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HEARTWATER IN THE CARIBBEAN

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ABSTRACT

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Cowdria ruminantium, causal rickettsia of heartwater in ruminants, was until recently only known to occur in Africa. It is transmitted by *Amblyomma* ticks.

Amblyomma variegatum, one of its African vectors, was introduced into the Caribbean area with cattle from Senegal about 1830. Before 1900 only Guadeloupe and Antigua were known to be infested. Martinique was invaded as late as 1948. The spread of the tick accelerated afterwards, especially during the last decade. It has now been found on Guadeloupe (Grande Terre and Basse Terre), Antigua, Martinique, St. Croix, Puerto Rico, St. Lucia, Nevis, St. Kitts, St. Maarten/St. Martin, Vieques, Anguilla, Marie-Galante and La Désirade. All of these islands are probably still infested today, except possibly St. Croix and La Désirade.

The existence of heartwater on Guadeloupe has been suspected since 1966, and was at last confirmed in 1980, having almost certainly been present for a century and a half. A strain of *C.ruminantium* was isolated in 1982. Retrospectively, a bovine disease with symptoms like those of heartwater has been known on the island since 1932. Two other African infections of which *A. variegatum* is a vector, *Theileria mutans* and *T.velifera*, also occur in cattle on Guadeloupe.

Heartwater has so far been diagnosed only in Guadeloupe and in near-by Marie-Galante. An investigation for its presence has been started on other islands where *A.variegatum* occurs. However, it has been shown that the American tick *Amblyomma maculatum* is a good experimental vector, and that *A.cajennense* can also transmit *C.ruminantium*, but probably not very efficiently. If the agent can adapt to these and other American *Amblyomma* species, it could spread to large areas in the western hemisphere, well outside

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those where the strictly tropical A.variegatum would find a suitable habitat.

An assessment of the extent of this serious threat to the livestock industry of the Americas should be followed by urgent action while there is still hope of removing the danger as long as the disease remains limited to a few of the smaller islands. Apart from a survey of the distribution of the disease and Amblyomma ticks, information is needed on animal movements between islands, on migration routes of birds (hosts of immature stages), animal husbandry methods, and species and numbers of domestic animals, as well as wild hosts which may interfere with tick eradication.

Severe dermatophilosis (cutaneous streptothricosis) of cattle appears to be closely linked with the presence of A.variegatum and causes high losses on the infested islands. This will make it easier to obtain the collaboration of livestock owners and authorities for eradication campaigns, even on islands where heartwater does not (yet) occur.

INTRODUCTION

Wild African ruminants are presumably the normal mammalian hosts of Cowdria ruminantium, the causative rickettsia of cowdriosis or heartwater. It is transmitted transstadially by African Amblyomma ticks. With few exceptions, the infection does not usually appear to have much ill effect on wild hosts. Domestic ruminants have been introduced by man on several occasions in the distant past into the endemic regions. Lacking innate resistance to heartwater, these animals must have suffered heavy losses until resistant "indigenous" breeds emerged, selected by natural disease pressure over a long period, and the infection in most cases became latent as in wild hosts. However, heartwater has become a major disease problem since fully susceptible exotic breeds of cattle, sheep and goats were exposed to it, first after the colonization of large parts of subsaharan Africa by Europeans, and more recently when many newly independent countries tried to improve livestock production quickly by using highly productive exotic stock which are susceptible to the infection.

A few of the tick vector species have been introduced with domestic animals to several islands near Africa and to the southern part of the Arabian peninsula. On certain islands, C.ruminantium infection also became established. However there is only one known instance where the disease and one of its vectors have succeeded in colonizing quite another part of the world, gaining a foothold in the western hemisphere. According to Curasson (1943), in about 1830 African zebu cattle were shipped from Senegal to the French Antilles, together with the African tick Amblyomma variegatum,

which even today is called on Guadeloupe the "Senegalese tick" (in contrast to Boophilus microplus, known as the "creole tick"). The fact that heartwater was imported into the area together with the vector has been confirmed only recently (Perreau et al., 1980). (It should be added that African N'dama cattle were also shipped from Senegal to the Caribbean (Virgin Islands) on at least one later occasion, about 1860 (Rouse, 1973) or 1880 (Hupp, 1978).)

