

SOME EXPERIMENTAL EVIDENCE FOR THE SURVIVAL VALUE OF THE ROOTPIERCING HABITS OF *MANSONIA* LARVAE (CULICIDAE) TO PREDATORS

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Mansonia larvae pierce *Pistia* plants with their breathing syphons, and are much less motile than most mosquito larvae. In clear water with no plants present they are eaten as readily by predators (water bugs, beetle larvae, fish) as *Culex fatigans*. If the *Mansonia* are attached to *Pistia* they are less frequently eaten.

The larval instars of *Mansonia* species (the first instar probably excepted) exhibit a peculiar siphonal oxygen uptake: the siphon pierces living vegetable tissue and connects with an air cavity inside the host plant. A root-piercing habit is also recorded for representatives of some other Culicidae genera (*Aedomyia*, *Ficalbia*). In the genus *Mansonia* however, the parallel siphonal modifications are most developed, as they have a saw-edged apparatus provided with hooks, adapted for piercing and anchoring.

In a *Mansonia* breeding place investigated (Sentani lake, Neth. New Guinea), the larvae occur in eutrophic waters, where they were observed to lead an almost sessile life under cover of the roots of the host plants, mainly the common water lettuce, *Pistia stratiotes*. This is a floating water-weed with long, pendulous roots and shorter rosette roots, the latter close to the surface. *Mansonia* larvae were found in large numbers here, as well as another root-piercing species: *Ficalbia modesta*. Predators were present in great numbers, but surface dwelling, free swimming mosquito larvae were scarce — the minute *Ficalbia minima* excepted — while food and space in which to live seemed to be present abundantly.

It seemed likely that the immobility of *Mansonia* (and *Ficalbia*) larvae is an advantageous device against predators which mainly react to distinctly moving prey. It should be noted that this immobility never can be complete. A *Mansonia* larva has to perform a constant fanning movement with the mouthbrushes for its food uptake — a movement which immediately stops for some time when the animal is disturbed by a passing object. Other movements have to be performed at moulting, and at pupation.

Mansonia certainly belongs to the most abundant and most noxious mosquito species in many parts of New Guinea (and in many other parts of the world); some species are of medical importance as vectors of filariasis.

The aim of the experiments reported in this paper was to compare two larval types, the free swimming and the sedentary, in the risk they run from some local

predators under test conditions. Free swimming species could not be collected from the *Mansonia* breeding place in sufficient numbers for the tests, and *Culex fatigans* larvae were used. This substitution does not seem unreasonable as the behaviour of *Culex fatigans* does not differ substantially from a *Culex* species taken occasionally from the *Pistia* field.

MATERIAL

Fourth instar larvae of *Mansonia uniformis* and *M. bonnewepsterae* were collected from a breeding place in the Sentani lake, described in more details elsewhere (V. D. ASSEM, 1958). As these larvae are very much alike in dimensions and breathing habits, they were used indiscriminately in all experiments. Fourth instar *Culex fatigans* larvae, collected from dirty drums, were used as free swimming species. Predators were collected in the *Mansonia* breeding place together with the Diptera-larvae.

Predators used in the tests were :

Diplonychus sp. (Belostomatidae). Adult, free swimming bugs, about 2 cm long; the hind legs are modified for rapid swimming, the front legs curved and spine like for catching prey.

Cybister sp. (Dytiscidae). Slender, mobile larvae, about 6 cm long.

Eleotris sp. (Gobiidae). Only young specimens, 2—3.5 cm long, of this fish were collected. This species is not very mobile, most times lurking for food from under cover.

The majority of tests were done with *Diplonychus* and *Eleotris*. The host plant used was *Pistia stratiotes*. *Mansonia* larvae readily accept this plant; there is no preference for a special location on the roots. All experiments were carried out in small glass tanks, 20—15—12.5 cm in dimensions.

TECHNIQUE AND RESULTS

M. uniformis/*bonnewepsterae* larvae and *C. fatigans* larvae of about the same dimensions were offered simultaneously to a predator. Tests were done in tanks containing clear water only, parallel ones in tanks containing *Pistia* plants. In a *Pistia* tank the predator was introduced half an hour after the introduction of the larvae to be sure that all *Mansonia* were attached by that time. At the end of every individual test, which lasted about 7 hours for *Pistia* tanks and about half that time for clear-water tanks, the numbers left of either mosquito species were counted. Predators were kept without food for one day before they were tested; after a test they were offered larvae to test the appetite— which was positive after all *Pistia* tests.

No attempt was made to imitate the natural conditions of the breeding place entirely or to work with concentrations of predator or prey comparable to natural conditions. Predators had to be confined to the small space of the test tanks; in nature the larval density varies considerably, the roots generally are far more dense. The *Pistia* roots in the breeding place were found covered with debris, producing an extra cover for the larvae. Light conditions were different in nature; in the tests light from the side — shielded as far as possible — could produce some extra contrast favouring the predators.

Table I. Clear water tests. Larval density 10M—10C.

predator	numb. tests	numb. larv. offered		numb. larv. left		tot. time tests in hours	mean numb. prey/hour testing		ratio M/C
		M	C	M	C		M	C	
<i>Diplonychus</i>	10	100	100	22	44	37.30	2.34	1.76	1/0.75
<i>Eleotris</i>	11	110	110	44	44	57.45	1.13	1.13	1/1
<i>Cybister</i>	3	30	30	22	16	10.00			

The results of the tests with larval density 10 *Mansonia*- 10 *Culex* are summarized in Table I (clear water) and Table II (*Pistia*).

