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BIOLOGY AND CONTROL OF THE TABANID VECTORS OF LOIASIS

by

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1. INTRODUCTION

Loiasis is a filariasis occurring in tropical Africa. The causal parasite, *Loa loa*, occurs in man and in monkeys, but human and simian strains seem different (Williams, 1962c) and it is probable that monkeys do not constitute an important reservoir of *Loa loa* for human infections. Stoll, in 1947, estimated that about 13 million Africans were parasitized by *Loa loa*.

Loiasis is a disease causing mainly transitory oedema known as "Calabar swelling", and fever. It is sometimes a painful and disabling disease, but not affecting survival, and is far less serious than malaria, sleeping sickness and other vector-borne African diseases.

The main, if not the only, vectors of human loiasis are day-biting horse-flies of the genus *Chrysops* - *C. silacea* and *C. dimidiata*; the taxonomic status of these two species is not perfectly satisfactory even now and they constitute probably a "complex *silacea-dimidiata*" because intermediate forms are known (Crewe, 1961; Williams, 1962c). The vector occurs mainly in Central Africa, from Western Nigeria to Uganda and the Congo (Leopoldville) (Oldroyd, 1957).

2. BIOLOGY OF *CHRYSOPS SILACEA* AND *C. DIMIDIATA*

The main studies have been carried out in the Southern Cameroons on *C. silacea*, with some investigations also on the "Bomb form" of *C. dimidiata* and on other species of the genus *Chrysops*. The biology and development of both vectors are very similar.

2.1 Pre-imaginal stages

Females of the loiasis vector Chrysops lay eggs on leaves and branches situated above marshy areas where, under dense shade, mud is covered by a thin layer of flowing water. The most favourable breeding sites are in deep valleys in the dense rain-forest, along streams. Eggs hatch about six days after egg-laying, and young larvae drop into the mud and spend their life in the upper layer of mud, in the five centimetres under the water surface. The larval development is very slow, with probably eight to nine larval instars in almost one year. Late-instar larvae migrate in mud outside the water, but near the edge of the breeding site, and pupate erect, with the cephalothorax emerging from the mud. About five to six days later the adult emerges and stands near the pupal pelt one hour before flying (Crewe, 1961; Crewe & Williams, 1961; Williams, 1961, 1962a).

Seasonal variations of abundance of larvae and pupae are related to rainfall; late-instar larvae are abundant during the beginning of the rainy season, and the peak of pupae occurs four weeks later (Williams, 1962b). If the pupation is delayed, the larval life is extended another year until the next rainy season.

2.2 Adults

Adults of C. silacea and C. dimidiata mate probably only once in their life, soon after emergence. Females bite and take blood every five days, and lay eggs about every five days, but their survival is dependent on large sugar consumption, and nectar or fruit exudations are probably ingested daily. In natural conditions the average longevity of female flies is about three to four weeks (Crewe & Beesley, 1963).

Adults do not seem to fly very far from their breeding sites in the rain-forest. They can cover up to 1.2 kilometres in 24 hours and 3.3 kilometres in six days, but do not cross wide-open areas (Beesley & Crewe, 1963).

3. ENTOMOLOGICAL CONTROL OF LOIASIS TRANSMISSION

The entomological control of loiasis transmission can be obtained either by suppressing contact between flies and human populations, or by destroying the vectors. It should certainly be possible to protect populations by general forest-clearing around villages and farms, and in using protective clothing and repellents and screening doors and windows of houses, but such methods are too costly and sophisticated for large areas of developing countries (Williams, 1962c). Vector control might be probably more efficient and cheaper, and can be directed either against adult flies or against pre-imaginal stages.

3.1 Adult *Chrysops* control

Female *Chrysops* haunt mainly the dense rain-forest and limited clearings. No studies have been carried out on the possible use of poisoned or chemosterilizing baits. The control could be done by air-spraying with residual insecticides, but it is doubtful if the insecticides could penetrate through the rain-forest canopy, and they would be washed away very soon by the frequent rains.

Experiments of adult horse-fly control by insecticide air-spraying carried out in the past in Canada and the United States of America have not been very promising (Gerry, 1949; Howell, 1949; Brown & Morrison, 1955) and suggest that, in tropical forest, *Chrysops* could be more easily controlled during their long-lasting larval development.

3.2 *Chrysops* breeding-site control

Breeding sites could be cleared of *Chrysops* larvae by preventing the females from laying eggs, but the periodic destruction of all available leaves, branches, poles and other laying places would be an enormous task, the convenient breeding sites being fairly numerous, very scattered, and supporting a dense and rapidly growing vegetation (Williams, 1962a, 1962c; Beesley & Williams, 1962).

Horse-fly larvae have been efficiently suppressed for long periods in Northern America by insecticide larviciding (Gjullin & Mote, 1945). The larval development being very slow, one application controlling one generation gives one-year control in temperate climates. The most promising compound, in field conditions, has been dieldrin (Hansens, 1956; Jamnback & Wall, 1957, 1959), and in laboratory investigations some organo-phosphorus compounds have been more efficient than dieldrin (Hoffman, 1960).

Investigations carried out in the Southern Cameroons show that dieldrin is there also the most promising compound, in the laboratory as well as in field conditions, being highly toxic for Chrysops larvae, long-lasting, and concentrating itself in the upper layer of mud in which Chrysops larvae are usually found. Emulsion is much more efficient than pellets and would be the best formulation for practical use. Applications of 0.4 g dieldrin per square metre have given a complete control of larvae during the 10 months of the experiment, and would probably be efficient for a longer period (Williams, 1963a, 1963b; Williams & Crewe, 1963; Williams et al., 1963; Crewe & Williams, 1964). However, it must be stressed that such a dosage of dieldrin (4 kg/ha) will clear all animal life from treated areas because in temperate conditions even 0.56 kg/ha kills almost all wildlife, and the maximum permissible dosage when wildlife is involved seems to be 0.11-0.22 kg/ha in marshy areas (Hansens, 1956). Besides, with such a residual insecticide, soil contamination will stand for years, and probably dieldrin will slowly migrate in streams and rivers on long distances with very serious effects on fish and other aquatic animals (Hamon et al., 1965). Other insecticides, with a shorter residual life, such as BHC or organo-phosphorus compounds, could be less efficient but far less dangerous.

For complete protection of the human population, treated areas must include the neighbourhood of all inhabited places in a radius of about 3 kilometres. Such a task cannot be carried out at the present time, but only in special conditions, because in rain-forest about 15% of the total ground surface constitutes convenient Chrysops breeding sites (Crewe & Williams, 1961). More investigations are needed to establish more convenient and less hazardous Chrysops control methods. Similar methods could be more easily used for Tabanus control because Tabanus larvae, at least in Africa, are much more susceptible to insecticides than Chrysops larvae (Williams, 1963a). In Africa the Tabanus species not only carries animal diseases of economic importance, but is also, in some areas, directly noxious to cattle (Holstein, 1957).

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