AMBLYOMMA VARIEGATUM IN THE WESTERN HEMISPHERE

The tick was introduced early in the 19th century when Senegalese zebus were sent to the French Antilles, and also to French Guyana (Curasson, 1943). Fortunately, the tick does not appear to have colonized the mainland. Neumann (1899) recorded one engorged female from Guatemala in the Hamburg Museum, collected by Pöhl; this record has been repeated in the literature, but there has been no mention of new findings. Reports of the tick in Venezuela and French Guyana (Doss et al., 1974, repeated by Maldonado Capriles and Medina Gaud, 1977) appear to be based on misunderstanding the papers by Fiasson (1949) and Flock and Fauran (1959). Fiasson (1949) unambiguously stated that A.variegatum has not been found in Venezuela. Floch and Fauran (1959) definitely do not include this tick amongst the species occurring in Guyana and record it only in the Antilles.

Guadeloupe* appears to have been first settled by the tick, while it is also known to have been present on Antigua since the 19th century (literature review by Morel, 1966). Martinique was invaded only about 1948, following the importation of a few oxen from Guadeloupe (Morel, 1966). St. Croix was found to be infested in 1967 (Hourrigan et al., 1969), and Puerto Rico in 1974 (Strickland et al., 1976; Maldonado Capriles and Medina Gaud, 1977). Butler (1975) reported A.variegatum on St. Lucia, where it has been present since before 1970 (Dr. K. Scotland, personal communication, 1983). The tick has been discovered on Nevis and St. Kitts about 1977-1978 (pers.comm., Drs. B.S. Nisbett and G.B. Swanston, 1982). Hooker (1909) reported A.variegatum on St.

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* In this paper the name Guadeloupe designates the twin islands of Basse Terre and Grande Terre, not the more extensive political entity which comprises several more islands.

Kitts, having seen specimens in the collection of the USDA Bureau of Entomology; this report is presumably the source of further literature references for this island (Hoogstraal, 1956; Strickland et al., 1976). However, when our team (M.J. Burridge, G.I. Garris, and G. Uilenberg) visited St. Kitts in 1982, it became apparent that neither the livestock owners nor the veterinary authorities had any recollection of the occurrence of A.variegatum earlier than some 4 years before; it was thought to have come from Nevis where it had been discovered slightly earlier (about 1977). The tick is still restricted in its distribution on Nevis and St. Kitts, but is spreading on both islands. Did it disappear after 1909 and return recently ? It is tempting to consider the more logical possibility that Hooker's specimens were mislabelled, but on the other hand, strangely enough, the tick is called on Antigua the "St. Kitts' tick" according to livestock owners (pers.comm., Mr. R. Hall, 1982). On St. Martin/St. Maarten A.variegatum was reported only last year (Uilenberg, 1982), but was first found in 1978 or 1979 (pers.comm., Drs. G.D. Thye and D. Murillon, 1982). A.variegatum is also present on Vieques, off the coast of Puerto Rico (pers.comm., U.S.D.A., San Juan, 1981), on Anguilla (Dr. G.D. Thye, pers.comm., 1982) and,probably since a long time, on Marie-Galante (E. Camus and N. Barré, unpublished, 1982). It has also been found on the isle of La Désirade, near Guadeloupe, where it is introduced with slaughter cattle from Guadeloupe, but does not appear to have a permanent foothold (N. Barré and E. Camus, unpublished, 1983).

A.variegatum is almost certainly still present on all these islands, except possibly La Désirade (see above) and St. Croix where it was eradicated in 1970 according to Strickland et al. (1976); however, a few specimens were collected on St. Croix after 1970 (Graham and Hourrigan, 1977).

HEARTWATER IN THE WESTERN HEMISPHERE

The first recorded indication of the occurrence of cowdriosis in the Antilles may be the description of an acute to peracute fatal disease of cattle on Guadeloupe, associated with nervous symptoms ("madness of cattle") and sometimes with haemorrhagic diarrhoea which is also frequently seen in bovine heartwater; it was ascribed to anthrax (Nouval, 1932).

