Philology* (forthcoming).
Schaefer, B. (1985) 'Predicting Heliacal Risings and Settings' *Sky and Telescope*: 261-263.
——— (1986) 'Atmospheric Extinction Effects on Stellar Alignments' *Archaeoastronomy* 10: 32-42.
——— (1987a) 'Heliacal Rise Phenomena' *Archaeoastronomy* 11: 19-33.
——— (1987b) 'Extinction Angles and Megaliths' *Sky and Telescope* 73: 426.
Schaefer, B., and Lillier, W. (1990) 'Refraction Near the Horizon' *Publications of the Astronomical Society of the Pacific* 102: 796-805.
Schaefer, B. (1993a) 'Astronomy and the Limits of Vision' *Vistas in Astronomy* 36: 311-61.
——— (1993b) 'Astronomy and the Limits of Vision' *Archaeoastronomy* 11: 78-90.
——— (1998) 'To the Visual Limits' *Sky and Telescope*, no. May: 57-60.
——— (1999) 'Astronomy in Historical Studies' *Archaeoastronomy* 14, no. 1: 89-108.
Schaefer, B. (2000) 'New Methods and Techniques for Historical Astronomy and Archaeoastronomy' *Archaeoastronomy* 15: 121-136.
Smith, W., Wayte W. and Marindin G.E. eds. (1890) *Dictionary of Greek and Roman antiquities*, 3rd ed. London: Murray.
Thom, A. (1967) *Megalithic Sites in Britain*. Oxford: Clarendon Press.
Unger, G. (1892) "Zeitrechnung der Griechen und Römer." In *Handbuch der klassischen Alterthumswissenschaft*, edited by I. Müller, 716-831. 2nd ed. Munich: Beck, 1892.
Van Der Waerden, B. L. (1984) 'Greek Astronomical Calendars I. The Parapegma of Euctemon' *Archive for History of Exact Sciences* 29, no. 2: 101-114.
——— (1984) 'Greek Astronomical Calendars I. The Parapegma of Euctemon' *Archive for History of Exact Sciences* 29, no. 2: 101-114.
Wachsmuth, C. (1863) *Ioannis Laurentii Lydi Liber de ostentis ex codicibvs italicis auctus et calendaria graeca omnia*. Leipzig: Teubner.
——— (1897) *Ioannis Laurentii Lydi Liber de ostentis et calendaria Graeca omnia*. 2 ed. Leipzig: Teubner.
West, M.L. (1978) *Hesiod. Works and Days*. Oxford: Oxford University Press.

Table One: Astronomical Phenomena in Ovid

#	Error	Fasti Ref.	Star Sign	Ovid's Date	Dates calculated using PLSV				Ideler's Dates	
					Apparent phenomena	days after	True phenomena	days after	Apparent phenomena	True phenomena
01	X	1.311-4	Cancer	Jan 3rd. ES	AES α Jun 1 AMS α Jan 16 AER α Dec 29	+149 +13 +5	TES Jul 3 TMS Jan 3 TER Jan 9	+181 0 +6	AES γ Jun 9 AMS γ Jan 29	TMS γ Jan 25
02	X	1.315f.	Lyra	Jan 5th. R	AMR α Nov 5	-61	TMR Oct 24	-73	AMR Nov 5	TMR earlier
03		1.457f.	Delphinus	Jan 9th. R	AMR α Jan 3	-6	TMR Dec 9	-31	AMR Dec 31	
04		1.653f.	Lyra	Jan 23rd. ES	AES α Jan 28	+5	TES Feb 9	+17	AES Jan 28	TES Feb 9
