experiments, where pmx–r donors were treated with acridine orange and acriflavin, which resulted in elimination of this factor (under publication).

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## CHANGES IN THE PROTEIN CONTENT OF THE MATERNAL AND EMBRYONIC TISSUES OF THE VIVIPAROUS SCORPION *HETEROMETRUS FULVIPES* DURING GESTATION PERIOD

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ABSTRACT

Changes in the protein content of the maternal and embryonic tissues of *Heterometrus fulvipes* have been followed during the gestation period.

The protein content of the hepatopancreas of the mother increases upto the 4th stage, followed by a decrease upto 6th, subsequent to which, a gradual increase is observed upto the time of parturition. The haemolymph protein also increases upto the 4th stage, beyond which a steady decrease continues upto parturition. The pedipalpal muscle shows no marked changes in the protein content.

A continuous increase of protein is noticed in the embryos throughout the gestation period. However, when expressed per gram wet weight a decline is recorded between the 4th and 5th stages. A comparison of the pattern of variations of proteins in the maternal tissues with that of the embryos lends no support for the supply of proteins from maternal stores to any significant extent. Embryonic requirements are suggested to be met by the dietary proteins of the mother directly.

INTRODUCTION

THE pattern of variations in the protein content of the maternal and embryonic tissues of viviparous forms is studied only in a few insects[1–5] and in mammals[6]. Storage of nitrogen by the maternal animal during pregnancy is known in mammals. Supply of proteins to the embryos in the form of albumin, transferrin and γ-globulin through yolk sac splanchnopleure is also well documented[7–9]. As in mammals, storage of proteins during pregnancy and utilization at times of increased embryonic requirements or maternal starvation is known in insects also[1–3].

Conversion of amino acids into other forms of storage material to sustain the embryonic development is also known amongst insects[5]. But for these few

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instances of viviparous forms, no invertebrate has been investigated from the point of view of maternal and embryonic relationships with reference to proteins. In this investigation the changes of proteins in different tissues of the pregnant scorpion, *Heterometrus fulvipes*, and its embryos are studied at Eight different stages of embryonic developments and also after parturition (Ninth stage).

## Materials and Methods

Scorpions collected from near the foot of Tirumala Hills were kept in suitable vivaria containing moist sand. Cockroaches were provided as food *ad lib.*

Haemolymph, hepatopancreas, pedipalpal muscle and the embryos were obtained from gravid females at appropriate stages of the gestation period as reported earlier[10] and the total protein content was estimated in each, employing the method of Lowry *et al.*[11], In view of the occurrence of marked diurnal rhythm of activity in the scorpion *H. fulvipes*[12] all the estimations were carried out between 8–10 A.M.

## Results and Discussion

The data are presented in Table I. The protein content of the hepatopancreas of the mother increases upto the 4th stage followed by a decrease upto 6th, subsequent to which a gradual increase is observed upto the time of parturition. A steep decline appears by about a week, after parturition.

Table I

*Protein content in the maternal tissues and 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.

| Stage (approximate age in months given in parenthesis) | | Maternal tissues | | | Embryo | |
|---|---|---|---|---|---|---|
| | | Hepatopancreas mgs/100 mgs wet wt. | Muscle mgs/100 mgs wet wt. | Haemolymph gms/100 ml | mgs/embryo | mgs/gram wet wt. |
| 1. | (1) | 15·88±0·408 (14) | 14·71±0·461 (16) | 4·28±0·208 (20) | .. | .. |
| 2. | (2) | 16·40±0·450 (16) | 13·34±0·338[a] (15) | 4·84±0·183 (30) | 0·019±0·001 (2) | 25·00±1·00 |
| 3. | (3) | 17·60±0·387 (15) | 13·65±0·329 (16) | 7·95±0·654[b] (17) | 0·043±0·001[b] (3) | 41·59±1·30[b] |
| 4. | (5) | 19·16±0·584[a] (11) | 12·96±0·355 (14) | 9·75±0·605 (12) | 0·078±0·002[b] (4) | 49·25±1·06[a] |
| 5. | (7) | 17·57±0·760 (13) | 12·44±0·372 (14) | 6·55±0·297[b] (16) | 0·156±0·005[b] (4) | 21·80±0·64[b] |
| 6. | (8) | 14·09±0·498[b] (10) | 12·29±0·322 (15) | 5·57±0·471 (12) | 0·319±0·004[b] (10) | 27·07±0·29[b] |
| 7. | (9) | 14·88±0·555 (15) | 12·15±0·420 (12) | 4·19±0·048[b] (14) | 0·581±0·006[b] (8) | 33·46±0·77[b] |
| 8. | (10–11) | 17·89±0·566[b] (11) | 15·02±0·171[a] (10) | 4·09±0·038 (10) | 4·160±0·539[b] (9) | 60·91±2·58[b] |
| 9. | | 13·84±0·785[b] (11) | 14·08±0·574 (6) | 4·15±0·042 (8) | 6· 79±0·485[b] (4) | 70·73±0·36[a] |

* 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] $p < 0·01$.

The changes in the protein content of the pedipalpal muscle of the maternal animal are not highly marked, excepting for a gradual decline from the 1st stage up to the 6th followed by a steady increase until a level comparable to the 1st stage is reached by the end of gestation. Even after parturition (stage 9), the protein content is not altered in the muscle.

The haemolymph protein content increases from the 1st stage to the 4th stage of the embryonic development. From then onwards, it decreases upto the final stage and remains unaltered till about a week after parturition. A continuous increase of protein is noticed in the embryos throughout the gestation period. However, when expressed per gram wet weight a decline is recorded between the 4th and 5th stages.

