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The Secretary of the Expert Committee on Malaria has the honour to communicate hereunder the following note:

CHANGES OF ANOPHELINE FAUNA AND INTRA-SPECIES CHANGES FOLLOWING THE APPLICATION OF MODERN INSECTICIDES

by

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The widespread use of the new and more effective insecticides has in many places brought about a reduction of anopheline populations to levels not previously obtainable. This has been particularly true where the goal has been malaria eradication or even vector eradication. Little thought has been given, however, to what effect the profound disturbance of one element of the anopheline fauna may have on other species which are associated in the same environment. Studies made in connexion with the recent attempt to eradicate Anopheles l. labranchiae in Sardinia have shown that there must exist a dynamic equilibrium between anopheline species, and that when one species is brought down to extremely low levels another species may fill the now vacated ecological niche. Of particular importance to malariologists is the matter of whether the replacement species is a better or poorer vector of malaria. Where the effectiveness of the anopheline as a vector is a function of the frequency of contact with man in the domestic situation, one would suppose that the selective

action of residual house spraying would result in the replacement species being less domestic, and in consequence less effective a malaria vector. Experience in Sardinia in 1952, however, illustrates that this may not necessarily be true - the replacement species in one part of the island being a more effective vector, while in another it was a species not known as a vector at all.

Anopheles hispaniola was not found by Aitken in a survey of the anopheline fauna of Sardinia in 1946, nor had it previously been reported from the island by other investigators (Aitken, 1953). The species was first encountered in July 1947. As a major effort to eradicate labranchiae from Sardinia, all man-made structures as well as such natural resting places as grottoes were residually sprayed during the winter of 1947-48. During the spring and summer of 1948 all breeding places were larvicided on a weekly basis. Since that time, all areas in which labranchiae could be found have been subject to larviciding and in many cases to residual spraying as well.

Since 1949 hispaniola has become a common inhabitant of streams of the south-eastern portion of the island. During the summer of 1952 the writers made a study of a valley in south-eastern Sardinia where labranchiae was found for the first time since 1949 (Trapido and Aitken, 1953). Although all treatment was withheld from this valley during the summer of 1952, labranchiae failed to develop in appropriate breeding places along the margin of the stream coursing through the valley, although it had been abundant in this situation when the valley was surveyed in 1946 before the eradication effort. On the other hand, larvae of hispaniola, which were not found here at all in 1946 were now abundant and widespread. In the absence of labranchiae in the stream margin habitat, hispaniola had invaded this ecological niche. Thus it appears that when a vacuum is created by the eradication or near eradication of one species of anopheline, another may move in to fill the vacant niche.

In the present case, the replacement may have come about in this manner. Anopheles hispaniola adults in Sardinia did not rest in houses or domestic animal shelters, while labranchiae was quite domestic. The residual spraying programme would thus have severely affected the labranchiae population, but had little or no effect on hispaniola. While it might be supposed that the larviciding of all

breeding places would have affected the larvae of both species in equal measure this is not so. It has been shown by Trapido (1951) that on disturbance of the water, hispaniola larvae dive and avoid the surface for much longer periods than do those of labranchiae. Thus where oil-base surface film larvicides were used, as they were in Sardinia, the opportunity for contact with the film would be much greater in the case of labranchiae than hispaniola. This differential effectiveness would be enhanced by the fact that the ecological niche shared by both species is one in which the water is freshened by slow movement. The diving by hispaniola larvae would permit the species to be out of contact with the surface for long enough for the oil film to be carried away. In still water breeding places, which are not the preferred habitat of hispaniola, the surface avoidance of this species would have less survival value, since the oil film would be more likely to persist long enough to contact larvae when they did come to the surface.

What we still do not know is how effective hispaniola will be in maintaining its dominant position in the breeding places it has invaded. It would take observations over a period of several years, in the absence of further chemical treatment, to establish this. It is quite within the realm of possibility that once the balance has been disturbed in favour of hispaniola, as it has in the area studied, the re-establishment of significant labranchiae populations may be delayed for a long period of time if not permanently. Should this be true, we may now have before us a method of naturalistic control of one anopheline species by another, the process having only been initiated by a chemical attack of sufficient force to upset the former balance and establish a new one. Where the invading anopheline is not a malaria vector, as in the present case, we are faced with the new concept of malaria control by anophelism!

Anopheles sacharovi, a domestic species, and a very effective vector of malaria in the eastern Mediterranean, had been reported from Sardinia prior to 1940, but was not found either in the pre-eradication survey of the island by Aitken in 1946, nor was it found in some 14 million inspections made from 1947 through 1950. Yet in 1952, 11 sectors representing six distinct localities in the northern part of the island were positive for sacharovi. (Aitken, Maier and Trapido, 1953).

There is at present no ready explanation of how this may have come about. This species is presumably even more domestic than labranchiae, and assuming a population of it had been present at levels so low that it escaped detection, it should have been affected by the residual spraying at least as much as was labranchiae. No study of the surface avoidance of the larvae has been made, so we do not know how larvae would have been affected by larvicides in comparison with labranchiae. We are faced, however, with the fact that a significant proportion of the maculipennis complex positives in the northern part of the island during 1952 were sacharovi, replacing labranchiae. Since this species is probably the most effective vector of malaria of the maculipennis complex, there may have been brought about the potential intensification of the malaria transmission problem should control measures ever be lifted in the area of its appearance.

Other evidence, which are too involved to present here, indicate that the distribution and densities of other anophelines in Sardinia, such as A. claviger and A. marteri have also changed since the near eradication of labranchiae.

A similar replacement phenomenon seems to be occurring on the Italian mainland as well. The residual spraying of man-made structures in the Pontine Bonifica of Latina Province, carried on since the war, has reduced the population of labranchiae to the point where neither adults nor larvae have been found in several years. Yet during the summer of 1952, we are informed by Dr. E. Mosna, larvae of claviger, which were formerly confined to the waters of the cold springs at the foot of the Apennines, began to appear in the warmer waters of the irrigation canals in the Bonifica itself, from which labranchiae had disappeared.

It is plain from all this that the various anopheline populations of a region are in dynamic balance with one another, and even a selective attack on one element of the anopheline fauna unwittingly effects the others. It also appears that this changed balance may either mitigate or intensify the malaria transmission hazard. We should be alert for these changes and prepared to assess their significance when we set out to apply the pressure of chemical toxicants against a particular species.

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