05	X	1.655f.	Leo (breast)	Jan 24th. ES	AES α Jul 1 AMS α Feb 11 AER α Jan 11	+158 +18 -13	TES Jul 27 TMS Jan 26 TER Jan 21	+184 +2 -3	AES Jul 6 AMS Feb 6	TMS Jan 24
05.5										
06		2.73-6	Lyra	Feb 2nd ES	AES α Jan 28	-5	TES Feb 9	+8	AES Jan 28	TES Feb 9
07	X	2.77f.	Leo (back)	Feb 2nd. ES	AES α Jul 1 AMS α Feb 11	+149 +9	TES Jul 27 TMS Jan 26	+175 -7	AES Jul 6 AMS Feb 6	TMS Jan 24
08		2.79f.	Delphinus	Feb 3rd .ES	AES α Jan 8	-26	TES Jan 31	-3	AES Jan 13	TES Feb 1
09		2.145f.	Aquarius (middle)	Feb 5th. R	AMR θ Mar 5 AES θ Jan 3	+28 -33	TMR Jan 22 TES Jan 27	-14 -9	AMR θ Feb 25	TMR Jan 22
10		2.153f.	Bootes (feet)	Feb 11th. ER	AER α Feb 23	+12	TER Mar 3	+20	AER Feb 27	TER Mar 6
11		2.243-5	Crater, Corvus, Hydra	Feb 14th. ER	AER α Feb 14	0	TER Feb 23	+7	AER Feb 8	TER Feb 25
11.5										
12		3.399–402	Pisces (one of)	Mar 3rd. ES	AES α Feb 25	-5	TES α Mar 20	+17	AES φ Mar 7	
13	X	3.403–6	Bootes	Mar 5th. MS	AMS α Jun 17 AER α Feb 23	+104 -10	TMS Jun 2 TER Mar 3	+89 -2	AMS Jun 10 AER Feb 27	TMS May 28 TER Mar 6
14	X	3.403–7	Vindemitor	Mar 5th.MR?	AER ε Feb 15	-18	TER Feb 24	-9	AMR Sep 18 AER Feb 14	TMR Aug 31 TER Feb 26
15	X	3.449f.	Pegasus (neck)	Mar 7th. ER	AER γ Jul 20 AMR γ Mar 18 AES γ Feb 17	+135 +11 -18	TER Aug 9 TMR Feb 7 TES Mar 7	+155 -28 0	AMR γ Mar 11	
16		3.459–516	Corona	Mar 8th. ER	AER α Mar 7	-1	TER Mar 15	+7	AER Mar 10	
17	X	3.711f.	Scorpio (first bit)	Mar 16th. MR	AMR α Nov 22 AMS ζ Apr 9	-114 +24	TMR α Nov 8 TMS ζ Mar 25	-128 +9	AMS α May 13	TMS α Apr 26
17.5										
18		4.163f.	Scorpio	Apr 1st. S	AMS ζ Apr 9 AMS α Apr 25	+8 +24	TMS ζ Mar 25 TMS α May 5	-7 +34	AMS α May 13	TMS α Apr 26
19	X	4.165–170	Pleiads	Apr 2nd. MS	AMS η Nov 8 AES η Apr 6 AMR η May 30	-145 +4 +58	TMS Oct 30 TES Apr 26 TMR Apr 17	-154 +24 +15	AMS Nov 9 AES Apr 8 AMR May 28	
20		4.385f.	Libra	Apr 6th. ??	AER α Mar 29 AMS α May 6	-8 +30	TER Apr 7 TMS Apr 14	+1 +8	AMS α May 18 AMS β Jun 4	TMS α Apr 10 TMS β May 2
21		4.387f.	Orion	Apr 9th. S	AES β Apr 13 AES α Apr 30	+4 +21	TES β Apr 26 TES α May 14	+17 +35	AES ε Apr 19 AES α Apr 28 AES β Apr 11	TES β Apr 26 TES α May 11
22		4.677f.	Hyades	Apr 17th. ES	AES α Apr 17	0	TES May 1	+14	AES Apr 20	

Table One continued

23	X	4.901–3	Aries	Apr 25th. S	AES α Mar 19 AMS α Oct 18 AMR α Apr 18	-37 +176 -7	TES Apr 4 TMS Oct 10 TMR Mar 11	-21 +168 -45	AES Mar 20 AMR Apr 15	TES Apr 5
24	X	4.901–4	Canis (major)	Apr 25th. R	AMR α Jul 30 AER α Jan 5 AES α May 2	+96 -110 +7	TMR Jul 19 TMR Jan 12 TES May 13	+85 -103 +18	AMR Aug 2 AES May 1	TMR Jul 19
