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BIOCHEMICAL CHANGES AND ENERGY UTILISATION IN DEVELOPING STAGES OF THE ESTUARINE PRAWN, *MACROBRACHIUM IDELLA* (HILGENDROF)

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ABSTRACT

Changes in the biochemical composition, caloric content and energy utilisation during the embryonic stages of *Macrobrachium idella* were studied. The results show that protein contributes to about 67.4% of the total energy available for development. The gross efficiency of the prawn works out to be 44.0%.

INTRODUCTION

CONSIDERABLE attention is being given to the study of energy flow in ecosystems and some important contributions in this field have appeared in recent years (Kinne and Kinne, 1962 ; Lasker, 1962 ; Blaxter and Hempel, 1966 ; Pandian, 1967 ; Pandian and Schumann, 1967 ; Flüchter and Pandian, 1968).

The embryology of *Macrobrachium* has been worked out by several earlier authors (Nataraj, 1947 ; Parameswara Aiyar, 1949 ; Rajalakshmi, 1960). Hatching of *Macrobrachium idae* (Heller) has been studied by Pandian and Katre (1972). Recently considerable information on the rearing of *Macrobrachium idella* have been obtained by Pillai and Mohamed (1973). The present communication deals with the changes in biochemical components, caloric content and gross growth efficiency from the egg to zoea stages of *Macrobrachium idella*.

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MATERIAL AND METHODS

Berried females of *M. idella* begin to appear in the Cochin Backwater in June and continue to do so till December. However, peak abundance of these forms is from September to November. The minimum number of eggs occurring per brood is about 5,000. For the present study, freshly collected berried females were divided into four arbitrary stages based on the following features :

Egg Stage I—Eggs opaque, greenish, round or oval in shape. Diameter is 0.45 mm.

Egg Stage II—Eggs translucent, light green in colour, oval with a narrow peri-vitelline space and at one end, a small transparent plate (the blastoderm) is easily distinguishable. Diameter is 0.57 mm.

Egg Stage III—Eggs translucent, brownish-yellow in colour, embryo further developed with anterior transparent plate differentiated into cephalic lobe. Diameter is 0.58 mm.

Egg Stage IV—Eggs transparent, dull whitish in colour, embryos well-developed with conspicuous black eye spots at the anterior end, rudiments of cephalothoracic appendages developed, posterior region coiled. Diameter is 0.65 mm.

A few healthy berried females carrying the eggs at stage IV were separated and kept in the laboratory until the eggs hatched into Zoea I within 24 hours. The zoeae moulted into zoea II within 48 hours. During this period, the zoeae were not fed on any outside food material. A few distinguishing features of the zoeae I and II are given below:

Zoea I—Body divisible into an anterior cephalothoracic region and a posterior abdomen. Telson not separated from the 6th abdominal segment. Eyes sessile. No pereiopod. TL=1.92 - 2.10 mm.

Zoea II—Eyes stalked, pereiopods I and II developed. TL=2.14 - 2.36 mm.

Eggs and zoeae were first washed with distilled water to remove any adhering material. They were then wiped, counted, weighed on an electric balance and dried in an oven at 70°C to constant weight. The dried materials were ground into a fine powder and stored in glass tubes in a desiccator until analysed.

Procedures for the estimations of carbohydrate, lipid, protein and caloric content were the same as described elsewhere (Sumitra Vijayaraghavan and Vijayakumaran, 1973). Gross efficiency and energy loss were calculated according to the procedure suggested by Brody (1945). Due to scarcity of such materials as the egg membrane, moults, etc., it was not possible to account for the losses of energy occurring as a result of rapid embryonic changes. Hence, for the calculation of gross efficiency, the following equation was used.

$$\text{Gross efficiency} = \frac{\text{Combustion value of zoea I}}{\text{Combustion value of egg I}} \times 100$$

From the biochemical values of the samples, the caloric values were calculated using the following conversion factors (Brody, 1945); for carbohydrate: 4.1 cal mg^{-1}; for protein: 5.6 cal mg^{-1} and for lipid: 9.4 cal mg^{-1}.

RESULTS

Table 1 gives the results of the biochemical composition of the 4 stages of egg and 2 stages of zoeae of *Macrobrachium idella*. As can be seen from the table, the water content increased from 56.16% in the egg stage I to 76.68% in the egg stage IV. Similarly, the increase in the water content was from 80.44 % to 83.53% in zoeae stages I to II. The dry weight of a single egg decreased from 26 μg to 16 μg (Table 2), thus showing a net loss in dry weight of about 10 μg during the embryonic development. The dry weight loss from the zoea I to II amounted to 6 μg. The difference in dry weight between the egg stage IV and zoea I was almost negligible. This probably indicates, that the energy loss by the egg membrane and probably by a small portion of the yolk given out into the water during hatching and thus these two remain un-utilised, may not be large. This is also reflected from the caloric values (Table 3).

