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SURVEILLANCE OF POTENTIAL YELLOW FEVER VECTORS IN ENDEMIC ZONES

by

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1. Introduction

In yellow-fever endemic zones operations for surveillance of potential vectors may have several different objectives:

To establish initially the distribution of the vectors;

To determine the theoretical risks of transmission as a function of the abundance and the ecology of the vectors;

To demonstrate the circulation of the virus.

The present document is concerned only with the confirmed potential vectors of yellow fever, which are all mosquitos.

2. Distribution of the vectors

The distribution of *Aedes aegypti* in yellow-fever endemic zones was generally well known in former times. The situation is now evolving rapidly, eradication campaigns having eliminated this mosquito from vast regions, while accidental introduction takes place from time to time into the countries from which the species had been eliminated.

The distribution of the other potential vectors is generally far less well known, particularly in tropical Africa. In order to be effective, surveys have to be conducted during the rainy season, which is the very period when it is most difficult to move around away from the major highways.

Distribution studies are generally confined to establishing the presence or absence of each of the vectors and the end product is usually a map in which the geographical unit is either an administrative division, or a square degree, or a fraction of a square degree, depending on the density and precision of the field studies (Muspratt, 1956; Yasuno et al, 1969; Mouchet, 1970a, b and c; Hamon et al, 1970).

Such studies constitute above all a source of base-line data for the surveillance operations proper.

3. Theoretical risks of transmission as a function of the abundance and ecology of the vectors

Evaluation of the abundance of yellow-fever vectors was originally done only on A. aegypti, and most of the indices at present in use are applicable to that species alone.

When the larval habitats are accessible and relatively permanent, the indices of frequency and abundance are essentially based on a count of them. When these habitats are not all equally accessible or are very temporary in nature, the evaluation of abundance has to be based on a study of the adult mosquitos.

3.1 Larval indices

3.1.1 Aedes aegypti

Originally surveys were limited to determining the proportion of habitats positive for A. aegypti (Graham, 1911; MacFie & Ingram, 1916; Beeuwkes et al, 1933), but the value of this information varied with the number of potential habitats available. This procedure is nevertheless still used nowadays (Yasuno & Tonn, 1969; Tonn et al, 1969a).in research on the vectors of haemorrhagic fevers in South-East Asia; taking into account the abundance of potential habitats and the average larval densities per positive habitat, it then becomes possible to evaluate the number of adult mosquitos produced per day in a given area (Tonn et al, 1969b).

In yellow-fever endemic zones a "premise index" of A. aegypti, defined as the percentage of houses containing larval habitats of that mosquito, was then used. This index was very widely employed in Africa (OIHP, 1937) and was later adopted by WHO, which classified as a danger zone any endemic region in which it exceeded one per cent. (i.e., one positive dwelling per 100 visits) (WHO, 1950). This index is sometimes difficult to use in tropical countries where the term "dwelling" covers entities differing very widely from one another; moreover, it does not take into account the number of positive habitats per dwelling. The most recent surveys conducted in tropical Africa have therefore used a Stegomyia index ("Breteau's index") defined as the number of Aedes aegypti breeding places per 100 inhabited rooms (Pichon et al, 1969; Mouchet, 1970a, b and c; Hamon et al, 1970).

With a view to simplifying field studies, it has been suggested that only one larva or pupa be collected for each positive habitat (WHO, 1968; Rao et al, 1969). This method saves considerable time in identifying the material collected, but it can lead to highly questionable conclusions when various species, morphologically similar, co-exist in the same type of habitat.

3.1.2 Other vectors

When the larval habitats of the main jungle vectors are accessible, their frequency and abundance can be evaluated with indices similar to those used for A. aegypti. This has been done, in particular, for those species living in plants with ensheathing leaves which sprout at ground level (Teesdale, 1941 & 1957; Gillett, 1969) as well as for mosquitos whose ecology is similar to that of A. aegypti (Yasuno et al, 1969; Mouchet, 1970b). Over limited areas it is even possible to establish the average number of positive habitats per unit of area, the average larval density per habitat, and the daily capacity for production of adult mosquitos, as is being done in various projects.