24.5										
25	X	5.111–14	Capella	May 1st. ER	AER Aug 21 AMR Apr 7	+112 -24	TER Sep 8 TMR Mar 9	+130 -53	AER Aug 26 AMR Apr 7	 TMR Mar 10
26	X	5.159–64	Hyades (all)	May 2nd. ER	AER α Oct 26 AMR α Jun 11 AES α Apr 17	+177 +40 -15	TER Nov 12 TMR May 16 TES May 1	+194 +14 +1	AMR Jun 9	TMR May 16 TES May 3
27		5.379f.	Centaurus	May 3rd. ER	AER ϵ Apr 25	-8	TER ϵ Apr 30	-3	AMR ε Apr 15	TMR ε May 3
28	X	5.415f.	Lyra	May 5th. ER	AER α Apr 11	-24	TER Apr 19	-16	AER Apr 14	TER Apr 22
29	X	5.417f.	Scorpio (middle)	May 6th. MR	AMR α Nov 22 AER α Apr 25 AMS α May 19	+200 -11 +13	TMR α Nov 8 TER α May 5 TMS α Apr 29	+186 -1 -7	 AMS α May 13	 TMS α Apr 26
30		5.493f.	Orion	May 11th. S	AES α Apr 30 AES β Apr 13	-11 -28	TES α May 14 TES β Apr 26	+3 -15	AES ε Apr 19 AES α Apr 28 AES β Apr 11	TES β Apr 26 TES α May 11
31	X	5.599–603	Pleiads (all)	May 13th. ER	AER η Sep 26 AMR η May 30 AES η Apr 6	+136 +17 -37	TER Oct 15 TMR Apr 17 TES Apr 26	+155 -26 -17	AMS Nov 9 AES Apr 8 AMR May 28	 TMR Apr 16
32		5.603–620	Taurus (front)	May 14th. R	AMR α Jun 11	+28	TMR May 16	+2	AMR June 9	TMR May 16
33		5.723f.	Canis (major)	May 22 ES	AES α May 2	-20	TES May 13	-9	AES May 1	
34		5.731f.	Aquila (beak)	May 25th. ER	AER α May 20	-5	TER May 31	+6	AER May 24	TER Jun 3
35		5.733	Bootes	May 26th. MS	AMS α Jun 17	+22	TMS Jun 2	+7	AMS Jun 10	TMS May 28
36		5.734	Hyas	May 27th. R	AMR α Jun 11	+15	TMR May 16	-11	AMR Jun 9	TMR May 16 TES May 3
36.5										
37		6.195f.	Aquila	Jun 1st. R	AER α May 20	-12	TER May 31	-1	AER May 24	TER Jun 3
38		6.197f.	Hyades	Jun 2nd. MR	AMR α Jun 11	+9	TMR May 16	-17	AMR Jun 9	TMR May 16 TES May 3
39		6.235f.	Bootes	Jun 7th. MS	AMS α Jun 17	+10	TMS Jun 2	-5	AMS Jun 10	TMS May 28
40		6.469–72	Delphinus	Jun 10th. ER	AER α May 25	-16	TER Jun 7	-3	AER May 26	TER Jun 10
41		6.711f.	Hyades	Jun 15th. MR	AMR α Jun 11	-4	TMR May 16	-30	AMR Jun 9	TMR May 16 TES May 3
42	X	6.717–19	Orion (shoulders)	Jun 17th. ER	AER α Nov 29 AMR α Jul 5	+165 +18	TER α Dec 12 TMR α Jun 16	+178 -1	AES ε Apr 19 AES α Apr 28 AES β Apr 11	TES β Apr 26 TES α May 11
43		6.720	Delphinus	Jun 18th. ER	AER α May 25	-24	TER Jun 7	-11	AER May 26	TER Jun 10
44	X	6.733–6	Anguitenens	Jun 21st. ER	AER α Apr 17 AMS α Jul 18	-65 +27	TER Apr 27 TMS Jul 5	-55 +14	AER α Apr 19	
45		6.785–90	Orion (belt)	Jun 28th. R	AMR ϵ Jul 14	+16	TMR ϵ Jun 22	-6	AMR ε Jul 13	TMR ε Jun 21

Table Two – Astronomical Phenomena in Italy in Pliny

#	Error	*NH* 18	Date	Star and phenomenon	Apparent date	days after	True date	days after
01		234	Jan 4th	Delphinus MR	AMR α Jan 3	-1	TRM Dec 9	-26
