

CHANGES IN THE LIPID CONCENTRATIONS OF THE HAEMOLYMPH DURING DEVELOPMENT IN *ORTHETRUM SABINA* (DRURY) (ANISOPTERA: LIBELLULIDAE)

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The total lipid concentration in the haemolymph increases in the different larval instars and reaches a maximum in the imago. Qualitative analyses of the different kinds of lipid reveal that the haemolymph has free fatty acids, phospholipids, mono-, di- and triglycerides in all larval instars as well as in the imago. Variations in the percentages of different lipid fractions are discussed with reference to the mode of life.

INTRODUCTION

The total lipid content of insect haemolymph generally lies between 1.5 and 5.5%, but can vary considerably during development (cf. FLORKIN & SCHEER, 1971). Changes in the lipid concentrations of the haemolymph during the various stages of development in many species of insects have been recorded by NOWOSIELSKI & PATTON (1965), SRIDHARA & BHAT (1965), NELSON et al. (1967), BEENAKKERS & GILBERT (1968), KINNEAR et al. (1968), WANG & PATTON (1969), LEE et al. (1976), and WOODRING et al. (1977). All these studies are on neopteran insects and the Palaeoptera have received no attention. The present investigation has been conducted to throw some light on this problem.

MATERIAL AND METHODS

Larval and adult *Orthetrum sabina* were used. These are available in plenty throughout the year in and around the Erode city, Madras. The

methods of collecting the eggs and the rearing procedures in the laboratory have been given elsewhere (VARADARAJ & SUNDARA RAJULU, 1977). By repeated trials, it was found that only from the sixth instar onwards sufficient quantities of haemolymph could be obtained for analyses. The samples of haemolymph were obtained and the estimations were made following the method outlined by GOWRI & SUNDARA RAJULU (1976). Individuals in intermolt condition were used for lipid estimations.

RESULTS

Sixth instar larvae have 121.4 ± 7.3 mg of lipid per 100 ml of haemolymph (Tab. I). The value steadily increases from this instar to 150.5 ± 12.1 mg/100 ml in 10th instar individuals. It is interesting to note that the haemolymph lipid shows a steep rise to 173.2 ± 5.7 mg/100 ml in the 11th instar (Fig. 1). There is a further increase in the late instars and the imago has 220.4 ± 10.9 mg of lipid per 100 ml of haemolymph (Tab. I).

Table I

Total concentration of lipid in the haemolymph of *Orthetrum sabina* in various instars

| Instars | Total lipid (mg/100 ml) |
|---------|-------------------------|
| 6 | 121.4 ± 7.3 |
| 7 | 128.7 ± 6.6 |
| 8 | 135.6 ± 8.4 |
| 9 | 140.3 ± 9.2 |
| 10 | 150.5 ± 12.1 |
| 11 | 173.2 ± 5.7 |
| 12 | 187.9 ± 11.4 |
| 13 | 199.8 ± 7.3 |
| Imago | 220.4 ± 10.9 |

* Average of values for ten individuals in every instar.

declines to 4.8 in the imago. This percentage is about five times less than that found in the 11th instar.

The phospholipid is 25.2% in the 11th instar larvae whereas in the preceding instars it ranges from 40.5 to 38.0%; in the imago it declines to about half of the percentage found in the 6th instar i.e., from 40.5 to 22.9%. But the quantity of phospholipids is almost the same in all the instars (Tab. II).

Qualitative analyses of the different kinds of lipid reveal that the haemolymph has free fatty acids, phospholipids, mono-, di- and triglycerides in all larval instars as well as in the imago (Tab. II). A careful study of the differential concentration of the lipid in the various instars may disclose that the percentages of free fatty acids gradually increase from the 6th instar to the 10th instar individuals. But the percentage shoots up from 5.8 in the 10th instar to 26.0 in the 11th instar larvae (Fig. 2). Another striking point to be noted is that the percentage of free fatty acids

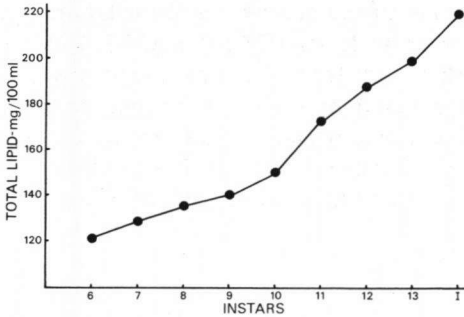


Fig. 1. Total concentration of lipid in the haemolymph of *Orthetrum sabina* during the various instars. (I: Imago).

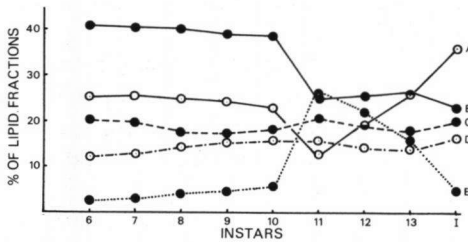


Fig. 2. Concentration of different kinds of lipid fractions in the haemolymph of *Orthetrum sabina* during the various instars. (A: triglycerides; - B: phospholipids; - C: diglycerides; - D: monoglycerides; - E: free fatty acids).

