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Mobilisation Pattern of Carbohydrate Reserves in Castor Semilooper Moth, *Achoea janata* Linn

ANNIE JOHN and D MURALEEDHARAN
Department of Zoology, University of Kerala, Kariavattom 695 581

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A circadian rhythmic pattern was noticed in the levels of glycogen and trehalose present in the fat bodies of adult moth of *Achoea janata* during the first gonotrophic life span. Exposition of the moths to altered photoperiods (LL and DD) also elicited the same circadian pattern although a slight phase shift could be observed with regard to their peaks. Further, a hike in the trehalose level at any life stage brought forth a concomitant decrease in the levels of glycogen in fat bodies.

Key Words: *Achoea janata*, **rhythm, trehalose, glycogen**

Introduction

In most insects, carbohydrate reserves are noticed either as glycogen or as trehalose which may be converted to glucose to meet their energy requirements to a great extent. Trehalose has often been designated as the mobile energy reserve while glycogen serves as the precursor of trehalose. Hence, fluctuations in the contents of these carbohydrate reserves reflect the extent of activity of an insect. Many of the recent reviews have highlighted different aspects pertaining to carbohydrate metabolism in insects in relation to their energy requirements and food utilization (Kilby 1965, Wyatt 1967, Chippendale 1978, Ramdev & Rao 1979, Steele 1981). Ramdev and Rao (1984) monitored haemolymph trehalose concentration in the caterpillars of *Achoea janata*. Apart from that, very few attempts have been made to relate fluctuations of these carbohydrate reserves to the stages of insect activity. The present report relates to the investigations on the rhythmic pattern noticed in glycogen and trehalose contents in the fat bodies of the adult moth of castor semilooper, *Achoea janata*, during its first gonotrophic life span.

Materials and Methods

Adult moths to the present experiments were obtained from the stock colony of *Achoea janata* (Lepidoptera: Noctuidae) maintained in our laboratory under constant conditions (temp. 29 ± 3°C: LD–12: 12; r.h. 90 ± 3%). Caterpillars were allowed to feed on castor *(Ricinus communis)* leaves supplied afresh every day. Adult moths were maintained in cages and fed on cottonsoaked 10% sucrose solution. Newly emerged adults of mixed sexes which molted within a period of ± 2 hr were isolated and maintained at varying photoperiods (12 : 12, LL, DD) to be used for subsequent experiments.

Fat body was seen as the most conspicuous organ occupying a significant portion of the body cavity with an yellow shade. A known weight of dried fatbody tissue dissected out at every 4 hr interval from different experimental groups of moths (maintained at different photoperiods) from 0 hr after emergence up to the time of egg laying was processed for carbohydrate estimations. Carbohydrates in the dried samples were subjected to acid-alkali hydrolysis (Wyatt & Kalf 1957). Trehalose and glycogen estimations were carried out using Anthrone reagent as per the method followed by Seifter et al. (1950) with minor modifications. Spectrophotometric measurements of the samples were taken using a Spectronic 20 (Bausch & Lomb) at a wavelength of 630 nm for trehalose and 620 nm for glycogen. A minimum of five separate measurements using different samples were taken and the mean was denoted as the value of each time of the day.

Results

The circadian mobilisation pattern of glycogen and trehalose in the moths maintained under different photoperiods are represented in figure 1. Under the normal photoperiod (12 : 12) glycogen peak was at 04 hr of the day on all the 3 days of the first gonotrophic cycle. However, an additional peak in its concentration was noticed at 12 noon on Day 2 and at hr 20 on Day 3. A phase shift could also be noticed in glycogen levels when moths were maintained in complete light (LL) and complete dark (DD). In the case of animals exposed to LL, the glycogen peaks were observed at 12 noon on all 3 days. However, the first peak reached its climax at hr 16 only. In animals exposed to DD, glycogen peaks were observed at 8 AM on Day 2 and Day 4 but on Day 3, it was at 12 noon. With regard to trehalose levels under normal conditions and constant light, they peak at the same time of the day with alternate nocturnal and diurnal rhythms. In constant darkness (DD) there is a change of the peak on Day 3 and Day 4. Thus, the peaks in trehalose levels showed fluctuations on different days during the first gonotrophic period. Further, on different hrs of the day, when glycogen levels showed significant depletion, a corresponding hike in trehalose could be easily recognised. However, the maximum concentration of glycogen at 12 noon in 12 : 12 seems to phaseshift 4 hrs backwards in DD at 08 hr and forwards in LL at 16 hr, the latter attaining the highest concentration.

