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The Aedes problem in Africa, with particular reference to West Africa

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INTRODUCTION.

Investigations carried out since the last 25 years in tropical Africa by several Institutes and Organisations (East African Virus Research Institute, Entebbe, Uganda - South African Institute for Medical Research, Johannesburg, South Africa - Virus Research Center, Lagos, Nigeria - Pasteur Institutes and ORSTOM CENTERS of Dakar, Sénégal, and of Yaoundé, Camerons - OCCGE, Bobo Dioulasso, Haute Volta -...) have shown that arboviruses belonging to groups A, B and Bunyamwera are very widespread. In some areas up to 96% of the inhabitants, but infants, possess antibodies against ~~various~~ one or several unrelated arboviruses, the highest rates being generally observed in wooded savannahs.

Arboviruses, in tropical Africa, are transmitted by various species belonging to several arthropods groups, but the majority of proven natural and laboratory vectors are mosquitos. Man-biting anophelines are the only known/for O'nyong nyong virus, whereas some other arboviruses are transmitted by Culex and Mansonia species, but the main role seems to be played by Aedes species. Our observations will be restricted here to the Aedes subgenera which have been implicated in diseases transmission.

GENERAL ECOLOGY OF Aedes sp. IN TROPICAL AFRICA.

Aedes mosquitoes are characterized by their "dormant" eggs, which can survive through long periods of drought, and are reactivated by their immersion in water. The hatching of a same batch of eggs can be scattered on several weeks and, in extreme conditions, several months and even years.

Many types of breeding places are favorable for Aedes development, the main categories being: ground pools and marshes, rock holes, crab burrows, plant axils, tree holes and domestic containers. Larval breeding places as well as adult behaviour are under the dependance of the environment and can differ widely between rain-forest, savannah, and subdesertic conditions.

Crab-burrows constitute important breeding places in coastal areas. They support several species of the subgenus Aedimorphus and are the only breeding places of Ae. (Skusea) pemaensis. All crab-burrow breeding Aedes bite man in large numbers, by day and by night, in the vicinity of their burrows.

Plant axils are mainly used by specialised species of the subgenus Stegomyia which are found sometimes also in tree-holes. They constitute important breeding places in rainy areas, as the rain-forest, but may also be important in some savannah areas during the rainy season. Large number of such breeding places are due to the human activity under the form of banana, pine-apple and taro (Colocasia sp.) plantations, and are favored by A. simpsoni, one of the natural vectors of yellow fever in East Africa.

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Tree-holes and bamboo-holes are very common in Africa, from the mangrove and swamp coastal forests to the subdesertic thorn bush areas. They constitute breeding-places of many species of the subgenera Stegomyia and Diceromyia, and are also used by one group of species of the subgenus Aedimorphus.

Rock-pools, according to their degree of water pollution and of shade, can be occupied by several species belonging to the subgenera Stegomyia and Aedimorphus, but are highly specific for Ae. (Stegomyia) vittatus over all its range of distribution.

Aedes ~~problema~~ o.2

Ground-pools are mainly used by species of the subgenera Aedimorphus and Neomelaniconion (ex Banksinella).

Domestic containers are almost exclusively occupied by species belonging to the subgenus Stegomyia. Ae. (St.) aegypti is the most common domestic mosquito breeder, but Ae. (St.) vittatus occurs sometimes in such breeding places in dry areas, whereas several other species, including Ae. (St.) luteocephalus and Ae. (St.) africanus, are not uncommon in domestic containers in forested areas.

In Madagascar and Mascareignes Islands Ae. (St.) albopictus occurs in all types of breeding places but ground pools.

ENVIRONMENT, DYNAMICS OF POPULATIONS AND BEHAVIOUR.

In rain-forest areas the relative humidity is always high, the temperature is more or less even, and the light intensity varies from nil to moderate, dense shade being always present. In such conditions, which/to frequent rainfalls, breeding-places are available all the year round, with however some seasonal variations. Tree-holes are plentiful and fallen leaves and bracts constitute often long-lasting micro rain-pools which are the characteristic breeding-places of many forest Aedes mosquitoes. Predators also occurs all the year round in the majority of the breeding-places and exert a very strong pressure on the mosquito populations. Many Aedes species occur in such areas but the number of specimens of each species is often low. At ground level females are active almost 24 hours a day, the peak of activity occurring mainly by day-time. At the canopy level females are mainly active by night. The same species may be active at ground level by day, and at the canopy level by night, which helps to disseminate diseases from the wild canopy-resting vertebrates to/which enter the forest by day. Adult mosquitoes rest mainly at ground level, on fallen leaves, bushes, grasses and so on, and can be easily collected with hand-nets, but the resting-sites of many Stegomyia species are unknown and such species can only be collected when they come to bite.

In savannah-areas seasons, are well marked and Aedes mosquitoes, but domestic species, are rare or totally absent during the dry season. During the rainy season light is intense by day-time, whereas temperature is high and relative humidity is moderate, except during rainfall; so the great majority of Aedes species are dusk or night-biters. However, under dense shade, in residual forest patches or along gallery forests, females of a very limited number of species can bite by day-time. In desertic thorn-bush areas conditions are more/and almost no Aedes species is active by day.