In clear-water tanks the number of larvae caught is roughly the same for both mosquito species. The slightly higher proportion of *Mansonia*'s caught by *Diplonychus* sp. is most probably due to the attraction of a contrasting object to detached

Table II. *Pistia* tests. Larval density 10M—10C.

predator	numb. tests	numb. larv. offered		numb. larv. left		tot. time tests in hours	mean numb. prey/hour testing		ratio M/C
		M	C	M	C		M	C	
<i>Diplonychus</i>	11	110	110	103	68	101.00	0.07	0.41	1/6
<i>Eleotris</i>	10	100	100	98	29	65.45	0.03	1.07	1/35
<i>Cybister</i>	2	20	20	19	10	15.15			

Mansonia. The larvae approach such object and try to attach themselves to it by fierce backward movements. Some *Mansonia* were observed trying to establish themselves on the floating dark-brown bugs, subsequently to be caught by this predator. In the far less conspicuous and bottom dwelling *Eleotris*, *Culex* and *Mansonia* larvae suffered alike from predation.

In the *Pistia* tanks the predation on the same larval density is lower, due to a general protection from the weeds. At the same time, however, the relative numbers of larvae caught by predators differ substantially for the two mosquito species: the ratio *Mansonia*-*Culex* preys being in total about 1 to 10. This difference is likely to be due to an extra protection, derived from the root-piercing habits, for the *Mansonia* species.

Table III. *Pistia* tests. Larval density 30M—10C.

predator	tests numb.	numb. larv. offered		numb. larv. left		tot. time tests in hours	mean numb. prey/hour testing		ratio M/C
		M	C	M	C		M	C	
<i>Diplonychus</i>	7	210	70	193	53	53.15	0.3	0.3	1/1

One test series was arranged for *Diplonychus* sp. with increased larval density: 30 *Mansonia*- 10 *Culex* per tank. The increase of the number of available *Mansonia*'s, increases the number of *Mansonia* preys, bringing the ratio M-C to about 1 to 1. The results of this series are summarized in Table III.

Table IV. *Pistia* tests. *Mansonia* only, larval density 10 cq. 30.

predator	numb. tests	numb. larv. offered	numb. larv. left	tot. time tests in hours	mean numb. prey/hour testing
<i>Diplonychus</i>	10	100	94	70.45	larval dens. 10 0.08
<i>Diplonychus</i>	4	120	105	31.00	larval dens. 30 0.4

In a series of *Pistia* tests, *Culex fatigans* larvae were omitted as a deterrent prey. The results from these tests differ for *Diplonychus* and *Eleotris*.

For *Diplonychus* the numbers of *Mansonia* larvae taken are comparable with the numbers found in the simultaneous *Mansonia-Culex* tests for both 10 c.q. 30 *Mansonia* larvae per tank (Table IV). In the absence of a deterrent prey *Eleotris*

Table V. *Pistia* tests. *Mansonia* only, larval density 10.

predator	numb. tests	numb. larv. offered	numb. larv. left	tot. time tests in hours	mean numb. prey/hour testing
<i>Eleotris</i>	14	140	73	88.00	0.7

sp. however, takes a higher number of *Mansonia* than in the choice tests (Table V), but the score is lower than that for free swimming *Culex* larvae in *Pistia* tests (cf. Table II).

CONCLUSIONS

In the absence of a suitable host plant *Mansonia* and *Culex* larvae suffer alike from the predators tested. In tanks containing *Pistia* plants, *Mansonia* larvae suffer considerably less from predation than free swimming larvae. At a higher *Mansonia* density an increase in predation was recorded. In tests without alternative prey the numbers taken by *Diplonychus* were comparable with those taken in choice tests; the numbers taken by *Eleotris* were considerable higher. In the breeding place however a number of alternative prey is always present, and it is doubtful whether predation by this fish is of any practical importance.

The tests produce some evidence for the advantage of the root-piercing habits of *Mansonia* in relation to predators. This habit, which is acquired independantly a few times in the Culicidae family, is an adaptation reducing predation.

This result is in general agreement with the conclusions of JACKSON (1953). She found that the predatory mosquito larvae *Culex (Lutzia) tigripes*, if offered several types of mosquito larvae as prey, ate the greatest number of the most active species. Thus *Aedes aegypti*, which is very active, was eaten more often than *Culex sp.*, and *Culex* more often than the comparatively inactive *Anopheles gambiae*. It seems likely that *Mansonia* would be eaten by *Lutzia* even less frequently than *Anopheles*.

ZUSAMMENFASSUNG

Mansonia-Larven besitzen Atemsiphonen, die geeignet sind, unter Wasser Pflanzengewebe anzubohren (besonders *Pistia stratiotes*). Die Larven atmen Luft, die sie aus den Pflanzen beziehen. Diese Larven sind verhältnismäßig unbeweglich.

Mansonia- und *Culex fatigans*-Larven sind den Nachstellungen folgender Räuber ausgesetzt: Erwachsenen Wanzen von *Diplonychus* sp., Larven der Käfergattung *Cybister*, Jungfischen der Gattung *Eleotris* (Gobiidae).

Im klarem, pflanzenfreien Wasser werden beide Arten Mückenlarven in annähernd gleicher Anzahl gefressen. Das zeigt, daß *Mansonia* nicht geschmackswidrig ist.

Wenn die *Mansonia* an *Pistia* angeheftet sind, werden sie in viel geringerer Anzahl gefressen als *Culex*, vorausgesetzt, daß beide Arten vorhanden sind. Wenn keine *Culex* zur Verfügung stehen, fressen *Diplonychus* und *Cybister* nur wenige der angehefteten *Mansonia*, während *Eleotris* seine Nachstellungen verstärkt.

Daraus wird gefolgert, daß die durch diese Lebensweise gewonnene Unbeweglichkeit für *Mansonia* vorteilhaft ist und eine der Ursachen darstellen könnte, daß sie in Neu Guinea so häufig ist.

REFERENCES

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