02	X	234	Jan 5th	Lyra (Fidicula) mr	AMR α Nov 5	-61	TMR Oct 24	-73
03		235	Jan 8th	Delphinus ES	AES α Jan 8	0	TES Jan 31	+23
04		235	Jan 25th	Leo MS	AMS α Feb 11	+17	TMS Jan 26	+1
05		235	Feb 4th	Lyra (Fidicula) ES?	AES α Jan 28	-7	TES Feb 9	+5
06		237	Feb 23rd	Arcturus ER	AER Feb 23	0	TER Mar 3	+8
07	X	237	Mar 5th	Cancer R	AMR α Aug 11 AER α Dec 29 AES α Jun 1 AMS α Jan 16	+159 -66 +88 -48	TMR Jul 16 TER Jan 9 TES Jul 3 TMS Jan 3	+133 -55 +120 -61
08	X	237	Mar 8th	Pisces - north R	AMR ϕ Apr 11 AES ϕ Mar 2 AMR τ Mar 29	+34 -6 +21	TMR ϕ Feb 16 TES ϕ Mar 26 TMR τ Feb 7	-20 +18 -29
09	X	237	Mar 9th	Orion R	AMR α Jul 5 AER α Nov 29 AES α Apr 30 AMS α Nov 26	+118 +265 +52 +262	TMR Jun 16 TER Dec 12 TES May 14 TMS Nov 16	+99 +278 +66 +252
10	X	237	Mar 15th	Scorpio S	AMS α May 19 AMS ζ Apr 9	+65 +25	TMS α Apr 29 TMS ζ Mar 25	+45 +10
11	X	237	Mar 21st	Pegasus MS	AMS α Sep 9 AES α Feb 5 AMR α Feb 15 AER α Jun 30	+172 -44 -34 +101	TMS Aug 31 TES Feb 23 TMR Jan 16 TER Jul 17	+163 -26 -64 +118
12		246	Apr 5th	Pleiades ES	AES Apr 6	+1	TES Apr 26	+21
13		247	Apr 8th	Libra S	AMS α May 6 AER α Mar 29	+28 -10	TMS Apr 14 TER Apr 7	+6 -1
14		247	Apr 17th	Hyades ES	AES α Apr 17	0	TES May 1	+14
15		248	May 2nd	Hyades MR	AMR α Jun 11	+40	TMR May 16	+14
16	X	248	May 8th	Capella mr	AMR Apr 7 AES May 23	-21 +15	TMR Mar 12 TES Jun 8	-57 +31
17	X	248	May 10th	Pleiades R	AMR May 30 AER Sep 26 AES Apr 6	+25 +139 -34	TMR Apr 17 TER Oct 15 TES Apr 26	-23 +158 -14
18	X	255	May 11th	Arcturus MS	AMS Jun 17	+37	TMS Jun 2	+22
19	X	255	May 13th	Lyra (Fidicula) R	AER α Apr 11	-32	TER Apr 19	-24
20		255	May 21st	Capella ES	AES May 23	+2	TES Jun 8	+18
21	X	255	May 22nd	Orion (sword) S	AES ι Apr 13 AMS ι Nov 14 AMR ι Jul 21 AER ι Dec 10	-32 +176 +60 +202	TES i May 2 TMS i Nov 5 TMR Jun 27 TER Dec 22	-20 +167 +36 +214
22		255	Jun 2nd	Aquila ER	AER α May 20	-13	TER May 31	-2
23		255	Jun 7th	Arcturus MS	AMS Jun 17	+10	TMS Jun 2	-5
24	X	256	Jun 21st	Orion (sword) S	AES ι Apr 13 AMS ι Nov 14 AMR ι Jul 21 AER ι Dec 10	-69 +146 +31 +172	TES i May 2 TMS i Nov 5 TMR Jun 27 TER Dec 22	-50 +137 +6 +184
25		268	Jun 26th	Orion R	AMR α Jul 5	+9	TMR a Jun 16	-10
26		269	Jul 17th	Canis/Procyon R	AMR Sir Jul 30 AMR Pro Jul 24	+13 +7	TMR Sir Jul 9 TMR Pro Jul 8	-8 -9
27		269	Jul 19th	Canis R	AMR Jul 30	+11	TMR Jul 19	0
28		270/1	Jul 23rd	Aquila MS	AMS αAug 4	+12	TMS Jul 24	+1
29		271	Jul 30th	Leo MR	AMR α Aug 14	+15	TMR Jul 28	-2
30	X	271	Aug 11th	Lyra (Fidicula) S	AMS α Aug 26	+15	TMS Aug 17	+6