Proteins and amino acids are generally not stored to any appreciable extent as reserve metabolites in a normal adult organism. Retention of nitrogen on a significant scale is observed only during periods of tissue growth, childhood and pregnancy[13]. Mammals, when provided with adequate food materials, complete their pregnancy with a net gain of nitrogen[14–17]. Storage of proteins by mammals is normally regarded as a prelude to meet the requirements of the foetus during the last few weeks of pregnancy as well as future lactation[6]. Storage during pregnancy and utilization at times of need is known in insects also[1–3]. The viviparous insect, *Diploptera punctata*, is known to store proteins in the fat body during pregnancy[1] which is available to the embryo during starvation or when fed with protein free diet[2]. Tobe and Davey[3] have reported the accumulation of protein in the fat body and oenocytes of the adenotrophic viviparous insect, *G. austeni*, for providing amino acids to the milk glands where larval nutrients are synthesized.

In the present study also, it is observed that the scorpion, *H. fulvipes*, stores proteins in its hepatopancreas as well as in the haemolymph as indicated by an increase upto the 4th stage of the embryonic development. This is probably, a preparatory step to meet the protein requirements of the growing embryo and the mother during pregnancy. The subsequent decrease in the haemolymph proteins throughout the gestation period suggests the possible transport to the embryo, where the protein content of the whole embryo continuously increases. Hepatopancreas, on the other hand shows a decline in protein content only upto the 6th stage followed by a gradual increase upto parturition. The decline indicates utilization either for energy release or for incorporation in the embryonic tissues or for conversion into other forms of reserve foods. In view of the steep decline in the protein content/gm wet wt. of the follicles with the embryos between the 4th and 5th stages and only a slight increase between the 5th and 6th stages, the decline noticed in the maternal hepatopancreas between these stages may not be due to incorporation into the embryonic tissue. It is likely that much of it is utilized for energy release and or conversion into other forms of reserves. Conversion of amino acids to lipids has been reported in the insect, *G. morsitans*[5].

The embryonic growth and development is accompanied by a gradual and continuous increase of protein content of the whole embryo. Such a trend, is reversed between 4th and 5th stages, when the protein content is expressed per gram wet weight of the embryo, appearing paradoxical. Nevertheless, it is between these stages, that certain important structural modifications are noticed in the diverticular wall leading to a transformation from a thick fleshy condition to a thin and more elastic condition accompanied by accumulation of fluids within the diverticulum. Such changes in the diverticular wall and the accumulation of fluids might account for the actual decline of proteins between the 4th and 5th stages. The increase in the protein content per gram wet weight upto 4th stage may include more of the diverticular component than of the embryo. It is actually form the 5th stage onwards that the embryonic part of tissue is observed to predominate over the diverticular tissue. Consequently, the gradual increase in protein content from 5th stage onwards can alone be taken to represent the rate of increase of embryonic proteins.

The increase in the protein content of the hepatopancreas from the 6th stage onwards upto parturition is indicative of an active synthesis, which is perhaps compensatory for the drain observed during the preceding stages and preparatory to meet the demands of the postparturition period for about a week, when the maternal scorpion does not feed. This view is supported by the fact that the protein content of the hepatopancreas decreases after parturition.

The increase in the protein content of both maternal hepatopancreas and the embryo from the 6th stage onwards, suggests that the developing embryo derives its proteins directly from the maternal dietary sources without forcing a drain on the reserve stores in the maternal tissues.

In insects, proteins are not transferred as such from the maternal haemolymph to the embryo, but are synthesized from the maternal sources in special organs, such as the brood sac in *D. punctata*[18] and the milk-glands in *G. morsitans*[5] and *G. austeni*[1]. The nutrients are then sucked orally by the embryos[3,19]. In *H. fulvipes*, the transfer of proteins to the embryo through the appendix, is demonstrated (unpublished). However, it is not clear whether the proteins are transported as such from the mother or after resynthesis and modification in the end piece of the appendix.

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## AUSTRALIAN SCIENTISTS CLAIM NEW LASER ADVANCE

Australian scientists have found a new method of boosting the power of lasers which they believe could have a major impact on the future development of fusion energy. The process involves the use of an electron beam to boost the power of a laser to between a hundred and a thousand times that of a conventional laser.

The new laser process is based on theoretical work begun by Prof. Hora in 1962 and developed experimentally during recent years by the ANU group. Last year the ANU group carried out a crucial experiment in which a laser beam was fired into low-density plasma to produce an emission of high-energy electrons. In the past six months the group has been trying to find the conditions to reverse the process—to fire a beam of free electrons into a laser beam, so amplifying the beam.

This type of laser is called a non-linear force-free electron laser and it could provide very high-power, high-intensity laser beams which are between a hundred and a thousand times more powerful than conventional lasers. The system could provide a new way of controlling nuclear fusion, to provide a source of clean, cheap and virtually unlimited energy. The latest results show that the laser radiation from the new system could accelerate thick blocks of plasma very efficiently for compression and use in nuclear fusion.

It is believed that this scheme for laser fusion is more efficient and could achieve fusion with less energy than another free-electron laser fusion project being developed at the Stanford University in California.

Prof. Hora presented an account of the work at an international conference in Venice, Italy, in December 1978 and Dr. Hughes reported the team's findings at a conference in Florida at the same time. In March 1979 a report of their experimental work was published in *Physical Review Letters*.