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Ornithodoros porcinus ticks, bushpigs, and African swine fever in Madagascar

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Abstract. African swine fever (ASF) has recently made its appearance in Madagascar. Ticks of the *Ornithodoros moubata* group, considered to be *O. porcinus* Walton, 1962 were formerly known to occur in western Madagascar, but seem to have disappeared from that region. However, three new sites where they occur were found in the humid and cool central highlands of Anatananarivo province. These ticks are known to be efficient reservoirs and vectors of ASF and constitute a considerable complication to the control of the disease. The authors also discuss another potentially complicating factor, the presence of a species of African bushpig, *Potamochoerus larvatus*.

Key words: *Ornithodoros porcinus*, African swine fever, bushpig, Madagascar

Introduction

The island of Madagascar has remained free from many important infectious diseases of livestock, including African swine fever (ASF), until a very contagious outbreak of fatal disease in domestic pigs appeared in 1997 and was finally diagnosed as ASF (Roger *et al.*, in press). The disease has spread to many parts of the country, and it is estimated that over half of the domestic pig population of Madagascar has been killed by the disease and/or slaughtered to prevent losses.

Eradication of this highly resistant virus from a country of the size of Madagascar (ca. 600.000 km^2) is obviously extremely difficult and costly. Moreover, the task might be confounded by two factors, the presence of ticks of the *Ornithodoros moubata* group and of another potential wild reservoir, the bushpig (*Potamochoerus larvatus*).

Ticks of the *Ornithodoros moubata* group are known to occur in Madagascar since the early 20th century (Lamoureux, 1913), and to be the vectors of *Borrelia duttoni*, which causes human recurrent fever, reported in western

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Madagascar since 1911 (Thézé, 1911). Both ticks and disease may well have existed in the country as early as the beginning of the 18th century, according to the biography of a British sailor, Robert Drury (Grandidier and Grandidier, 1906). The ticks have been reported from western and central Madagascar by a number of authors (Uilenberg *et al.*, 1980), while recurrent fever was only known in western Madagascar (Rodhain and Fontenille, 1989).

However, since about the middle of the 20th century recurrent fever has not been reported any more in Madagascar (E.R. Brygoo *in* Uilenberg, 1963, Rodhain and Fontenille, 1989). At the same time the incidence of the disease also diminished greatly in East Africa (Walton, 1962); this decrease is attributed by Walton to improvement in the construction of human dwellings and to the use of insecticides.

While a few ticks were still found in 1988 in pigsties in the area of Mahasolo, in the Sakay, a comparatively low area (ca. 800–900 m altitude) in the west of the province of Antananarivo, more recent surveys have consistently failed to find the tick, not only in western Madagascar in human dwellings as well as pigsties (Rodhain and Fontenille, 1989), but even in the Mahasolo region (unpublished surveys by teams of the veterinary services and the Institut Pasteur).

The study presented here is the beginning of an attempt at assessing the importance as reservoirs of ASF of ticks of the *O. moubata* group and of the bushpig in Madagascar.

Materials and methods

In April and May 2000, over 70 traditional pigsties, particularly in areas where ticks had been found earlier or where the owners suspected their existence, were searched manually for the presence of ticks, by exploring cracks and holes in mud-walls and wooden structures with a screwdriver or similar tool, digging up the soil of the floor and passing this through a sieve, and examining the roof structure. The pigsties visited were situated in the Mahajanga region (north-western Madagascar), along the road from Antananarivo to Mahajanga, in the area of Antananarivo, and in various parts of Antananarivo province (near Tsinjoarivo in the south-east of the province, and in several villages and towns in the Sakay region in the west of the province).

