INTRODUCTION
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From time immemorial it is known that animals and plants are very sensitive to changes in the environmental conditions (see Duclaux, 1869; Turner, 1886; Rasmussen, 1915). Animals lead a normal and active life when conditions are favourable and in the adverse season they become quiescent and remain in a state of suspended animation (Rasmussen, 1915, 1916a, b, c, 1918, 1921; Mann, 1916).

The earlier workers in this field of study paid much attention to the changes in the external features of the animals in these seasons (Shaw, 1925a, b; Wade, 1930; Lachner, 1942). The neuropteran insect Chrysopa carnea (Neuroptera), for instance, is brown in colour during the inactive winter phase and the hue changes to light green in the active summer months (Tauber and Tauber, 1973).
Many insects are found to react to seasonal variations by having appropriate sequence of development. The Hessian fly *Mystacina destructor* (Diptera) has the active larval as well as adult phases in the favourable spring season and has the dormant pupal diapause in the unfavourable summer months (Zhukovsky, 1950).

Physiology of dormancy has received much attention in later years (Lees, 1955, 1956; Harvey, 1962). It was observed that during quiescence there is a considerable depression of metabolism. The dormant eggs of *Melanoplus* (Orthoptera), for example, have only about a quarter of the normal oxygen requirement (see Richard and Davies, 1977). This is connected with the disturbance of cytochrome system since the quiescent eggs of *Melanoplus* are relatively insensitive to hydrogen cyanide and pupae of *Hyalophora cecropia* (Lepidoptera) contain virtually no cytochrome-C while in diapause.

Investigations were conducted by recent workers on the biochemical variations of the aestivating or hibernating animals from the active ones to combat the prolonged non-feeding conditions and the related

The haemolymph in insects in normal conditions has more than 20 free amino acids in different proportions. With the onset of dormancy, in relation
to adverse seasons, the levels of histidine, alanine and proline increase markedly in *Antheraea pernyi* (Lepidoptera). Return to the normal active life results in a marked depletion in the concentration of these amino acids. The rise in the alanine and proline concentration are attributed to the existence of anaerobic physiological conditions and the depletion of cytochrome system during dormancy (Mansingh, 1967).

Similarly in *Disterea grandiosella* (Lepidoptera) and *Ostrinia nubilalis* (Lepidoptera) serine, proline and alanine accumulate in the haemolymph during quiescent life (Morgan and Chippendale, 1983).

In *Trogoderma granarium* (Coleoptera) the protein content of the active larvae is only 46.54 mg/100 larvae whereas in the quiescent individuals the value rises to 90.22 mg/100 larvae (Karnavar and Nair, 1969).

In the same species Shashigupta and Agarwal (1976) have recorded directly opposite results; it is found that after a month of diapause the protein content per larva is 629 ± 14.5 μg. The value decreased to 298 ± 20.4 μg/larva after 6 months diapause.
Brown (1980) on the codling moth *Cydia pomonella* (Lepidoptera) found that the haemolymph in the diapause individuals has more of soluble proteins than the active ones.

Such fluctuations do not seem to be universal. In *Hyalophora cecropia*, for instance the haemolymph proteins are in no way affected during quiescence (Telfer and Williams, 1953).

Information on the quantitative variations or otherwise of the proteins in the haemolymph in relation to active and quiescent life are available for many other insects like *Ostrinia nubilalis* (Chippendale and Beck, 1966), *Dendrolimus pini* (Lepidoptera) (Luzev and Beloseroév, 1977) and *Diatreaa grandiosella* (Turunen, 1979).

Electrophoretic studies on *Trogoderma granarium* indicate profound differences in the protein pattern of the haemolymph in the active and quiescent larvae which according to Cohen (1972) reflected the physiological variations related to the mode of life.
Variations in the fat body proteins have been observed by Martin (1969) in *Pyrrhocoris apterus* (Hemiptera). In the larvae of *Diptera* and *Leptoceridae*, Turunen and Chippendale (1980) note a low molecular weight protein in the fat body in association with diapause and call it "diapause-associated protein".

The carbohydrate constituent of the haemolymph and fat body too shows quantitative and qualitative variations in relation to the types of activities in many species. Martin (1969) observes that the fat body in *Pyrrhocoris apterus* contains 5.2% of glycogen in normal individuals and this titre increases to 18.4% 9 days after diapause. In *Trogoderma granarium*, Karanav and Nair (1969) record that the normal values of the glycogen is 9.65 mg/100 larvae while the same decreases to 4.72 mg/100 larvae in quiescent individuals.

