Biological Markers in Feeding Experiments of Mosquito Larvae (*Culex* (*Lutzia*) *raptor*)

Mosquito larvae are mainly filter feeders and a few species are predatory. Larval stages of the mosquito *Culex* (*Lutzia*) *raptor*, belonging to the subgenus Lutzia are voracious cannibals, but preferably feed on the larvae of other mosquito species. The significance of such carnivorous larval behaviour as an integral part of regulatory control mechanism of some mosquito populations has not been adequately explored. In this paper we report such predation and selective feeding habits exhibited by *C.* (*L.*) *raptor*.

The larvae of *Lutzia* inhabit open pools of various kinds, shallow wells and domestic collections of water, where they are found to occupy the same niche as the larvae of other mosquito species. Field collected larvae of *Lutzia* were maintained in $12'' \times 8''$ enamel trays half filled with water at a temperature of $25 \pm 2°C$. The basic datum for all the experiments was the number of prey present in the tray with the constant number of predators, and the predation rate was calculated by subtracting the remaining number of prey from the original count. The mortality of predators was nil and that of prey negligible. However, the dead ones, if any, were replaced by larvae of the same age from the insectory.

In the first experiment, where *Lutzia* had no choice except to feed on one another, 39 larvae were reduced to 26 in 18 h. However, when provided with larvae of other mosquito species, the number of *Lutzia* larvae remained constant. Hence, cannibalism in this species is more a matter of necessity than of preference.

When population is started with *Culex fatigans*, an important filarial vector, and *Lutzia*, there is an initial increase in the number of eggs of the prey over the predator. The eggs of both the species hatch in about 4 days and the young larvae of *Lutzia* immediately begin to feed on the larvae of *C. fatigans*, maintaining an almost uniform rate of feeding till they pupate on the 8th or 9th day. *Lutzia* larvae do not feed on the pupae. In an experimental tray containing 350 freshly emerged larvae of *C. fatigans* along with 6 freshly hatched *Lutzia* larvae, there was a gradual and uniform reduction in the number of *C. fatigans* (Figure 1). The rate of feeding, though uniform, has a varied effect at the population level. The last 2 days of the larval period are especially critical for the prey, because the percentage consumption and hence the mortality of the population is as high as 33–36%.

In the third experiment, where *Lutzia* larvae were given the choice, they showed preferential feeding on *Aedes aegypti*, *Anopheles stephensi* and *C. fatigans* in this order (Table). However, when variability exists among the larvae, preference is specific for a particular colour and size. The preference of *A. aegypti* over *A. stephensi* is attributable to 3 main factors, namely, the colour, the motility and the position of the larva. The *A. aegypti* larva is yellow in colour, moves more slowly and is vertical in position. Between *A. stephensi* and *C. fatigans*, both of which are blackish grey in colour, the former is preferred for its smaller size. The role of size as an important physical factor in feeding has been discussed elsewhere[1].

In test experiments, where equal number of wild types and mutant larvae of 2 species were used, preferential feeding was found not to be species-specific (Figure 2). The mutant of *A. aegypti* used is 'ym', black in color and *C. fatigans* is 'go', golden in colour. It is significant that unlike the wild type *C. fatigans*, which is normally least chosen, the mutant 'go' was consumed at a rate equal to that of the yellow strain of *A. aegypti*.

[1] P. T. Rajasekharan and B. N. Chowdaiah, in preparation.

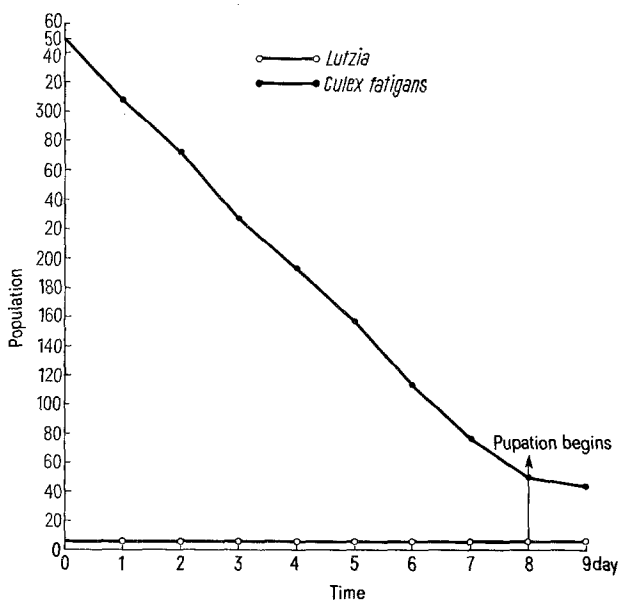

Fig. 1. Feeding rate of *Lutzia* on *C. fatigans*.