31		309	Aug 12th	Delphinus S	AMS α Aug 18	+6	TMS Aug 8	-4
32		309	Aug 22nd	Vindemitor MR	AMR ϵ Sep 20	+29	TMR Sep 1	+10
33		310	Sep 9th	Capella ER	AER Aug 21	-19	TER Sep 8	-1
34		310/1	Sep 12th	Arcturus R	AMR Sep 20	+8	TMR Sep 8	-4
35		311	Sep 18th	Spica MR	AMR α Oct 5	+17	TMR Sep 22	+4
36		311	Sep 21st	Pisces- knot S	AMS α Oct 4	+13	TMS α Sep 25	+4
37	X	312	Oct 3rd	Auriga MS	AMS ι Nov 29 AMS β Dec 28 AMS α Dec 19 AER ι Sep 29	+57 +86 +77 -4	TMS I Nov 20 TMS b Dec 19 TMS a Dec 9 TER I Oct 18	+48 +77 +67 +15
38		312	Oct 4th	Corona (begins) R	AMR θ Oct 9	+5	TMR Sep 13	-21
39	X	312	Oct 5th	Haedi ES	AES ϵ May 6 AER ϵ Aug 30	-152 -36	TES May 31 TER Sep 15	-127 -20
40		313	Oct 8th	Corona (bright star) R	AMR α Oct 8	0	TMR Sep 20	-18
41		313	Oct 10th	Pleiades ER	AER Sep 26	-14	TER Oct 15	+5
42		313	Oct 31st	Arcturus S	AES Nov 9	+9	TES Nov 28	+28
43	X	313	Oct 31st	Hyades MR	AMR α Jun 11 AER α Oct 26 AMS α Nov 13	-142 -5 +13	TMR May 16 TER Nov 12 TMS Nov 4	-168 +12 +4
44		283	Dec 20th	Aquila R	AMR α Dec 17	-3	TMR Dec 2	-18
45	X*	234	Dec 30th	Canis MS	AMS α Nov 22 AER α Jan 5	-38 +6	TMS Nov 15 TER Jan 12	-45 +13

Table Three: Stellar Phenomena in March

MARCH	ZODIAC	GEMINUS			OVID	COLUMELLA	PLINY	CLODIUS TUSCUS
		Euctemon	Eudoxus	Callippus				
1	Psc 09							
2	Psc 10					Vindemitor R		Vindemitor R (begins)
3	Psc 11				Pisces (one) ES			Arcturus MR
4	Psc 12	Arcturus ER Vindemitor R						Arcturus ER
5	Psc 13				Bootes MS Vindemitor R?		Cancer R Vindemitor R	[as above]
6	Psc 14	Equus R						
7	Psc 15				Equus ER	Equus MR		Equus MS Corona MS
8	Psc 16				Corona ER		N Piscis R	Equus S Sun at middle of Pisces
9	Psc 17			S Piscium R			Attica: Orion R	'S Fish' MS (begins)
10	Psc 18							Equus MS Vindemitor S Arcturus R
11	Psc 19							
12	Psc 20							'S Fish' R (stops)
13	Psc 21		Crown ER			N Piscium R (stops)		Argo ER Leo's tail [S]
14	Psc 22					Argo R		
15	Psc 23					Scorpius S (begins)	Scorpius S	Equus S
16	Psc 24				Scorpio MR (first parts)	Scorpius S		
17	Psc 25				[Kite ER]	Sun to Aries		Sun to Aries
18	Psc 26							
19	Psc 27							
20	Psc 28							
21	Psc 29	Scorpius S (first parts)				Equus MS	Equus MS	Equus MS
22	Psc 30			N Piscium R stops	Sun into Aries			Aries R?
23	**Ari 01**			Knot Piscium R		Aries R (begins)		[as above]
24	Ari 02					Equinox		
25	Ari 03			Aries R (begins)		Equinox	Equinox completed	Equus MS
26	Ari 04				Equinox			Pisces R Aries MR
27	Ari 05							
28	Ari 06							
29	Ari 07							Scorpius S
30	Ari 08							Scorpius S
31	Ari 09							