CHANGES IN THE LIPID CONTENT OF THE MATERNAL AND EMBRYONIC TISSUES AND VARIATIONS IN THE MATERNAL HEPATOSOMATIC INDEX DURING THE GESTATION PERIOD OF THE VIVIPAROUS SCORPION, *HETEROMETRUS FULVIPES*

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ABSTRACT

Changes in the lipid content of the maternal and embryonic tissues and variations in the maternal hepatosomatic index during gestation period of the viviparous scorpion, *Heterometrus fulvipes*, have been followed. It is inferred that the embryonic needs of lipids are met by the maternal stores, amply supplemented by dietary sources and other intermediaries that contribute to lipid synthesis. The lipids stored in the embryo throughout the gestation period are shown to be utilized for energy release and growth during the final stages of development. The hepatosomatic indices are considered to support the viewpoint that lipid stores are utilized predominantly by the maternal animal and/or the embryos during the gestation period.

INTRODUCTION

EMBRYONIC development requires raw materials and free energy, which in most cases are provided by food stores laid down in the oocytes during oogenesis. But in viviparous animals they are delivered continuously from the maternal animal[1]. Such a need to meet the embryonic requirements of nutrients, in addition to its own, would naturally be reflected in the intermediary metabolism and in the way the maternal food intake and reserves are handled. Changes of carbohydrates[2] and proteins[3] in the maternal animal and in the embryos during gestation period have been studied out, to have an insight into the above mentioned aspects, in the viviparous scorpion, *Heterometrus fulvipes*. Similar studies on the changes in the lipid content of the maternal and embryonic tissues during gestation period are considered to give a comprehensive picture supplementing the above findings. The present study is aimed at achieving that end. The information on the role of lipids during the gestation period in sustaining maternal and embryonic requirements is totally lacking in scorpions, justifying the importance of the present study. As the information on the mobilization of reserves from tissues can also be had from a determination of tissue somatic indices, the hepatosomatic index of the maternal scorpion is determined throughout the gestation period.

MATERIALS AND METHODS

Scorpions were collected and maintained as reported by Subburam and Reddy[2]. Hepatopancreas, pedipalpal muscle, haemolymph and embryos were obtained from gravid females at appropriate stages of the gestation period as reported earlier[2].

Lipids were extracted from the haemolymph, muscle, hepatopancreas and the embryos by the method of Folch *et al.*[4] and the total lipid contents were estimated employing the semi-micro method of Ponde *et al.*[5]. The hepatosomatic index was determined as follows:

$$\text{Hepatosomatic index} = \frac{\text{Weight of the hepatopancreas}}{\text{Weight of the animal}} \times 100.$$

In view of the occurrence of marked diurnal rhythm of activity in the scorpion, *H. fulvipes*[6], all the studies were carried out between 8 A.M. to 10 A.M.

RESULTS

Lipid content of the hepatopancreas of the maternal animal

The total lipid content of the hepatopancreas of the maternal animal shows a steady and gradual increase from the first stage to the third stage of the embryonic development and this is followed by a decline upto the fifth stage. Another phase of increase appears between the fifth and the sixth stages and from then onwards a steady drop continues beyond parturition (Table I).

Lipid content of the pedipalpal muscle of the maternal animal

The total lipid content of the muscle shows a steady and gradual decrease throughout the gestation period excepting for a singificant increase in the sixth stage (Table I).

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TABLE I

Total lipid content in the maternal tissues and in the embryos at different stages of development during the gestation period of the viviparous scorpion, Heterometrus fulvipes

Values represent the mean ± S.E. Number of observations (N) is given in parentheses