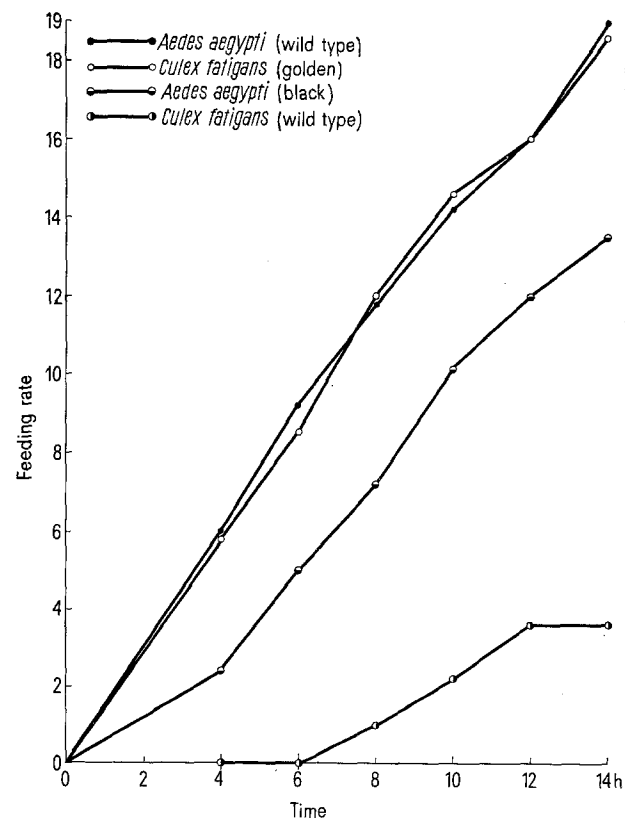

Fig. 2. Feeding behaviour of *Lutzia* in a 'choice' experiment.

Various factors – chemical or physical – might be responsible for such behaviour of instinctive selection in insects. From our data, it is evident that colour is an important physical factor attracting the predator to the prey. This should be taken into consideration in selecting control measures, since a laboratory mutant strain introduced in to a field experiment stands the danger of being predated upon preferably to the natural population.

The food requirements of adult mosquitoes is dependent upon their prior nutritional history as larvae[2,3]. Preferential feeding habits of adult mosquitoes on certain plants have been shown[4,5]; but no such data is available for the larvae, especially of the carnivorous species. The essential amino acid requirement of *A. aegypti* larvae has been described[6]. It has been pointed out that if specific feeding habits of the adult mosquitoes on certain plants could be proved, these plants could be exterminated thus leading to the extermination of the mosquito species involved[4]. Our observations on larval behaviour indicate that such feeding habits are more preferential than specific and the situation may be similar among adults. The inability of a mosquito to thrive in the presence or absence of a specific plant remains to be demonstrated. The use of mutants in feeding experiments might open a new area of investigation, these being responsible for bringing about an interaction between predator and prey. An extensive analysis of various factors involved in feeding habits of both larvae and adults of various mosquito species is very much warranted[7].

Zusammenfassung. Die in Laborzuchten kannibalistischen Larven der Mücke *Culex* (*Lutzia*) *raptor* ernähren sich bei freier Wahl von Larven anderer Mückenarten (Präferenzfolge: *Aedes aegypti, Anopheles stephensi, Culex fatigans*). Versuche mit einer gelben Mutante von *C. fatigans* zeigen, dass *A. aegypti* wegen ihrer gelben Naturfarbe allen anderen Arten vorgezogen wird. Auch die Bewegungsintensität der Larven scheint eine Rolle zu spielen.