Results

The apparent absence of the tick in the low-lying coastal Mahajanga area, and the comparatively low Mahasolo region (see above) was confirmed. However, three new sites (Map 1) where these ticks occur were discovered, all in the relatively cool and humid highlands of central Madagascar. One site is in an eastern suburb of Antananarivo itself (altitude 1285 m, latitude and longitude 18°54.852′S, 47°34.793′E), in an empty pigsty underneath a human habitation; they were easily detected as they appeared to be actively looking for a host although they may of course have fed on humans and possibly other hosts since ASF had killed the pigs in September 1998. Another site is in south-eastern Antananarivo province, south of Tsinjoarivo, at an even higher but not precisely determined elevation, at roughly 19°40′S and 47°40′E; the ticks were collected in a pigsty by the owner and brought to us, but we have not been able to verify their presence *in situ*, as the actual pigsty could not be located, several reportedly having been destroyed by fire; ASF has also swept through this region. Finally, a pigsty at Mahitsy, about 30 km to the north-west of Antananarivo, along the road to Mahajanga, was found to be infested by these ticks. The altitude of this site is also about 1285 m above sea level, its latitude and longitude are 18°44.894′S and 47°20.780′E. It is unknown at this stage whether these new findings indicate an extension of the geographical distribution of the tick, or whether the tick had simply not been detected earlier in these sites.

Discussion

We attribute the apparent disappearance of the tick in the Mahasolo region to the use of insecticides/acaricides in pigsties and on pigs, which has become generalized in the Sakay area in recent years.

In 1962 Walton divided the *Ornithodoros moubata* complex in Africa into four species. He created three new taxa, *O. compactus*, with tortoises as hosts, *O. apertus*, mainly from porcupine burrows, and *O. porcinus*, with two subspecies, *O. porcinus porcinus*, mainly from warthog burrows, and *O. porcinus domesticus*, considered by Walton as primarily a human parasite, widely distributed in human dwellings. He selected a neotype for *O. moubata*, a species of more arid conditions than *O. porcinus,* found in warthog and porcupine burrows, as well as in human dwellings. Van Der Merwe (1968) did not consider the ticks described by Walton as *O. porcinus* to be a separate species, but a subspecies of *O. moubata*; Walton (1979) did not agree with her position and even created an additional subspecies, *O. porcinus avivora*, feeding mainly on chickens in low coastal areas in East Africa. Whatever the truth, and while we tend to agree with van der Merwe's opinion that the division of *O. porcinus* into subspecies is of doubtful value, there are undoubtedly morphological and biological differences between *O. porcinus* and *O. moubata sensu* Walton, 1962 and these differences may be of great

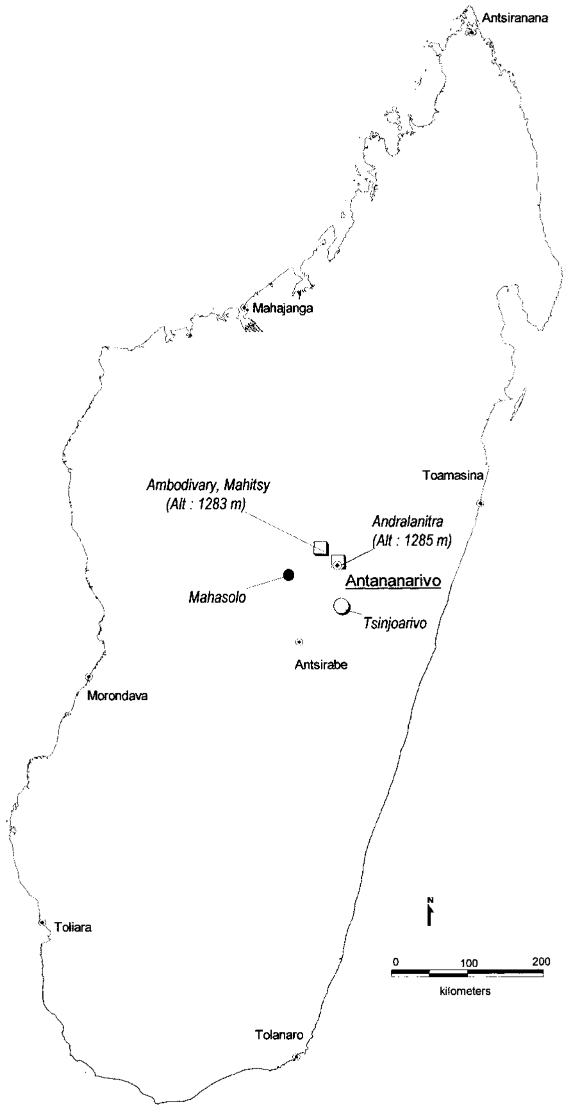

Figure 1.

practical importance. For example, according to Walton (1979), *O. porcinus* is the established reservoir vector of ASF, while the role of *O. moubata sensu* Walton in this respect was as yet unknown.