Carbohydrate content of the egg stages I to IV and of the zoea I and II showed an increasing trend (Table 1). However, their lipid content and the total protein decreased. The caloric content per unit dry weight decreased progressively from 6231 cal/g in the egg stage I to 4410 cal/g in the zoea stage I (Table 1).

TABLE 1. *Changes in chemical composition of developing eggs and freshly hatched zoea of* Macrobrachium idella. *All the values are based on dry weights.*

	Egg				Zoea	
	Stage I	Stage II	Stage III	Stage IV	Stage I	Stage II
Number per mg ..	38.46	43.48	58.82	62.50	62.50	100.00
Water content % ..	56.16	56.42	68.25	76.68	80.44	83.53
Carbohydrate % ..	4.39	4.47	5.81	5.88	5.76	8.38
Lipid % ..	12.32	7.21	6.78	5.74	5.32	8.25
Protein % ..	80.00	80.00	60.00	60.00	60.00	55.00
Energy cal/g ..	6231	4743	4318	4535	4410	5122

DISCUSSION

The water content recorded a net increase of 36.5% during the embryonic development of *M. idella*. This explains the increase in the egg diameter from 0.45 mm to 0.65 mm. Such an increase appears to be a general feature of the developing crustacean eggs (Pandian, 1967, 1970; Pandian and Schumann, 1967).

The protein content of the eggs of *M. idella* showed a higher value than those reported for *Crangon crangon* (Pandian, 1967) and *Eupagurus bernhardus* (Pandian and Schumann, 1967) and lower value for lipid as compared to *Crangon crangon* and *Eupagurus bernhardus*. Similar variations were also seen in the caloric content of the eggs. The caloric values noted earlier were 6445 cal/g, 6292 cal/g and 6231 cal/g of dry weight in the eggs of *Crangon crangon*, *Eupagurus bernhardus* and *Macrobrachium idella* respectively (Pandian, 1967 ; Pandian and Schumann, 1967 and the present authors).

In general, all the bio-chemical and caloric values showed a decreasing trend, when the values were calculated as per egg or per zoea (Table 2). However, in *M. idella*, the main source of energy for the development appears to be derived from protein. Of the total, 0.0914 calorie seem to be lost during the development by a single egg, only 24.2% seems to be derived from fat (0.0221 cal), whereas as high as 67.4% is probably supplied by protein (0.0616 cal). The contribution of carbohydrate seems to be only about 1%.

TABLE 2. *Changes in chemical composition and caloric content of a single egg of* Macrobrachium idella *at the beginning and end of the embryonic development.*

	Egg				Zoea	
	Stage I	Stage II	Stage III	Stage IV	Stage I	Stage II
Weight (μg) ..	26.00	23.00	17.00	16.00	16.00	10.00
Carbohydrate (μg) ..	1.14	1.03	0.99	0.94	0.92	0.84
Lipid (μg) ..	3.20	1.66	1.15	0.92	0.85	0.83
Protein (μg) ..	21.00	16.00	10.00	10.00	10.00	6.00
Energy (cal) ..	0.1620	0.1091	0.0734	0.0726	0.0706	0.0512

The present study supports the concept proposed by Needham (1950) that terrestrial animals utilise fat for their development, while in aquatic animals, thesource of energy for the development comes from the oxidation of proteins. In contrast to this, Stolfi (1933) earlier found that in the case of *Loligo vulgaris*, of the total energy used for the development, 61.5% was derived from fat. The contribution of fat for the development in several animals are : 75.0% in *C. crangon* (Pandian, 1967), 66.6% in *E. bernhardus* (Pandian and Schumann, 1967), 66.0% in *Crepidula fornicata* and 87.7% in *Homarus gammarus* (Pandian, 1969, 1970).

TABLE 3. *Percentage values of gross efficiency and energy loss in some animals.*

Animal	Gross efficiency	Energy loss	Reference
Chick ..	44	56	Brody (1945)
Silk worm ..	45	55	Brody (1945)
Crangon crangon ..	*54	*46	Pandian (1967)
Eupagurus bernhardus ..	*55	*45	Pandian and Schumann (1967)
Homarus gammarus ..	*60	*40	Pandian (1970)
Macrobrachium idella ..	44	56	Present work

*Calculated by the authors.

In *M. idella*, the gross efficiency was 44.0% and the energy loss was 56.0% (Table 3). The data of Pandian (1967) and Pandian and Schumann (1967) were used for calculating the gross efficiency and energy loss in different animals which they analysed and these values together with the values of some other animals given by Brody (1945) have been included in Table 3. According to Brody (1945), gross efficiency for the development in animals remains more or less constant inspite of the differences in the size of the animals belonging to different species. This generalisation appears to be true as the values obtained in the present study are very close to those given by Brody (1945). In other animals given in Table 3, the values of gross efficiency are high and those of energy loss low. However, despite these differences, the value of gross efficiency and energy loss in animals are important, for these indicate the maximum capacity of animals to utilise the ingested food.

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