Ebola, bats and evidence-based policy

At the time of writing, West Africa is still dealing with the worst known Ebola epidemic. Quite rightly, the international focus has been on reducing the transmission rate of this disease until it is eradicated from the human population. Once the epidemic curve has declined to this point, scientific attention should be re-directed to the prevention of future zoonotic outbreaks. There already has been much written on how the West African epidemic might have been sparked, but speculation often has been presented as fact and in some cases has been contrary to available evidence. Such inaccurate reporting on the drivers of the emergence of this epidemic is unfortunate, as this can influence policy decisions while failing to identify how Ebola and other serious zoonoses should be controlled.

Viral phylogenetic and epidemiological analyses of the current West African human outbreak indicate a single zoonotic transmission event from a reservoir host in Guinea in late 2013 (Baize et al. 2014), followed by human-to-human transmission (Gire et al. 2014). area number of bat species appear to be the reservoir hosts of filoviruses, including Ebola (Olson et al. 2012, Olival & Hayman 2014). Bats are increasingly being implicated in zoonotic virus emergence (Luis et al. 2013), possibly because of a growing and closer human-bat interface and a number of postulated behavioural and physiological traits of bats, such as adaptations to flight (O'Shea et al. 2014). The ability to fly also can enable long-range distribution of pathogens through the hosts mixing within and amongst metapopulations. For example, we demonstrated panmixia across the continental range of the straw coloured fruit bat *Eidolon helvum* (Peel et al. 2013). Viruses within this species, which do not include Ebola, were similarly and unsurprisingly distributed across the continent.

Despite the increasing volume of research on filoviruses in bats, there is little understanding of the quantitative intra- or inter-specific dynamics of Ebola in bats (Olival & Hayman 2014). Longitudinal studies on infection dynamics are required to identify reservoir species and to help us to understand the drivers of zoonotic spillover (Wood et al. 2012). Some bat species might suffer from spillover, as is widely accepted for terrestrial species, and this dynamic could be an important risk factor for human infection. Little filovirus surveillance has been conducted in insectivorous species of bats, which makes the suggestion that *Mops condylurus* was the source of infection in the index human case in Guinea (Saéz et al, 2015) noteworthy if somewhat speculative; however this species has been reported to be seropositive for Ebola virus in Gabon (see Olson et al. 2014 for review).

In Ghana, where Ebola cases have never been reported, several bat species show seropositivity to Zaire Ebolavirus (Hayman et al. 2012), including common species (e.g. *Epomophorus gambianus*, *Rousettus aegyptiacus*) with ranges from Central to West Africa, including Guinea. There has been little or no filovirus surveillance in these species outside Central Africa. It would not be surprising if Ebola virus has been endemic across these bat distributions for millenia. It has been suggested the epidemic is consequent to recent virus introduction from Central Africa (Bausch and Schward 2014), including an epidemic wave moving across the continent (Vogel 2014), but without knowledge of the genetics of pre-existing Ebolavirus in West African bats, this can only be speculative (Gire et al. 2014). Also, such an argument is countered by the pre-existence of antibodies to Zaire Ebolavirus in West African bats (Hayman et al. 2012) and the results of recent niche mapping for the virus in Africa (Pigott et al. 2014).

Consumption of bats (and other wildlife) has always been common in West Africa (Kamins et al. 2011). Although Ebola in people has previously been associated with direct transmission from fruit bats (Leroy et al. 2009), the risks from bat viruses are not new and immediate, but are long-established and of low probability. This needs to be reflected in the communication of the public health message. Bush meat is an important economic and nutritional commodity in West Africa; the current demonization of bush meat risks being counterproductive, as trust in authority will be lost when hunters and consumers identify the mismatch between public awareness messages and reality (Kümpell et al. 2015). As with the current Ebola epidemic (Baize et al. 2014), in resource-poor rural settings in Africa, early zoonotic disease emergence will likely be missed. This emphasises the importance of improved medical surveillance and long-term interdisciplinary studies focussing on inter-specific transmission dynamics and novel disease detection (Wood et al. 2012).

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