Stages	Maternal tissues			Embryos	
	Hepatopancreas mg/100 mg wet weight	Muscle mg/100 mg wet weight	Haemolymph mg/100 ml	Mg/embryo	mg/gr. wet wt.
1	24·06±0·62 (10)	1·70±0·02 (11)	458·57±21·22 (14)		
2	26·40±1·16[a] (10)	1·54±0·05[a] (14)	477·69±27·32 (13)	0·0138±0·0005 (2)	18·41±0·635
3	27·68±1·68 (10)	1·44±0·06 (10)	487·00±34·84 (10)	0·0473±0·0017[a] (3)	39·43±2·092[a]
4	23·11±0·73[a] (10)	1·26±0·07 (13)	399·58±22·84 (12)	0·1017±0·0122 (4)	53·04±7·302
5	22·84±0·83 (10)	1·22±0·09 (10)	362·73±26·00 (11)	0·2080±0·0109[b] (8)	60·91±2·268
6	26·76±1·05[a] (10)	1·52±0·07[a] (11)	459·09±31·71[a] (11)	0·6422±0·0769[b] (9)	76·53±7·407
7	25·15±1·41 (10)	1·32±0·08 (10)	413·00±25·43 (10)	1·911 ±0·0824[b] (9)	109·24±3·986[b]
8	15·51±0·34[b] (9)	0·71±0·02[b] (10)	307·73±15·13[b] (11)	2·8500±0·0670[b] (10)	48·85±2·136[b]
9*	12·25±0·75[b] (8)	0·79±0·04 (8)	281·43±13·13 (7)	1·7140±0·0738[b] (7)	21·91±0·526[b]

* New born young ones and maternal animals about a week after parturition are considered to correspond to the ninth stage of development.

$a_p < 0.05$; $b_p < 0.01$.

Lipid content of the maternal haemolymph

The total lipid content of the haemolymph of the maternal animal shows a pattern of changes similar to that of the hepatopancreas (Table I).

Lipid content of the embryos

The total lipid content of the whole embryo shows a gradual and continuous increase throughout the gestation period. Newborn young ones show a significant decrease (Table I).

The changes in the lipid content per gram wet weight of the embryo reveal that there is an increase upto the seventh stage beyond which it declines significantly (Table I).

Variations in the maternal hepatosomatic index

The hepatosomatic index of the maternal animal shows a pattern of changes similar to that of the lipid content of the hepatopancreas (Table II).

DISCUSSION

Lipids are used as an energy source for embryogenesis by a number of animals belonging to different taxonomic groups whether oviparious, ovoviviparous or viviparous[7–11]

Storage of lipids in the maternal animal for embryonic utilisation is known in mammals[12], selachians[10] and insects[13]. In the case of *Glossina morsitans*, the lipids stored in the maternal animal during the first half of pregnancy are transported as such to the larvae during the second half of pregnancy[13]. In *H. fulvipes*, utilization of maternal stores of lipid by the embryo during a major part of the gestation period is indicated. Maternal metabolism is marked by a high synthetic activity and accumulation of lipids in the hepatopancreas and haemolymph from the first to the third stages, during which period the lipid content of the

follicles containing the embryos is also shown to increase. This suggests that upto the third stage, the embryonic requirements are probably met by the dietary lipids. Beyond the third stage the maternal stores appear to contribute to the embryonic growth and development, as indicated by the continuous increase in the whole embryos and a corresponding decline in the maternal tissues with an exception during the sixth stage.

TABLE II

Weight of the hepatopancreas and hepatosomatic index of the maternal animal at different stages of embryonic development during the gestation period of the scorpion, H. fulvipes

Values represent the mean ± S.E. Number of observations (N) is given in parentheses.

Stages	Average weight of the maternal animal in g	Average weight of the hepatopancreas in g.	Hepato-somatic index
1	7·65	1·378±0·085 (8)	18·136±0·970
2	8·27	1·740±0·238 (8)	20·694±1·259
3	8·92	2·204±0·120 (10)	24·643±0·394[b]
4	7·77	1·572±0·133 (10)	20·081±0·802[b]
5	7·91	1·388±0·098 (12)	17·377±0·767[a]
6	7·41	1·578±0·095 (12)	21·266±0·888[b]
7	8·27	1·716±0·154 (10)	21·278±0·769
8	10·40	1·678±0·078 (9)	16·236±0·630[b]

[a] $b < 0·05$ [b] $p < 0·01$.

The elevation of lipid stores of the mother during the sixth stage when an increase continues in the embryos also goes to suggest a second phase of synthetic activity of the mother at which time, the embryos are likely to derive lipid from either dietary sources and/or from other metabolites contributing to lipid synthesis. It could thus be inferred that, during the gestation period, the embryonic needs of the lipids are met by the maternal stores, amply supplemented by dietary sources and other metabolites that contribute to lipid synthesis.

While the lipid content of the whole embryo continues to increase throughout the gestation period, a remarkably steep rise is noticed only from the sixth stage onwards. This is perhaps correlated with the appearance of structures like hepatopancreas in the embryos[2,14] which might also participate in the synthesis and storage.