Later, Mauzé and Montigny (1954) reported a disease on the same

island, which decimated cattle imported from Florida and Jamaica but did not affect local cattle or animals imported from Puerto Rico. They found theilerial piroplasms in the blood of affected animals, for unstated reasons diagnosed the organism as Theileria parva (agent of East Coast fever in eastern and southern Africa), and believed A.variegatum to be the vector. This tick does not transmit T.parva; however at the time its role in the transmission of other bovine theilerial species, T.mutans and T.velifera, was not yet known. The Theileria sp. on Guadeloupe was later correctly suspected, on morphological and epidemiological grounds, to be T. mutans (Morel, 1967); serological and morphological confirmation for the occurrence of both T.mutans and T.velifera on Guadeloupe has just been obtained from bovine sera and bloodsmears (G. Uilenberg, N. Barré and E.Camus, unpublished data, 1983). T.velifera is non-pathogenic and T.mutans usually has a low pathogenicity; the association of A.variegatum with a fatal cattle disease points rather to cowdriosis. The fact that local cattle were not affected may be explained by innate resistance : the cattle population on the island has been exposed to the disease and its selection pressure for over a century and descends moreover to a large extent from the Senegalese zebu cattle originating from an endemic region in Africa, as opposed to the cattle imported from Florida and Jamaica. However, a mystery is the fact that cattle from Puerto Rico were not affected; at the time these were shipped to Guadeloupe (in 1951), A.variegatum was not known to occur on Puerto Rico and the animals could not have acquired any resistance to cowdriosis.

A few years later, Courmes (1962) again described several fatal cases of a peracute to acute disease with nervous symptoms in cattle on Guadeloupe, and for the first time suggested the possibility of a rickettsial cause. However, he did not mention cowdriosis. At last, Bück (1966) and Morel (1967) suspected heartwater to be the cause of the trouble on the island. It should be noted that both authors were familiar with the disease in Africa or Madagascar. Floch et al. (1972) described further outbreaks of disease with central nervous disorders, high temperatures and rapid death. Euzéby and Graber (1973) discarded the suggestion of cowdriosis, partly because no pericardial lesions were observed, partly because the intravenous administration of euflavine had a favourable effect in some of the disease cases. Similar obser-

vations were also reported by Floch et al. (1972). Hydropericardium is however far from regularly present in heartwater, especially in cattle. The fact that euflavine, a babesicidal drug with no known antirickettsial activity, sometimes has a beneficial effect can be explained by assuming that some of the disease cases were caused by Babesia bovis, well known to induce frequent cerebral symptoms. (The first cases of cerebral babesiosis on Guadeloupe due to B.bovis have just been diagnosed microscopically (E. Camus and N. Barré, unpublished, 1983).

Perreau et al. (1980) finally proved the existence of cowdriosis on Guadeloupe by demonstrating C.ruminantium in the endothelial cells of cerebral capillaries of a goat suffering from a disease with nervous disorders, and on the same premises a C.ruminantium strain was isolated last year, the first in the western hemisphere (N. Barré and E. Camus, unpublished, 1982). The properties of this strain are presently being studied on Guadeloupe and in Utrecht. Several more isolates have been obtained more recently and the infection is wide-spread and well established.

It may seem astounding that a disease, rated as the most important tick-borne disease in South Africa after East Coast fever had been eradicated there (Neitz, 1968), has gone unrecognized for a century and a half. As already mentioned, the infection most often is practically inapparent in local populations of ruminants with an innate (selected) resistance, and becomes overt only after susceptible animals are introduced. This appears to be the case on Guadeloupe too, where the disease has mainly been a problem in more recently imported breeds of cattle. It may be added that sheep and goat farming has proved difficult too (Morel, 1967). Unfamiliarity with the disease and the well-known difficulties of diagnosing it explain the rest.

Strains of C.ruminantium have recently been isolated also on the island of Marie-Galante, just south of Guadeloupe, where the infection appears to be of long-standing endemicity too (N. Barré and E. Camus, unpublished, 1983).

POTENTIAL AMERICAN TICK VECTORS OF COWDRIOSIS

The threat of heartwater spreading with its introduced African tick vector over the Caribbean islands and, even worse, to the American mainland, is bad enough. The danger would be even greater if the infection could transfer to American Amblyomma

species which may be suitable transstadial vectors. The disease could then extend its range not only to tropical regions climatically suitable for A.variegatum, but also far outside these areas. The agent would be independent of its African vector and could be transported in an infected ruminant with a rickettsiaemia, to be picked up by American ticks. Heartwater has been reported in sheep and goats imported from South Africa to Brazil (Alves de Souza and De Abreu Martins, 1937) and it is quite probable that amongst African wild ruminants imported into American zoological gardens and wildlife parks there have been carriers of the infection. Furthermore, as Camus and Barré (1982) point out, the disease might also spread with migratory birds carrying nymphs of A.variegatum infected in the larval stage, capable of transmitting cowdriosis as adults to a ruminant from where it could move to local American Amblyomma ticks. They point out the potential importance of bird migration routes, existing for instance between the Antilles and Venezuela.

