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TICK-BORNE BORRELIOSIS IN WEST AFRICA: RECENT EPIDEMIOLOGICAL STUDIES

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ABSTRACT: Tick-borne borreliosis in West Africa is classically considered a rare disease whose geographic distribution is limited to Saharan and Sahelian regions. We report results of epidemiological investigations which indicate that tick-borne borreliosis is endemic in all regions of Senegal north to the 13°30'N latitude and is a major cause of morbidity in these areas. Our findings indicate a considerable range extension for the vector tick Alectorobius sonrai and suggest that the persistence of Subsaharan drought is responsible for a large spread of tick-borne borreliosis in West Africa.

Key words: *Borrelia crocidurae*, Borreliosis, Relapsing fever, *Alectorobius sonrai*, Africa, Subsaharan drought.

INTRODUCTION

In West Africa, tick-borne borreliosis is due to the spirochaete *Borrelia crocidurae*. Wild rodents and insectivores act as the reservoir for infection and the only known vector is the ornithodorean tick *Alectorobius sonrai.* (1-4). This tick lives in burrows and human contamination occurs classically when burrows open in bedrooms (4). After an incubation period of 4 days to two weeks, illness begins abruptly with high fever, shaking chills and headache. The first attack lasts about three days and is followed by an interval of about ten days without symptoms, after which an average of six relapses occur, each lasting about two days. Severe meningo-encephalitic complications can ensue (5). However, the prognosis is much better than with *B. duttoni* - which is endemic in East and Central Africa but absent from West Africa - and mortality rate is probably less than 0.5 per cent.

Tick-borne borreliosis in West Africa is classically considered a rare disease and its geographic distribution is not well known (6). Most of the areas where the presence of the vector has been recorded are situated in Sahelian regions, from Mauritania and Northern Senegal to Tchad, where the average rainfall was less than 500 mm, and none reached the 750 mm isohyet which was considered the limit of vector's distribution (7).

In 1989, a French child living in Senegal had seven consecutive febrile episodes over a three-month period before the diagnosis was made. The history of this patient suggested a probable spread of the endemic area and that most *Borrelia* infections in other individuals may remain undiagnosed. We therefore decided to undertake a series of epidemiological investigations on tick-borne borreliosis in Senegal.

MATERIALS AND METHODS

In order to see how common relapsing fever is in Senegal thick blood smears from cases of fever of unknown origin in patients from various medical units and from randomly selected clinic outpatients from two rural dispensaries (Keur Moussa: 14°47'N, 17°07'W; Mlomp: 12°33'N, 16°35'W) were examined for *Borrelia*. To assess the incidence of the disease and to define its modes of transmission, a prospective study was done over two years among the population of Dielmo village (13°45'N, 16°25'W). The climate and vegetation are typically Sudanian in this area where annual rainfall averaged 1,000 mm before 1970. From June 1990 to May 1992, the villagers were visited at home six days a week for clinical and epidemiological monitoring. A thick blood film was taken in all cases of fever, stained with Giemsa, and 200 oil immersion fields were systematically examined for *B. crocidurae*.

Small mammals were trapped alive with lattice-works traps in Dielmo and 35 other rural areas in Senegal. The captured animals were tested for *B. crocidurae* by direct thick smear examination or intraperitoneal injection of white mice (8).

Tick surveys were made in ten regions situated south of the 14th parallel where the existence of *A. sonrai* was unknown and three regions between 14°30'N and 15°30'N which were considered at the southerly limit of the vector. Rodent burrows in houses and nearby fields were opened and examined for *A. sonrai* using a portable petrol suction device. A total of 70 rodent burrows were examined before a given study area was considered to be negative.

Data from 66 rain gauge stations were used to draw the isohyets charts of Senegal by Kriging geostatistical method (9) for the two periods of 23 years 1947-1969 and 1970-1992, i.e. before and after the begining of Subsaharan drought.

RESULTS

Epidemiological studies in Dielmo

The mean study population was 235 people. A total of 24 cases of borreliosis were diagnosed during follow-up, an average annual incidence rate of 5.1%. Cases appeared sporadically throughout the duration of the study. Age of patients ranged from 15 months to 52 years and no significant difference in the rate of incidence was observed in relation to age group. The daily recording of villager's presence and of their travelling was conclusive in precisely locating the place of infection for twenty patients who had spent every night at home the month preceeding the start of clinical symptoms.

A total of 251 rodents and insectivores were tested for *B. crocidurae* by direct examination of thick blood films and 232 were also studied by intraperitoneal inoculation of a white mouse. Two animals (0.8%) were found infected by the direct method (one *M. erythroleucus* and one *A. niloticus*) and seven animals (3.0%) by the inoculation method (6 *M. erythroleucus* and one *A. niloticus*). 8.2% of 342 burrows examined during four surveys contained *A. sonrai* (8.5% inside houses and 7.1% in the fields).

Batches of *A. sonrai* collected inside houses were ground in saline solution then inoculated intraperitonealy into white mice. Four of the batches developed to *B. crocidurae* infection in white mice. In six bedrooms of villagers who had recently suffered borreliosis, a sentinel white mouse was kept in a cage for one night. Two white mice developed an infection during the following days.

