Natural history of yellow fever vectors and reservoirs : Studies in East Africa

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Most of the work on this subject was carried out by the Yellow Fever Research Institute now renamed the East African Virus Research Institute. The classic studies by MAHAFFY, HADDOW, SMITHBURN, GILLETT, DICK, LUMSDEN KITCHEN *et al.* particularly in Bwamba County of Western Uganda are sufficiently well know to require no repetition here. Excellent reviews are available. The most recent being HADDOW's (1968) which unfortunately is in a journal not generally available to YF workers. As reprints are not available, we would strongly advise that further copies be made available to interested workers, perhaps by WHO.

Basically, these studies brought us to the point that YF in East Africa exists as an enzootic in wild, tolerant, African forest primates, principally monkeys. All species of African monkeys are susceptible to YF and they circulate virus in sufficient quantities to interest mosquitoes (SMITHBURN and HADDOW 1949). The monkey to monkey forest canopy transmission was shown to be maintained by an arboreal mosquito *Aedes (S.) africanus*. This forest situation obtains throughout the lowland rain forests which are uninhabited in East Africa. The occasional spill-overs to man at the forest fringes were noted and shown to be due to viraemic monkeys raiding banana plantations and being bitten by the peri-domestic *A. simpsoni*. A notable exception was the isolation by SMITHBURN *et al.* (1949 a) of YF virus from *Phlebotomus* species trapped in the Bwamba forest canopy. This finding has not been fully followed up.

THE DRY WOODED ENVIRONMENTS OF EAST AFRICA.

The picture presented in this situation is that of very low immunity rates in monkeys and man (less than 3 %) and fairly high immunity rates in certain Lemuroid primates (up to 13 %). These findings were also recorded on the East coast and offshore Islands of Zanzibar and Pemba posing a hazardous situation (LUMSDEN *et al.*, 1955).

In such dry areas it is difficult to imagine how mosquitoes can maintain YF virus except during the short rainy periods. GILLETT *et al.* (1950) failed to show transovarian transmission of YF in *A. africanus*. Laboratory tests by SMITHBURN (1949) and DICK (1952) showed that primates were highly susceptible and circulated YF virus to high titres. HADDOW and ELLICE (1964) challenged naturally immune Lemuroidae with virulent YF demonstrated that the immunity was specific.

Nest transmission by mites was made but has never seriously been taken up.

Transmission of YF virus from one galago family to another has not been investigated. The two species thought to be important are : — *Galago crassicaudatus* and *Galago senegalensis*. The tiny forest *Galagoides demidovii* is refractory. The Potto (*Perodicticus potto*) though susceptible is thought not to be important as it does not occur in great numbers (SMITHBURN, 1949 and HADDOW, 1968).

LUMSDEN (1955 a) after extensive entomological studies at Gede and Taveta areas of Kenya concluded that the galago cycle is likely to be separate and self contained. This was because of the high immunity rates in galagos alongside low immunity rates in man and monkeys despite the presence of *A. africanus*, monkeys and man biting *A. simpsoni*.

Yellow fever in East Africa so far has not given rise to any recorded human epidemic. The very occasional cases, some proven, as mentioned in the first

paper have occurred in widely scattered forested localities without involving the classical vector *A. aegypti*. It is only in Bwamba County and more recently in Marsabit that a high proportion of human immunes have been recorded especially near the cultivated forest fringes. But even in Bwamba it took a great deal of concentrated effort to detect an active human case. The problem of low pathogenicity to man and local monkeys in East Africa as opposed to the situation in South America and West Africa appear to point to the fact that the virus is perhaps in its native place.

The vectors then to be considered in East Africa include :

1. ***A. africanus*** : This mosquito has a very wide forest distribution in East African. The work on the platforms of the steel tower in Zika clearly showed the vertical movement range of this vector connecting the forest canopy and the forest floor (HADDOW *et al.* 1966 a). It is essentially involved as a monkey to monkey vector, but may also bite man by day at the forest floor and edge.

2. ***A. simpsoni*** : In Bwamba the zoonosis included man through anthropophilic peri-domestic *A. simpsoni* breeding in the leaf axils of certain cultivated and wild plants. *A. simpsoni* has been found biting man in large numbers only in Bwamba (GILLETT, 1951) and few other sites in Kenya e.g. Taveta near Mt. Kilimanjaro and Gede on the coast about 65 miles north of Mombasa. Over much of its range, however, the species appears to be almost wholly non-anthropophilic and hence would not play any part as a vector of YF epidemics.

3. ***A. aegypti*** only shows a very slight preference for man over much of its range in East Africa where it is essentially exophilic in oviposition, resting and biting activities. It attacks a wide range of available hosts including reptiles, birds and large and small mammals. *A. aegypti* has not been incriminated in YF transmission in East Africa. Our entomologists believe that there is an urgent need to understand factors underlying host selection in this species in view of the increased urbanization and communications.

MARSABIT, NORTHERN KENYA.

As presented in the previous paper, recent surveys (METSELAAR *et al.* 1970 and HENDERSON *et al.* 1970) sparked off by the 1960-1962 Ethiopian epidemic, revealed the presence of a high immunity rate in humans at Marsabit which was thought to have been acquired locally. The investigations are still going on and the findings so far are :

No *A. africanus* and *A. simpsoni* were found.

A. aegypti, however was observed biting man occasionally. Although *Mansonia africana* was abundant, the candidate vector was thought to be *A. (Aedimorphus) dentatus* which occurred in large numbers and was taken biting man frequently in the afternoons and after sunset just outside the forest. YF virus was isolated from this spp. during the Ethiopian epidemic by SERIE (1968).

No YF was isolated from mosquitoes, though 15 other virus strains were isolated, most of them being strains of Pongola virus.

The few vervet monkeys, baboons and bush babies captured were non immune.

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