Calls for an investigation of the potential vector role of American Amblyomma spp. (Anon., 1956, Uilenberg, 1977) have been heeded in recent years. So far three species have been studied, using African strains of C.ruminantium. A.maculatum has been found to be an efficient vector (Uilenberg, 1982), A.cajennense can transmit the infection but appears to be a poor vector (Uilenberg, in press). Transmission by A.americanum has not yet been achieved. A.cajennense and A.americanum would make suitable transstadial vectors because both immatures and adults are common on domestic livestock. These species will be further studied using African strains of C.ruminantium and also one recently isolated on Guadeloupe. A South American tick that should be examined is A.neumanni;immatures and adults both are common on cattle (Guglielmone and Hadani, 1982).

SUMMARY OF PRESENT KNOWLEDGE

Amblyomma variegatum, the most important vector of heartwater in Africa, occurs on Guadeloupe, Antigua, Martinique, Puerto Rico, St. Lucia, Nevis, St. Kitts, St. Martin, Vieques, Anguilla and Marie-Galante. It may have been eradicated on St.Croix. Isolated specimens have been found on La Désirade. The area concerned is shown in figure 1.

Heartwater in the western hemisphere has so far been found only on Guadeloupe and Marie-Galante.

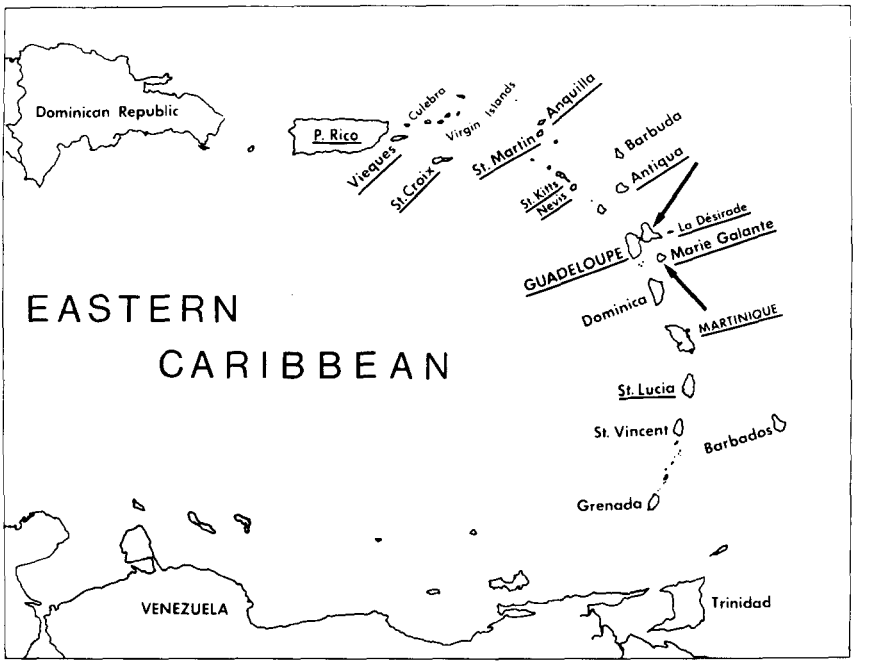

Fig. 1. Underlined names are of islands where A.variegatum has been found. Arrows point to Guadeloupe and Marie-Galante where heartwater occurs.

A.maculatum, widely spread in the eastern and southern USA, Mexico, Central America and northern South America, also reported in the past from Jamaica, is an efficient experimental vector of African strains of C.ruminantium.

A.cajennense, a common tick in much of South and Central America, also present in Mexico, Texas, Cuba, Jamaica and Trinidad, is an experimental vector of African C.ruminantium, but presumably a poor one.

