

## NATURAL PARASITES OF MOSQUITOES IN INDIA.

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(Read at Symposium, August 27-28, 1937.)

Several organisms have been recorded as parasites of mosquitoes, but only a few of them appear to be of importance in the economy of nature in the control of mosquitoes. One should, however, differentiate between parasites and epiphytes which do not obtain their nutriment from the host, as for example *Characium anophelesi* and *Vorticella*. Sometimes certain saprophytes, as for example the fungus *Saprolegnia* observed frequently on dead larvæ, are mistaken for parasites. Such fungi are really saprophytic and they come in only after the death of the larva.

The parasites recorded fall into the following groups: (1) Bacteria, (2) Fungi, (3) Protozoa, (4) Nematodes, (5) Trematodes, (6) Insects, and (7) Acarines.

Perroncito observed an organism resembling *Leptothrix buccalis* infesting *Anopheles maculipennis*, but no other bacteria have been recorded as causing any morbidity in mosquitoes. Among fungi, the Entomophthoraceæ are known to cause death in adult mosquitoes. Liston (1901) mentioned a filamentous fungus resembling *Trichiphyton* in *Anopheles* larvæ. Laveran (1902) observed a yeast in the body cavity of *Anopheles maculipennis*. Vaney and Conte observed *Botrytis bassiana* in larvæ of *Culex pipiens*. Keilin (1921*b*) described *Coelomomyces stegomyia* in larvæ of *Stegomyia scutellaris* and Iyengar (1936) described two species of *Coelomomyces* parasitic in *Anopheles* larvæ.

Protozoa: Jaffe (1907) observed a spirochaete (*Spirochaeta culicis*) in the gut of mosquito larvæ in Germany, and Sergent and Sergent (1906) observed a similar organism in larvæ of *Anopheles maculipennis* in Algeria. Their pathological importance is not known. A gregarine (*Lankesteris culicis*) parasitic in mosquito larvæ was studied by Wenyon (1911). Leger and Dubosq (1902) found a *Diplocystis* infesting mosquito larvæ in Corsica. A schizogregarine (*Caulleryella anopheles*) was observed by Hesse (1918) in larvæ of *Anopheles bifurcatus* in France. Among microsporidia a large number of forms was found to parasitize mosquitoes (Kudo, 1924). The genera concerned are *Thelohania*, *Nosema*, *Plistophora* and *Stempellia*. Among ciliates Keilin (1921*a*) found *Lambornella stegomyia* in the hæmocele of *Stegomyia scutellaris* in Malaya. Species of *Crithridia* have been observed in the gut of mosquitoes but they do not appear to cause any morbidity in the hosts.

**Trematodes:** Larval trematodes have been observed in mosquitoes and often cause the death of the host (Sinton, 1917). The further development of these trematodes appears to be in the body of fish (Soparkar, 1917).

**Nematodes:** Several observations indicate that genera belonging to the family Mermithidæ are frequent parasites of mosquito larvæ and adults (Iyengar, 1929a). They cause a fair degree of mortality.

**Acarina:** Several genera belonging to the family Hydrachnidæ have been observed as ectoparasites of mosquito larvæ and adults. The forms found on mosquitoes are the larval stages of these acarines; their adult stages are aquatic and free-living.

**Insecta:** Only one insect, *Culicoides anophelis*, has been observed parasitic on mosquitoes. This midge is an ectoparasite of adult mosquitoes and sucks the body fluid of the host, but it does not kill the host. It remains fixed to the abdomen of the mosquito by means of its mouth parts. The larvæ are free-living.

In the above list, many of the parasites are of doubtful importance as agents in the control of mosquitoes. Considering the incidence and the morbidity caused in the hosts, the following are of importance in India: (1) *Coelomomyces*, (2) *Microsporidia*, and (3) *Mermithidæ*.

#### 1. *Coelomomyces*.

This genus is probably allied to the *Chytridiales* but its affinities cannot be determined until the sexual phases are known. We have two species in India, *C. indiana* and *C. anophelesica*, both of which infest *Anopheles* larvæ and adults and cause considerable mortality. Several species of *Anopheles* have been observed to be susceptible to this infection. The vegetative forms consist of multinucleated mycelia in the hæmocele of the mosquito and are attached to the fat body by means of minute hyphæ. Sporangia are formed by apical constriction of the mycelium. A heavily infested larva is filled with numerous yellowish sporangia. The infection is fatal to *Anopheles* larvæ, and the pathological changes consist of the disappearance of the fat body and the suppression of the development of the imaginal buds. The larva is generally killed before pupation.

#### 2. *Microsporidia*.

Three genera of *Microsporidia* were recorded by me infesting mosquito larvæ in India, namely, *Thelohania*, *Nosema* and *Plistophora*.

*Nosema* attacks the epithelial cells of the midgut while the other two genera infest the adipose tissue of mosquito larvæ. These parasites cause considerable mortality in the infected hosts (Iyengar, 1929b). In heavily infected larvæ, the further development of the larva is arrested and the larva dies liberating the spores into the water. Their life-histories consist of a schizogonic cycle and a sporogonic cycle. In *Nosema*, the spore mother cell forms a single spore, in *Thelohania* it forms an octospore, while in *Plistophora* it forms more than

16 spores. The spores are minute and dehisce by extrusion of a polar filament, a characteristic of this group. The infection happens through swallowing the spores.

### 3. *Mermithidæ*.

These worms live in the hæmocele of the host and cause considerable mortality. The parasitic stages are the larval phases, the adults being free-living and short-lived. The life-history of *Mermis* parasitic in *Anopheles* larvæ was described by Iyengar (1929). These worms escape into the water by rupturing the body-wall of the larva. After some time in the water, they become sexually mature and give birth to numerous young larvæ which swim about in the water. This is the infective stage and they gain entrance into the hæmocele of a new host by piercing through the cuticle of the larva. The species infesting mosquitoes in India have not been specifically determined.

These three groups constitute, in my opinion, the parasites that play a significant rôle in the natural control of mosquitoes in India. Our knowledge of these different parasites is admittedly meagre; further studies are indicated in regard to their distribution, incidence, life-history, and ecology. Until further information on these points is available, it is difficult to answer the question which comes to one's mind, 'Can these parasites be utilized for a biological control of mosquitoes?'

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