The ticks of this group in Madagascar were found to correspond to Walton's *O. porcinus domesticus*, with a few traits nearer to *O. porcinus porcinus* (Uilenberg, 1963; a few specimens were examined by Walton, who considered them to be *O. porcinus domesticus* [*in* Uilenberg *et al.*, 1980]). For the time being we will continue to call them *O. porcinus*. The ticks recently discovered in the three sites on the highlands of Antananarivo province were found to be morphologically the same as those found earlier.

Obviously, the presence of this efficient reservoir of ASF virus in the highlands, important pig rearing areas, is of great concern as it is known that the virus can persist in *O. porcinus* for long periods and can also spread in the tick population by the sexual and transovarial routes (e.g. Plowright *et al*., 1969, 1970, 1974; Hess *et al*., 1989; Kleiboeker *et al*., 1998); furthermore, the tick may survive for years without feeding (Walton, 1964).

The other potentially complicating factor is the presence on Madagascar of a species of African bushpig, *Potamochoerus larvatus.* Considering the long evolutionary separation of Madagascar from the African mainland, there can be little doubt that this African mammal is a comparatively recent introduction, but it is unknown how and when the introduction occurred. (Wild pigs certainly were common in the early 18th century, as is apparent from Robert Drury's biography.) It is known that the African bushpig, similarly to the warthog, can be infected with ASF virus and become viraemic without showing clinical signs of infection (Oura *et al*., 1998; Anderson *et al*., 1998). (It should be noted that their experiments in Zimbabwe were carried out with bushpigs for which they used the name *Potamochoerus porcus*. It is only in fairly recent years that the existence of two species of bushpig is again generally admitted. For instance, Dorst and Dandelot (1970) only recognise the species *P. porcus* and consider *larvatus* to be a separate 'race' of this species in Madagascar. Vercammen *et al.* (1993) indicate that *P. larvatus* is distributed from Ethiopia to South Africa, while *P. porcus* is found in the equatorial forests of West and Central Africa. We do not know whether *P. porcus* occurs in Zimbabwe, or whether the authors of these papers did not recognise *P. larvatus* as a separate species). While the bushpigs were infective to *Ornithodoros* ticks during their viraemia, there is a fundamental difference between warthogs and bushpigs, as Anderson *et al*. (1998) point out, in that the latter do not frequent burrows which are favoured by the *Ornithodoros* tick vectors. The actual role of the bushpig in the epidemiology of the disease is therefore uncertain, even on the African continent. The uncertainty is even greater on Madagascar, as its bushpig population has been separated from that on the mainland for an unknown length of time and its susceptibility might have changed through genetic drift in the absence of natural infection. It is likely that on Madagascar bushpigs also rest in surface lairs and do not use burrows; no ticks were found during a limited search under bark and in cracks of trees and branches in and around such bushpigs lairs in north-west Madagascar, but it is unknown whether *Ornithodoros porcinus* ticks occur in that area at all. We suggest that an enzyme-linked immunosorbent assay for the detection of antibodies to salivary antigens of the tick in bushpig sera from areas where the tick is known to occur, might be a promising approach to determine whether there is natural contact between the tick and the bushpig in Madagascar. Such ELISAs have been developed for the detection of antibodies to salivary glands of *Ornithodoros* ticks in pig sera in Spain as well as in the USA (e.g. Oleaga- Pérez *et al.*, 1994, Wozniak *et al.*, 1996).

Finally, such a test could of course also be of tremendous help in determining the geographical distribution of the tick by testing pig sera from various regions.

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References

Anderson, E.C., Hutchings, G.H., Mukarati, N. and Wilkinson, P.J. 1998. African swine fever virus infection of the bushpig (*Potamochoerus porcus*) and its significance in the epidemiology of the disease. Veterinary Microbiol. 62: 1–15.

Dorst, J. and Dandelot, P. 1970. A field guide to the large mammals of Africa. Collins, London.

Grandidier, A. and Grandidier, G. 1906. Les aventures de Robert Drury pendant ses quinze années de captivité à Madagascar et son second voyage dans cette île (1701–1717 et 1719–1720). Collection des ouvrages anciens concernant Madagascar, tome IV. Paris, Comité de Madagascar. (pp. 340–341.)