3.2 Evaluation of the abundance of adult mosquitos

Evaluation of the abundance of adult mosquitos is done either directly or indirectly; here too the most elaborate methods concern A. aegypti.

Direct evaluation is generally based on determination of the number of mosquitos biting a bait in a given time (Gillett et al, 1969). The principle is therefore very simple, but its application is difficult, for the cycles of activity of the vectors vary with a number of external factors (temperature, wind, light intensity, level above the ground) while the attracting power of the baits is difficult to standardize (Gillett, 1969; Yasuno & Tonn, 1970; Yasuno & Pant, 1970). Despite these difficulties, this method has been and still is widely employed.

In certain areas the measurement of the abundance of adult vectors has been done by means of light traps. The results seem to be very uneven and, at any rate in tropical Africa, the potential vectors are not much attracted by such traps (Corbet, 1961; Doucet, 1961; Service & Boorman, 1965; Gayral, 1970).

Numerous models of traps with bait have been described but they are generally unwieldy and, in Africa, have never replaced direct capture on bait for studies of potential vectors of yellow fever. It would nevertheless be desirable to re-evaluate and, if possible, improve them, so that recourse to the traditional "human bait" can be eliminated.

Indirect evaluation is based on the use of ovitraps, the species then being identified either by direct examination of the eggs or by breeding from them. This method has been in use for a very long time in tropical Africa (Dunn, 1927a and b; Hocking, 1947; Surtees, 1960; Doucet & Cachan, 1962; Corbet, 1964; Service, 1965) and is particularly effective for detecting very low vector densities (Robinson, 1950; Gayral, 1970). It has also given very good results in tropical America (Galindo et al, 1951) and in South-East Asia (Yasuno et al, 1969), while its use has recently been standardized in the United States (Fay & Eliason, 1966; Jakob & Bevier, 1969).

3.3 Abundance of vectors and risks of transmission of yellow fever

The relationships formerly established between the Stegomyia index and the yellow-fever risk have an empirical basis. It would be desirable to evaluate more precisely the critical densities and the rate of reproduction of the disease from an imported case as a function of the abundance and the ecology of the potential vectors.

4. Demonstration of the circulation of the virus among the vectors

One of the best proofs of the circulation of yellow-fever virus might be to isolate it from the vectors. This has been done in endemic zones, in the course of enzootic waves of greater or lesser duration, both in Africa (Woodall, 1964) and in America (Burgher et al, 1944) as well as during epidemics (Beeuwkes & Hayne, 1931; Sérié et al, 1968). Nevertheless, the probability of encountering infected mosquitos seems to be very slight and most of the recent investigations conducted in areas of tropical Africa where the yellow-fever virus circulates sporadically have been unproductive (Chippaux & Chippaux-Hyppolite, 1966; Robin & Bres, 1969; Brottes et al, 1966; Rickenbach et al, 1969) although many other arboviruses have been isolated.

5. Discussion and conclusions

In the yellow-fever endemic areas as a whole the main outlines of the distribution of potential vectors are apparently known but, except in the case of A. aegypti, few data exist regarding the relative and absolute abundance of the main species in the various ecological zones.

Surveys on domestic and sub-domestic populations of A. aegypti can be done quite rapidly, with relatively limited facilities. Studies on the jungle forms of this same species and on the other potential vectors will be much more difficult to carry out and will require considerable resources over long periods.

With present survey methods it is possible to determine the zones in which the risk of epidemics would apparently be highest if the yellow-fever virus were introduced there, but it does not seem possible to express this risk satisfactorily in figures. Future vector surveillance operations should include a programme of research into means of evaluating this risk precisely.

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