Between seventh and eighth stages, when the lipid content of the whole embryo increases, a downward trend is recognisable (as a proportion of weight) in marked contrast to the elevation of both embryonic glycogen[2] and protein[3]. This implies that the accumulation of lipids is not keeping pace with the growth of the embryo, probably owing to its increased utilization. The subsequent drop from the eighth stage upto parturition marks the continued utilization in greater quantities, possibly for the synthesis of those structures needed for the growth of the embryo as in *L. maderae*[11] and also for the energy release as is known in forms like *Diploptera punctata*[15].

The changes of the hepatosomatic index, following a pattern almost similar to that of the lipids, probably reflect only changes of lipids more than anything else. Similar conclusions are arrived at, by a study of hepatosomatic indices in live-bearing selachians[10]. The sequence of changes in protein[3] and carbohydrates[2] of the hepatopancreas during gestation period follows a different pattern stregthening the viewpoint that the major weight changes are due to changes in the levels of stored lipids which might be predominantly utilized by the maternal animal and/or the embryo during the gestation period.

The possibility of maternal sacrifice through hepatic histolysis to meet the energy requirements during pregnancy appears remote because there is no difference in the average weight of the hepatic tissue between the first and the last stages of gestation period, although a drop in the hepatosomatic index is noticed in the final stage.

The pattern of variation of proteins in the maternal tissues when compared with the embryonic tissues revealed no significant supply of proteins from the maternal stores[3] and the embryonic requirements of proteins are suggested to be met from the dietary sources of the mother directly[3]. The carbohydrate requirements of the embryo on the other hand are shown to be met by the maternal supply upto the 6th stage beyond which the embryo relies on its own stores and/or the maternal supply[2].

The results reveal that the maternal animal has two physiologically active phases marked by synthetic activity and storage of nutrients during the gestation period. In the first phase lipid accumulates upto the third stage and during the second phase they are replenished during the fifth and sixth stages. Hepatosomatic index also follows a similar trend. Similar occurrence of two phases of synthetic activity and storage are observed for proteins of the hepatopancreas also[3].

H. fulvipes has such a long period of gestation lasting about 11 months[16] that it can hardly be sustained by the maternal stores accumulated just in one

phase of synthetic activity. The occurrence of an additional phase of synthetic activity leading to replenishment and storage of lipids and proteins may be considered a physiological adaptation for ensuring successful completion of development. While the 1st could be considered a preparatory phase, the second can be referred to as a "booster' phase.

It is also possible that this pattern of biochemical changes incorporates a seasonal effect as well. The developmental stages 4 and 5 appear during the monsoon months November, December and January. The period corresponding to these stages is marked by low synthetic abilities of the maternal animal. The onset of warmer climate in February, when the 6th stage appears probably, triggers off another phase of synthetic activity leading to replenishment of the reserves to be used during the gestation period as a supplement to the dietary sources.

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EFFECT OF TEPA ON THE FREE AMINO ACIDS OF OVARY IN *DYSDERCUS CINGULATUS* FABR.

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ABSTRACT

Free amino acid composition of ovary in *Dysdercus cingulatus* has been studied by two dimensional paper chromatography in normal condition and when treated with tepa (chemosterilant). In normal insect, fifteen identified and three unidentified ninhydrin positive spots (NPS) have been observed. The concentration of glutamic acid is maximum while alanine, tyrosine come next.

In insect treated with tepa, the colour intensities of alanine, aspartic acid, glutamic acid, isoleucine, leucine, methionine, phenylalanine, serine, tyrosine, and NPS[3] have been depleted while the opposite is true in the case of arginine, histidine, lysine, proline, NPS[1], NPS[3] and NPS[4]. It has been inferred that tepa, which affected the amino acid pool of the ovary in *D. cingulatus*, may affect normal oocyte development and other reproductive physiology of the insect.

INTRODUCTION

DYSDERCUS cingulatus is considered to be one of the important pests of cotton and is known to attack many other malvaceous food plants. Control of this pest with insecticides in the field has been reported but with limited success and has resulted insecticide resistance as well as contamination of the environment. The encouraging results of the use of chemosterilants in different groups of insects have created an interest in using such chemicals as a possible means of control. Sehgal *et al.*[10] obtained cent per