ACTION REQUIRED

The presence of heartwater on Guadeloupe and Marie-Galante, and possibly other Caribbean islands, poses a serious threat to the livestock industry in warmer regions of the western hemisphere. As long as the disease remains limited to a few small islands, it

should be possible to remove this menace through an intensive and sustained tick eradication effort. The problem might well become unmanageable should it reach one of the Greater Antilles or, even worse, the mainland. In view of the increasing extension of A. variegatum in the area in recent years, urgent action is needed. (In this connection, remembering that an experimental vector of heartwater, A.cajennense, occurs on Cuba, an undiagnosed disease of cattle in certain areas of Cuba should possibly be investigated afresh, as it shows some of the characteristics of heartwater, such as sudden death ("muerte súbita"), petechiae in the heart, pulmonary oedema, pericardial lesions, and haemorrhagic lesions of the digestive tract (Figueroa and Sutherland, 1968, Figueroa et al., 1970).)

Firstly, the extent of the danger has to be assessed. American (University of Florida, USDA* and University of Puerto Rico) and French (IEMVT**) teams, with collaboration from the Dutch University of Utrecht, have started to survey the distribution of cowdriosis in the Caribbean, as well as of A.variegatum and potential American Amblyomma vectors. Much of the information given here is the first result of this collaborative work.

A compilation of knowledge of the direction and extent of trade and other movements of animals in the region (including bird migration routes) is also of first importance to help in evaluating the danger and in preventing possible future extentions of vectors and disease, and even more, in the next stage, to help decide where the vector eradication campaign is to start. Knowledge of different methods of animal husbandry and of numbers of the various species of domestic animals in the area is also to be compiled, and will be useful for a flexible approach to tick eradication on the different islands, taking into account the various species of domestic hosts, total numbers of livestock, and numbers per premises. Possible wild hosts of A.variegatum will also have to be considered in view of its very wide host range. For instance deer have been introduced to St. Kitts, Nevis and St. Croix, as well as other islands not known to be tick-infested, such as Barbuda and

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* United States Department of Agriculture.
**Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux.

Culebra (near Puerto Rico). These animals present a formidable obstacle to tick eradication. (Deer prevented the eradication of Boophilus microplus on St. Croix, according to Hourrigan et al. (1969).) Barbuda also hosts wild pigs, and feral donkeys occur on Nevis. Mongoose are almost ubiquitous, but fortunately are unlikely to have a significant role as A.variegatum hosts, as appears from studies on Puerto Rico (Dr. G.I. Garris, unpublished, 1982), and from African tick literature. Vervet monkeys have also been introduced on St. Kitts (and on Barbados, not known to be infested); fortunately, the tick has practically never been found on vervet monkeys in Africa. Rhesus monkeys occur on Puerto Rico in an Amblyomma-infested area (Dr. B.H. Bokma, pers.comm., 1983). The above information on possible wild mammalian hosts on various islands is sketchy and certainly needs to be completed.

Another disease associated with A.variegatum, but not necessarily transmitted by the tick, is dermatophilosis (= cutaneous streptothricosis), a bacterial dermatitis caused by Dermatophilus congolensis. It has been noticed that very severe forms of dermatophilosis in cattle in the Caribbean area appear to be closely linked with the presence of the tick, as reported by Morel (1967) on Guadeloupe and Martinique, by Butler (1975) on St. Lucia,by Thoen et al. (1980) on Puerto Rico, and confirmed by information gathered from the authorities on St. Martin, Antigua, St. Kitts and Nevis, as well as personal observations, during a 1982 visit by our team (M.J. Burridge, E. Camus, G.I. Garris and G. Uilenberg). Similar observations have been made on Vieques (B.H. Bokma, pers.comm., 1983). Barber (1895) discussed already a theory on the connection between a severe skin disease of cattle in Antigua, and the presence there of a large tick species from Senegal. On islands such as Nevis, St. Kitts, St. Martin and Puerto Rico, severe dermatophilosis has been noticed only since A.variegatum appeared recently, and only in the parts infested by the tick. Apalling mortality from dermatophilosis has occurred in many herds, not counting losses in condition and production and the cost of long-term antibiotic treatment, resulting in some cases in farmers going out of busisness. The authorities are rightly concerned about this disease and, consequently, about A.variegatum. This fact will make it easier to engage their collaboration for a campaign to eradicate the tick and to attract funds to make such a campaign

possible, even on islands where cowdriosis does not yet occur.

It is absolutely essential that the eradication campaign be international. All islands concerned must be involved. The experience gained in eradication campaigns on St. Croix and Puerto Rico will be of great value.

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