Discussion

The circadian rhythmic pattern noticed in the glycogen and trehalose concentration in the fat bodies during the first 4 days after adult emergence shows that these moths require varied levels of carbohydrate reserves during different times of the day. The variation in the utilisation of carbohydrate reserves may be dependent on the activity of the insect. A rapid depletion in trehalose concentration depending on the activity of the insects has already been established in insects like blow fly, *Phormia regina* and Saturniid silkmoth, *Hyalophora cecropia* (Evans & Dethier 1957, Murphy & Wyatt 1965). Also an increase in glycogen level brought about a concomitant decrease in trehalose and vice versa, indicating the existence of a homeostatic mechanism in the fat body carbohydrate reserves since glycogen is a precursor of trehalose.

Glycogen concentration was at its highest during constant light (LL). In adult females of *Culex tarsalis* long photoperiods remitted in the maintenance of high glycogen concentrations (Takahashi & Harwood 1964). Higher glycogen levels in LL coincide with increased fat body size, revealing its relationship with fat

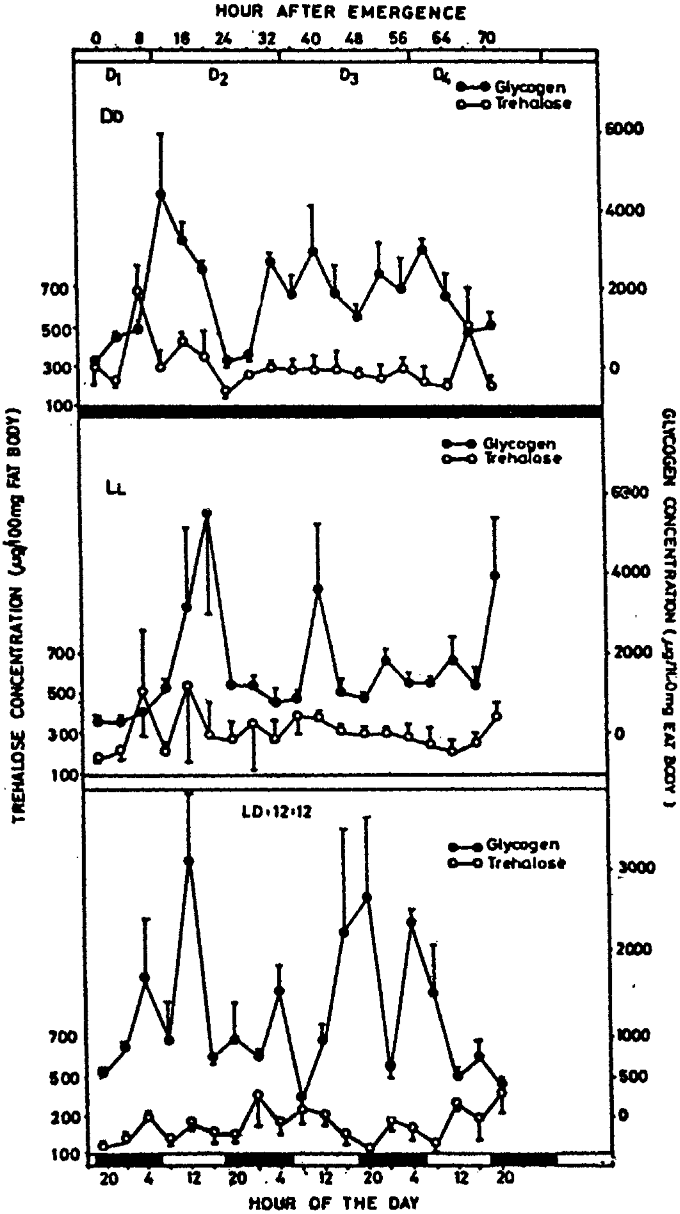

Figure 1 Graphical representation of the circadian carbohydrate activity rhythms in the moths of *A. janata* exposed to different LD cycles (12 : 12; DD, LL). Each point is the mean obtained from 5 separate determinations and the bars are ±SEM

synthesis in the above insects. Synthesis of glycogen can be accompanied by changes in phosphorylase and glucokinase activity. Since glycogen was determined on fresh weight basis, individual variations in ingestion of sugar solution could cause relatively minor variations in glycogen level (Takahashi & Harwood 1964). This could very well explain the wide fluctuations brought about in the rhythm and the phase shifts of glycogen levels on Day 3 of DD and Day 2 of LL and in the two additional peaks in the normal rhythm and in the trehalose levels on Day 3 and Day 4 of DD. A rather interesting demonstration of haemolymph trehalose regulation is the daily rhythm in trehalose level in *Gryllus domesticus* (Nowosielski & Patton 1964). Thus, the fluctuations noticed in the glycogen and trehalose levels in the fat bodies of this insect seem to be due to the interconversion of these two carbohydrate reserves to meet the different energy requirements during different physiological processes like flight, mating, egg maturation, etc.

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