Hess, W.R., Endris, R.G., Lousa, A. and Caiado, J.M. 1989. Clearance of African swine fever virus from infected tick (Acari) colonies. J. Med. Entomol 26: 314–317.

Kleiboeker, S.B, Burrage, T.G., Scoles, G.A., Fish, D. and Rock, D.L. 1998. African swine fever virus infection in the argasid host, *Ornithodoros porcinus porcinus*. J. Virol. 72: 1711–1724.

Lamoureux, A. 1913. Présence d'*Ornithodorus moubata* dans un foyer de fièvre récurrente à la côte ouest de Madagascar. Bulletin de la Société de Pathologie Exotique 6: 146–149.

Oleaga-Pérez, A., Pérez-Sanchez, R., Astigarraga, A. and Encinas-Grandes, A. 1994. Detection of pig farms with *Ornithodoros erraticus* by pig serology. Elimination of non-specific reactions by carbohydrate epitopes of salivary antigens. Veterinary Parasitol. 52: 97–111.

Oura, C.A.L., Powell, P.P., Anderson, E. and Parkhouse, R.M.E. 1998. The pathogenesis of African swine fever in the resistant bushpig. J. General Virol. 79: 1439–1443.

Plowright, W., Parker, J. and Peirce, M.A. 1969. African swine fever virus in ticks (*Ornithodoros moubata*, Murray) collected from animal burrows in Tanzania. Nature 221: 1071–1073.

Plowright, W., Perry, C.T. and Peirce, M.A. 1970. Transovarial infection with African swine fever virus in the argasid tick, *Ornithodoros moubata porcinus*, Walton. Res. Veterinary Sci. 11, 582–584.

Plowright, W., Perry, C.T. and Greig, A. 1974. Sexual transmission of African swine fever virus in the tick, *Ornithodoros moubata porcinus*, Walton. Res. Veterinary Sci. 17: 106–113.

Rodhain, F. and Fontenille, D. 1989. La récurrente à tiques malgache: une affection éradiquée? Bulletin de la Société de Pathologie Exotique 82: 192–198.

Roger, F., Randriamahefa, N., Crucière, C., Mala Rakoto Andrianarivelo, Diallo, A., Ratovo Andriambololona, Domenech, J. and Zeller, H. In: press. La peste porcine africaine (PPA) à Madagascar: maladie émergente ou ancienne? Proceedings of the World Veterinary Congress, Lyon, France, 23–26 September 1999.

Thézé, J. 1911. Un cas de fièvre récurrente, observé à Madagascar. Bulletin de la Société de Pathologie Exotique 4: 509–510.

Uilenberg, G. 1963. Existence de *Ornithodorus porcinus* Walton, 1962 (*Argasidae*) à Madagascar. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux 16: 147–150.

Uilenberg, G., Hoogstraal, H. and Klein, J.-M. 1980. Les tiques (*Ixodoidea*) de Madagascar et leur rôle vecteur. Archives de l'Institut Pasteur de Madagascar, 1979 (numéro spécial), 153 pp.

Van Der Merwe, S. 1968. Some remarks on the tampans of the *Ornithodoros moubata* complex in Southern Africa. Zoologischer Anzeiger 181: 280–289.

Vercammen, P., Seydack, A.H.W. and Oliver, W.L.R. 1993. The bush pigs (*Potamochoerus porcus* and *P. larvatus*). In: Pigs, peccaries and hippos. W.L.R. Oliver (ed.). IUCN, Gland, Switzerland.

Walton, G.A. 1962. The *Ornithodorus moubata* superspecies problem in relation to human relapsing fever epidemiology. In: Aspects of disease transmission by ticks, Symposia of the Zoological Society of London, (no. 6), pp. 83–156.

Walton, G.A. 1964. The *Ornithodorus moubata* group of ticks in Africa, control problems and implications. J. Med. Entomol. 1: 53–64.

Walton, G.A. 1979. A taxonomic review of the *Ornithodoros moubata* (Murray) 1877 (*sensu* Walton, 1962) species group in Africa. Recent Advances in Acarology Vol. II, 491–500.

Wozniak, E.J., Butler, J.F., Endris, R.G. and Zam, S.G. 1996. Detection and quantification of *Ornithodoros*-specific anti-tick antibody by competitive inhibition ELISA. J. Parasitol 82: 88–93.