INTRODUCTION

The success of any population depends upon the individual's capacity to adapt itself to adverse conditions and to reproduce maximally. Various physiological adjustments in the body could gear the animal to face unfavourable circumstances. By taking the appropriate period of the year when the factors such as temperature, food, surrounding medium etc. are conducive to maximal efficiency in reproduction, the animals could safeguard the spread of their progeny. Thus adaptations to prevent from being exterminated and to maintain a steady level of the population are most important criteria for the animal to be favoured by forces of natural selection. Migration, hibernation and aestivation are some of the phenomena whereby the animals escape the fury of uncompromising climatic changes. Among the physiological adaptations that enable the animals to endure unfavourable climatic conditions aestivation is less understood than the other two. It has been shown in higher animals that the respiration of the aestivating animals is depressed to a considerable extent. It is also known that the aestivating animals enter a dormant state, without feeding and utilizing the organic reserves of their body for the various metabolic requirements. Moreover, it is a known fact that the long term demands for energy in various tissues are met through

the oxidation of lipids though in the initial stages the immediate source of energy is through glycolytic metabolism. This has been proved by several workers in various vertebrate and invertebrate tissues. It has been shown that in Crustacea the energy is obtained primarily through the oxidation of fat and glycogen. Since aestivation is a long term, non-feeding period the energy requirements of the animals during that period for the various metabolic activities are met through the oxidation of these organic reserves in the body.

The common freshwater crab, Paratelphusa jacquemontii is a decapod crustacean which aestivates during the dry months of the year (April to June), and starts breeding with the advent of monsoon in June/July. The active feeding starts in July, followed by an increase in the body weight as well as in the amounts of organic reserves in the body, a major portion of which they utilize for the preparation of the reproductive elements.

The present investigation was therefore undertaken with a view to obtain a better understanding of the various physiological and biochemical changes occurring in the body of the animal before and after aestivation with emphasis on reproduction and lipid metabolism. The freshwater crabs Paratelphusa jacquemontii were collected locally throughout the year except in May when the animals were not available

in sufficient numbers. Organs and tissues such as the hepatopancreas, gonads, blood and certain parts of the central nervous system were studied.

Histological observations on the various tissues such as the hepatopancreas, gonads and parts of the central nervous system revealed the presence of certain follicles containing dense acidophilic colloid. Such follicles were found to be widely distributed in the connective tissue of these various organs (Chapter 1). Further observations on the chemical nature of the colloids revealed that they are proteinacious and probably contain tyrosine. Histochemical reactions of these colloid containing follicles were comparable to the thyroid follicles of higher animals. To substantiate the histochemical finding it was thought worthwhile to study whether these tyrosine containing colloids would incorporate radioactive I^{131}. A series of autoradiographic experiments both quantitative and qualitative were carried out using labelled I^{131} to test the regional capacity of these follicles to incorporate the labelled isotope (Chapter 2). The thyroid follicles are known to incorporate labelled iodine into the protein molecule of the colloid. The comparable thyroid-like follicles observed in the present investigation also showed the property of binding up the labelled iodine into the protein molecules of the colloid.

Among the various vertebrate organs the liver is known to play an important role in the metabolism of various substances and their intermediary products. The corresponding organ in crustaceans the hepatopancreas could be considered as the chief organ concerned with the major metabolic processes. Here too the production and storage of various metabolites are known to occur. The storage of fat is the most noteworthy, as this forms the major fuel during the aestivation period. This preference shown to fat is due to the fact that it could be stored dry in large quantities whereas the other metabolites, carbohydrates and proteins would require a certain amount of water. The metabolic water derived through the oxidation of fat is very precious for the existence of the aestivating animals since they have to conserve water. While fat forms the chief source of energy during the aestivation period, in the initial stages the energy is drawn from carbohydrates. In the normal periods the crustacean metabolism centers around glycogen as well as fat. Moreover, a sufficient amount of glycogen should be stored up concomitant with the build up of fat, since the glycogen metabolism acts as a spark to burn the fat fuel by providing a steady supply of oxaloacetate. Hence knowledge regarding the seasonal changes in the contents of these metabolites in the hepatopancreas was thought to be highly desirable and regular determinations in different months were carried out (Chapter 3). The major form of carbohydrate that is readily transported and utilized is glucose. When

there is an increase in the utilization of this substance by various tissues the blood which transports it should register a corresponding elevation in its level. This glucose is not only utilized for energy purposes but also for the formation of new chitin during the moulting period. Hence seasonal variations are bound to occur in the concentration of glucose in blood. Such a study (Chapter 3) could also give a better understanding of the metabolic state of the animal.

The changes in the content of any metabolite in the tissues are due to many adaptive adjustments that lead to the production or absorption of the substances. Such adjustments are necessarily reflected in the activity of the enzymes concerned with the metabolism as well as on the other physiological processes that enhance or assist such reactions. Seasonal variations in the fat content of the hepatopancreas should also be expected to show corresponding changes in the enzyme systems concerned with fat metabolism. Lipase being the most important enzyme in fat metabolism concerned with hydrolysis and esterification of fat, could be expected to show changes in its activity. A detailed study of this enzyme activity in the hepatopancreas during different seasons was therefore undertaken (Chapter 4).

For all life processes the expenditure of energy is inevitable. The reproductive activities also draw considerable

energy from the stored metabolites. During the maturation of the gametes depletion of the reserve fuel is known to occur. Recently considerable attention has been focused as the utilization of metabolites during gametogenesis. Mobilization of stored fat from the hepatopancreas of Pila was observed by George and Desai (1954), during the production of eggs and sperms. A considerable decrease in the fat content of the hepatopancreas of Paratelphusa was also observed at the time of gonadal development (Chapter 3). Hence, studies on the cyclic changes in the fat content of the gonads were also carried out (Chapter 5). Histochemical localization and distribution of various types of fats in the cellular elements of testis and ovary and their cyclic changes concomitant with reproductive activities were also investigated (Chapter 5). Changes in the cholesterol positive lipids in these organs are of particular interest since such changes would indirectly indicate the degree of synthesis of the respective gonadal hormones.

In addition to these observations histochemical studies on the precise localization and distribution of lipases and esterases were carried out to understand the lipid metabolism in gonads (Chapter 6). The activities of these enzymes in the seminiferous tubules and in the interstitial connective tissue as well as in the ovarian follicles were found to follow the pattern of lipid distribution in these tissues.

For the utilization of metabolities their free movement to and from the tissues would be necessary. The movement of the metabolites across the membrane barriers are assisted or facilitated by various factors. It is generally believed that phosphatases promote such active transport of substances across the membranes. Phosphatases are also known to help in triglyceride synthesis and extensive studies have been carried out on the phosphatase activity in relation to lipid metabolism and gonadal development. Therefore an attempt was made to study the distribution and localization of both acid and alkaline phosphatases in the gonads in relation to the developmental stages of the gonad and the utilization of lipids by the same (Chapter 7).

Since it is known that the reproductive activity and the general metabolism are under the control of hormonal action, a study of the various factors controlling the storage and release mechanisms of the neurosecretory substances in the various cell centres of the central nervous system was carried out (Chapter 8). The thyroid-like follicles referred to earlier were present in the peripheral connective tissue of certain parts of the central nervous system viz: the brain, thoracic ganglion and the eye-stalk ganglion. The storage of neurosecretory material in the neurosecretory cells, its release and the increased production of thyroid-like follicles with the onset of gonadal development were correlated and discussed.