Changes in the carbohydrate content of the fat body in relation to dormant life is known also from *Leptinotarsa decemlineata* (Coleoptera) and *Perillus bioculatus* (Hemiptera) (Dudash, 1978, 1980).
Information on the qualitative variations of the free sugars of the haemolymph in relation to the types of life is available from the works of Wyatt (1961) on *Myalophora sacropia*. In this species trehalose is the principal sugar of the haemolymph, the level of which lowers during quiescence. But in *Anthomus grandis* (Coleoptera), Nettles et al. (1972) observed that the trehalose level is unaffected by quiescence. It is likely therefore that the source of energy needed during inactive life may be differing from species to species.

This kind of data on the fluctuations of carbohydrates in relation to the activity levels have been recorded by several other workers like Pant and Pandey (1979), Hayakawa and Chino (1981), Isobe et al. (1981), Moreau et al. (1981) and Tsumuki et al. (1981).

Accumulation of large amounts of lipid is a characteristic feature of aestivating and hibernating animals. Giving examples from arthropods, Bennet and Thomas (1964) note that the fat content of *Hypura postica* (Coleoptera) is only 6 to 10% of the body weight in normal active adult individuals. The same rises to about 50%
at the beginning of aestivation, but falls to 10 to 16% by the time the weevils return to the fields in spring. In *Anthonomus grandis* a drop in the fat content from 20% to 3% during a period of 7 months diapause has been recorded (Lebbremsont et al., 1964).

Similar data on the quantitative fluctuations of the fat reserves in relation to aestivation have been recorded by several workers on many species of insects (Martin, 1969; Hashigupta and Agarwal, 1970; Bernard et al., 1974, Thompson and Leggett, 1978; Pant and Goets, 1981; Bhattacharya and Verma, 1982).

More precise studies have been conducted by several workers on the fluctuations of the types of lipids in relation to quiescence and active life. "

"Anand Singh and Smallman (1972) have found that diapause causes the increase of glycerol and sorbitol in *Lepidoptera*. *Isia isabella*.

This does not seem to be universal in all insects. In the case of *Diatreae grandiosa* the triglycerides showed a 90% increase in relation
to aestivation (Chippendale, 1973). But the oleate content decreases in such a situation in the above species (Turunen and Chippendale, 1976).

Pant and Pandey (1979) have brought out much more details; the phospholipids rise from 0.02 to 3.64 g/100g, free fatty acids increase from 0.20 to 0.58 g/100 g and the neutral lipids reach a higher level of 21.30 g/100 g from 14.68 g/100 g in relation to quiescence in *Antheraea mylitta* (Lepidoptera).

Millipedes are as sensitive as the insects to the changes in the environmental factors like humidity (Pertunen, 1953; Sundara Rajulu, 1963; Dowdy, 1968; Enghoff, 1976, Pedroli-Christer, 1981; Wegensteiner, 1982), temperature (Striganova and Rachmanov, 1972) and light (Tripathi, 1974). *Amblyiulus continentalis* takes to summer diapause in the hot and dry summer (Striganova and Rachmanov, 1972). The water content of the soil dictates the type of life in *Polygonium germanicum* (Wegensteiner, 1982).

In the *Nemaseue variscorne*, Enghoff (1976) notes that the males are less resistant than females to desiccation and high temperature. It is likely
that the haemolymph in these diplopd may show variations in its constituents, as in the hexapods, in relation to the modes of their lives. The available information on this important aspect of physiology of diplopods is quite meagre.

Pugach and Crawford (1978) have studied the changes in the haemolymph amino acids, proteins and inorganic ions in relation to changes in the season in a desert millipede Orthoporus ornatus. It is desirable that investigations are conducted on the variations in the haemolymph constituents, if any, in millipedes in relation to the active and quiescent life.

The aim of the present work is to study in relation to the pattern of life:

a) variations in the free amino acids of the haemolymph,

b) fluctuations in the protein constituents of the haemolymph,
c) changes in the carbohydrate components of the haemolymph,
d) how are the lipids of the haemolymph affected by the life pattern, and
e) whether the inorganic ions show any difference in relation to normal and quiescent life, in a millipede.