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Feeding behaviour of *Lutzia* in a 'choice' experiment involving the 3 species of mosquito larvae

	Initial No.	6 h	12 h	18 h	24 h	Total consumed
A. aegypti	50	39	30	21	14	36
A. stephensi	50	44	39	33	29	21
C. fatigans	50	50	49	46	43	7
Lutzia	10	10	10	10	10	Nil

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[3] R. S. PATTERSON, B. J. SMITTLE and R. T. DENEVE, J. econ. Ent. *62*, 1455 (1969).
[4] A. A. A. MALEK and W. F. BALDWIN, Nature, Lond. *192*, 178 (1961).
[5] A. A. A. MALEK, Bull. Wld. Hlth. Org. *30*, 137 (1964).
[6] K. R. P. SINGH and A. W. A. BROWN, J. Insect. Physiol. *1*, 199 (1957).
[7] This study has been supported in part by a grant from the World Health Organization.

Quantitative Bestimmung von RNS-Fraktionen im Gehirn frisch geschlüpfter Bienen (*Apis mellifica*)

Honigbienen erfüllen in ihren ersten Lebenstagen im Stock verschiedene Aufgaben[1], die mit spezieller Drüsentätigkeit gekoppelt sind. SALVISBERG[2] fand, dass der Gesamt-RNS-Gehalt des Gehirns in der ersten Woche nach dem Schlüpfen stark abnahm. In der vorliegenden Arbeit wurde untersucht, ob alle RNS-Fraktionen an dieser Abnahme gleichermassen beteiligt sind, und ob diese Veränderungen im RNS-Gehalt in Verbindung mit den verschiedenen Tätigkeiten der Bienen stehen.

Honigbienen, die bei 35°C im Thermostat schlüpften, wurden neun Tage auf Honigwaben bei gleicher Temperatur isoliert vom Stocke gehalten. An jedem der neun Tage wurde eine Probe von 10 Hirnen, ohne die Pigment- und Sehzellschicht der Augen, analysiert (total 70–150 µg RNS). Die Gehirne wurden in 50 µl Lösung I[3] zusammen mit 50 µl Phenol[4] während 20 min homogenisiert. Aus der wässrigen Phase wurde die RNS mit Aethanol ausgefällt und in eine Mischung von 10 µl Puffer I[5] und 10 µl Puffer II[6] aufgenommen. Die anschliessende Polyacrylamidgelelektrophorese erfolgte nach den Angaben von WEIDELI, KUBLI, CHEN[7]. Auf ein 7%-Gel (Monomere) wurde in Glasröhrchen von 5 mm Innendurchmesser ein 2,6%-Gel geschichtet und die in Puffer I/II aufgenommene RNS-Probe dem 2,6%-Gel aufgelagert. Die Elektrophorese fand zunächst 30 min mit 1 mA/Röhrchen, dann 120 min mit 3 mA/Röhrchen statt. Auf eine Farbstoffmarkierung der wandernden Grenzschicht wurde verzichtet. Die Gele wurden mit 1% Lanthanacetat in 15% Essigsäure fixiert und mit Chromalaun-Gallocyanin (pH 1,6) gefärbt[8]. Die Farbbanden der Gelstreifen wurden densitometriert und die Flächen der registrierten Peaks planimetriert (Figur 1).

Im Gehirn der Honigbienen nahm der RNS-Gehalt während zwei Tagen nach dem Schlüpfen der Imago stark ab (Figur 2). Vom 3. bis 5. Tag stieg der Gehalt von 18s und 28s RNS wieder an, der Gehalt der übrigen Komponenten fiel bis zum 4. Tag weiterhin leicht ab. Am 5. Tag trat eine schubartige Erhöhung des Gehaltes bei allen rRNS-Arten auf. Einzig der Wert einer unbekannten

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[2] W. SALVISBERG, DNS und RNS im Bienengehirn: Untersuchungen über Abhängigkeit von Alter und Jahreszeit, in Vorbereitung.
[3] Lösung I: 0,1 *M* NaAc pH 5,0; 0,5% Na-Dodecylsulfat; 10 µg/ml Polyvinylsulfat; 500 µg/ml Bentonit; 10^{-4} *M* $MgCl_2$; 0,1 *M* NaCl.
[4] Phenol: 80% Phenol; 0,1% Hydroxychinolin.
[5] Puffer I: 0,01 *M* NaAc pH 5,1; 10^{-4} *M* $MgCl_2$; 20% Saccharose.
[6] Puffer II: 48 ml 1 *N* HCl; 4,95 g *Tris*; 0,46 ml TEMED; ad 50 ml Wasser, pH 5,5.
[7] H. WEIDELI, E. KUBLI und P. S. CHEN, Rev. Suisse Zool. *76*, 788 (1969).
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