Distribution of A. sonrai in Senegal

Between 14°30'N and 15°30'N, out of 278 burrow examined, 118 (42%) contained A. sonrai. The proportion of positive burrows in each of the three regions studied was 41%, 37% and 32%, respectively. Between 13°30'N and 13°59'N, out of 465 burrows examined in five different regions (Dielmo village and one region per degree of longitude between 13°W and 17°W), 35 (7.5%) contained the vector. At this latitude, we constantly found *A. sonrai* from the Atlantic Ocean on the West and to the Mali border on the East. Between 12°30'N and 13°29'N, we found *A. sonrai* in one single burrow (13°15'N, 13°12'W) out of 454 studied in six different regions (one region per degree of longitude between 11°W and 17°W).

Borreliosis in clinic outpatients

In Keur Moussa, *B. crocidurae* was found in smears from 12 (0.9%) of the 1,340 children investigated. By age, the proportion of positive thick smears was 0/490 for children younger than 2 years old, 2/417 (0.5%) for those between 2 and 4, 5 /308 (1.6%) for those between 5 and 9, and 5/119 (4.2%) for those between 10 and 14. All patients who were positive complained of acute fever.

In Mlomp, we tested 927 patients of all ages with acute fever, including 580 children aged 5-14 years. No cases of infection were observed.

Between 1989 and 1993, we documented the origins of infection of 126 patients from various medical units. With the possible exception of one single case (a patient who travelled in different localities of south-eastern Senegal), all of the patients were infected to the north of 13°30'N latitude.

B. crocidurae in small mammals

Out of 2,164 rodents and insectivores belonging to 14 species captured in 23 locations between 13°30'N and 16°30'N, 195 (9.0%) were found infected by direct thick blood film examination (Table). Between 12°30'N and 13°15'N, we tested for B. crocidurae 367 rodents captured in 13 different locations (9 in south eastern Senegal and 4 in Casamance). No cases of infection were observed.

Table I. List of species of small mammals found infected with Borrelia crocidurae in West Africa.

RODENTS
Heliosciurus gambianus
Desmodilliscus braueri
Tatera gambiana
Taterillus gracilis (complex)
Cricetomys gambianus
Arvicanthis niloticus
Dasymys incomtus
Mastomys erythroleucus
Mastomys huberti
Mastomys natalensis
Mus musculus
Myomis daltoni
Rattus rattus
• Rattus norvegicus
INSECTIVORES
• Atelerix albiventris
Crocidura sp.

• data from the litterature

Relations to rainfall

Since the 750 mm isohyet has previously coincided with the known southerly limit of the vector, the drought in Subsaharan Africa, persistant since 1970, might explain the vector's progression and the spread of the disease towards the south. In order to test this hypothesis, we mapped the average annual precipitations in Senegal for the periods 1947-1969 and 1970-1992, and studied the relationship between the evolution of the rain gauge readings between these two periods of time and the present known distribution of the vector.

Between 13°30'N and 13°59'N, the latitudes where we constantly found *A. sonrai* for the first time, the average pluviometry have decreased by about 25% since the beginning of the drought period. Whilst the average rainfall varied according to the regions from 850 mm to 1,000 mm for the period 1947-1969, it was always below 750 mm for the period 1970-1992. Between 12°30'N and 13°30'N the average pluviometry decreased in similar proportions, but remained above 800 mm in each of the regions in which our studies were unable to demonstrate the presence of either A. sonrai or B. crocidurae. In the case of the only area in which we found the vector, rain gauge readings of the station nearest to the collection locality of A. sonrai indicated an average of 749 mm for the period 1970-1992.

DISCUSSION

Tick-borne borreliosis is endemic in all regions of Senegal north to the 13° 30'N latitude and is a major cause of morbidity in these areas. Investigations in Dielmo show for the first time that tick-borne borreliosis is locally transmitted in a Sudan savanna area of West Africa, with epidemiological features similar to those which have been previously described in the Sahel (1-4, 7).

Our findings indicate a considerable range extension for *B. crocidurae* and its vector *A. sonrai*. The southern locality where the vector has been collected reaches 13°15'N, i.e. more than one degree in latitude further south than its formerly known limit (7).

We believe that the most probable explanation for our observations is that the spread of the endemic area has occurred recently and that the persistence of Subsaharan drought is responsible for a large spread of tick-borne borreliosis in West Africa by allowing the vector tick *A. sonrai* to colonize new savanna areas. This would be the first known example of a vector-borne disease whose spread in West Africa has been caused by present climatic changes.

BORELIOZA W ZACHODNIEJ AFRYCE, AKTUALNE BADANIA EPIDEMIOLOGICZNE

Streszczenie

Borelioza z Lyme w Zachodniej Afryce była traktowana raczej jako rzadka choroba, której geograficzne rozmieszczenie jest ograniczone do regionów Sahary i Sahelu. Przeprowadzono badania epidemiologiczne, które wskazują na endemiczne występowanie boreliozy we wszystkich regionach Senegalu na północ od równoleżnika 13030,, gdzie jest głównym czynnikiem etiologicznym zachorowań. Występowanie wektora tej choroby, kleszczy Alectorobius sonrai i suszy w tym regionie współdecyduje o szerokim rozprzestrzenieniu się tej choroby w Zachodniej Afryce.

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