Seasonal variations of frequency are under the dependence of rainfall. Species with a very short larval cycle of development appear soon after the first rains whereas species with a longer larval life are rarely numerous before the middle or the second half of the rainy season. Some species, like Ae.(St.)vittatus, seem very susceptible to parasites and predators and have only one short peak of occurrence during the first months of the rainy season; when breeding-places become established the frequency of predators increase and these Aedes species are unable to maintain high larval densities. In savannah, and more in subdesertic areas, the number of species is lower than in forested areas, but the number of individuals can be very high during the rainy season.

Urban areas, and to some extent villages, with their domestic breeding-places offer special opportunities for Aedes development. Where water supply is plentiful the inhabitants do not store usually any water (with the exception of some communities of coastal West Africa) and the only breeding-places are the disused domestic containers filled with rain-water; then seasonal variations of occurrence and density are rainfall-dependent. But in areas where water is scarce large supplies of water are generally stored all year round, sometimes in open containers which then constitute ideal breeding-places for Aedes aegypti. Ae.(St.) aegypti, under all environmental conditions, has its peak of activity by day-time and, in urban areas, feeds extensively on man, indoors; and out of doors.

In sparsely inhabited areas very few Aedes species used as a regular supply of blood. Recent investigations have shown that in West Africa only some Diceromyia (furcifer-taylori group) and Stegomyia (africanus, luteocephalus, and to a lower extent aegypti, vittatus and metallicus) species prefer man, and probably also monkeys, to other vertebrates. The big majority of other Aedes species feed mainly on domestic cattle and wild game and bite man only by chance, or have entirely unknown preferences excluding man. But in savannah areas many species of Aedes build very large populations during the rainy season and even if one percent only of the females bite man, it is sometimes sufficient to constitute clouds of man-biting mosquitoes. In and around villages, in open areas, the man-biting species have one intense peak of activity at dusk, when humans are usually chattering out of doors, which ensures a high degree of contact between mosquitoes and one of their preferred hosts, as almost all african Aedes are exophagous.

On the reverse zoophilic species present generally a more or less even level of activity all the night long, or have a peak of activity in the middle of the night.

The species having a large distribution present usually almost identical biting cycles at ground level in the open savannah and at canopy level in forest. However it is interesting to stress here that some species have very different behaviours in different parts of their distribution area; so Ae. (St.) simpsoni bites extensively humans in Kenya, Tanzania and in some parts of Uganda, but seems entirely zoophilic elsewhere; Aedes (Aed.) fowleri possess two short and very high peaks of activity at dusk and dawn in Mascareignes Islands, whereas it has a very even level of activity all the night long in similar environmental conditions in West Africa.

Specific investigations on age-compositions of african Aedes populations have been carried out only in Uganda, on a restricted scale, but indirect evidence has been collected through dissections for metacyclic larvae of filarial parasites.

The majority of Stegomyia species, as well as several species of Aedimorphus (dalzieli, fowleri, hirsutus) and Skusea pembaensis survive through several gonotrophic cycles. The other investigated Aedes seem short-living. The average number of generations per year is unknown but, except in semidesertic areas, all species seem to be multivoltine.

MEDICAL IMPORTANCE AND PROBLEMS OF CONTROL.

In West Africa yellow fever is apparently widespread all over the savannah, but without acute cases in humans belonging to the local tribes, where several outbreaks have been recorded during the past 25 years in forested coastal areas. The transmission cycle in bush areas is certainly very different of that one established in the Bwamba County, Uganda, because Aedes (St.) africanus has a restricted distribution, lacking in the dry savannah, whereas Ae. (St.) simpsoni does not bite man in Central and West Africa. Analysis of all available data shows that the main vectors in rural dry areas are probably Ae. (St.) luteocephalus, vittatus and metallicus, and Ae. (Dic.) taylori and furcifer.

The other Aedes-borne arboviruses, such as Chikungunya, Bunyamwera, Uganda S, Zika, are more common in the humid sudanese savannah and in the guinean savannah than in the dry savannah and in forested areas. The vectors recorded in East and South Africa are either the same that the yellow fever vectors, or belong to the zoophilic group of savannah mosquitoes, one important role being played by Ae. (Neom.) circumluteolus.

Aedes aegypti is rarer in many villages than the Aedes africanus, luteocephalus and furcifer-taylori group. It is very rare now in urban areas except where it is dieldrin-resistant. In the bush it is often either scarce, or non man-biting or both. So in the majority of rural areas the most important Aedes species for public health are some tree-hole breeders which are not semi-domestic and are mainly found in the bush, but enter the villages by night, with usually a marked peak of activity at dusk.

In urban areas good results can be obtained by source reduction alone, as it was proven in the past during the yellow fever control operations, before both the discovery of vaccination and of the synthetic insecticides. In rural areas the Aedes control is almost impossible; however in special instances perifocal insecticide applications could give some results as the majority of tree-hole breeding mosquitoes seem to be restricted to the vicinity of their breeding places. Larval control could not be carried out without great difficulties, as many of the tree-holes are not situated at ground level. The control of ground pool species should be even much more difficult as they seem to possess a longer flight range.