Another fascinating feature is found in the triglycerides. The percentage of triglycerides is 24.9 in the 6th instar larvae; but in the 11th instar it diminishes to 12.5. In the imago the percentage is three times that found in 11th instar individuals. This shows a four-fold increase in the quantity of phospholipids compared to that of the 11th instar (Tab. II).

There is not much variation in the percentage of mono- and diglycerides even though their quantities show differences in the various instars (Fig. 2).

DISCUSSION

The fuel supply is of special importance for dragonflies because odonates can remain airborne for several hours in contrast to other pterygote insects (KALLUPUR & GEORGE, 1973). It is known from the work of KROGH &

Table II

Differential concentration (mg/100 ml) of lipid in the haemolymph of *Orthetrum sabina* in various instars in % of total haemolymph lipids

| Instars | Free fatty acids | | Phospholipids | | Monoglycerides | | Diglycerides | | Triglycerides | |
|---------|------------------|------|---------------|------|----------------|------|--------------|------|---------------|------|
| | Quantity | % | Quantity | % | Quantity | % | Quantity | % | Quantity | % |
| 6 | 3.0 ± 0.3 | 2.5 | 49.2 ± 3.9 | 40.5 | 14.7 ± 0.5 | 12.1 | 24.3 ± 1.9 | 20.0 | 30.2 ± 2.0 | 24.9 |
| 7 | 3.6 ± 0.2 | 2.8 | 51.5 ± 4.0 | 40.0 | 16.1 ± 0.6 | 12.5 | 25.1 ± 1.8 | 19.5 | 32.4 ± 2.3 | 25.2 |
| 8 | 5.4 ± 0.3 | 4.0 | 54.1 ± 4.0 | 39.9 | 19.3 ± 0.8 | 14.2 | 23.7 ± 1.3 | 17.5 | 31.1 ± 2.1 | 24.4 |
| 9 | 6.3 ± 0.4 | 4.5 | 54.3 ± 3.8 | 38.7 | 21.4 ± 1.4 | 15.3 | 24.3 ± 1.4 | 17.3 | 34.0 ± 2.4 | 24.2 |
| 10 | 8.7 ± 0.5 | 5.8 | 57.2 ± 4.2 | 38.0 | 23.6 ± 1.5 | 15.7 | 27.3 ± 1.7 | 18.1 | 33.7 ± 2.0 | 22.4 |
| 11 | 45.0 ± 3.5 | 26.0 | 43.6 ± 2.8 | 25.2 | 27.4 ± 1.3 | 15.8 | 35.5 ± 2.1 | 20.5 | 21.7 ± 1.9 | 12.5 |
| 12 | 41.7 ± 2.8 | 22.2 | 47.9 ± 3.3 | 25.5 | 26.5 ± 1.7 | 14.1 | 35.3 ± 2.2 | 18.8 | 36.5 ± 2.7 | 19.4 |
| 13 | 31.8 ± 2.8 | 15.9 | 52.5 ± 3.5 | 26.3 | 27.8 ± 1.6 | 13.9 | 35.8 ± 2.2 | 17.9 | 51.9 ± 4.1 | 26.0 |
| Imago | 10.6 ± 0.9 | 4.8 | 50.5 ± 3.9 | 22.9 | 36.1 ± 2.1 | 16.4 | 43.9 ± 2.9 | 19.9 | 79.3 ± 5.2 | 36.0 |

WEIS-FOGH (1951), CHANCE & SACKTOR (1958), ZEBE et al. (1959), CHEFURKA (1965) and CRABTREE & NEWSHOLME (1975) that in insects the sources of energy are carbohydrates and lipids. The steep rise in the lipid content of the haemolymph in the adults compared to the larval instars in *Orthetrum sabina* may, therefore, be related to the high energy requirements of the adults.

Among the different lipid fractions, the triglycerides are the predominating ones reaching 79.3 mg/100 ml of haemolymph, in the adults of the present species, when compared to those in the larval instars. Similar results have been recorded by MARTIN (1969) in the haemolymph of *Pyrrhocoris*. Since triglycerides are good energy sources (WEIS-FOGH, 1952; ZEBE, 1954; SACKTOR, 1965; TIETZ, 1967; MAYOR & CANDY, 1969), the increase in the dragonfly can presumably be related to the fuel supply.

The phospholipids are structural components and they will add to the weight (BARRON & TAHMISIAN, 1940; PETRUSHKA et al., 1959; WOLFE, 1964). The percentage of phospholipids decreases from 40.5 in the 6th instar to 22.9 in the imago. This may be related to the mechanism of the lowering of the weight of the adults for aerial life. The significance of the variations in free fatty acids is not clearly understood. It deserves further investigation.

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