

# CHANGES IN BIOCHEMICAL COMPOSITION AND ENERGY UTILIZATION IN DEVELOPMENTAL STAGES OF THE MOLE CRAB, *EMERITA HOLTHUISI* SANKOLLI

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## ABSTRACT

Changes in the biochemical composition, caloric content and energy utilisation during the embryonic stages of *Emerita holthuisi* were studied. The results show that protein contributes 74% of the total energy available for development. The gross efficiency of the development of *Emerita holthuisi* was found to be 46.15%

## INTRODUCTION

The mole crab, *Emerita holthuisi* is a tidal migrant and occurs along the surf zone of Clva beach (Goa). It is the most abundant form in this beach next to *Donax incarnatus* and provides food for the local people. The crab and its larvae are evidently important in the marine food chains. Detailed studies on the biology of *Emerita holthuisi* are being carried out and this paper deals with the energetics of developing stages. A review of literature shows that in crustaceans during the development of eggs 66 - 87% of energy is contributed by the oxidation of fat (Pandian & Schumann, 1967; Pandian, 1967; 1970a & 1972). However, in *Mocrobrachium idella* it has been reported that protein oxidation provides the main energy source (67%)—[Sumitra and Easterson — In Press]. The present paper gives information on the changes in chemical composition and caloric content of the developing eggs of *Emerita holthuisi*.

## MATERIALS AND METHODS

Berried females of *Emerita holthuisi* occur in the beaches of Goa from December to June with a peak abundance in March and in smaller numbers during September. The number of eggs per brood varies from 102 to 2309. For the present study, specimens of *Emerita holthuisi* were collected from the Colva beach from February to April (berried females with egg stages I - III). The eggs were divided into three arbitrary stages based on the following features.

Egg stage I:- Eggs round, golden-yellow to orange in colour. Yolk granules large. Segmentation commencing. Diameter 1.2 mm.

Egg stage II:- Eggs round, lemon-yellow in colour. Yolk granules large. Segmentation advanced. Embryo formed. Eyes begin to appear. Diameter 1.6 mm.

Egg stage III:- Eggs round to oval, light brown in colour. Eyes well formed. Embryo well developed. Diameter 1.8 mm.

In the laboratory, berried females (egg stage III) were kept in glass aquaria containing sea water at 28°C and of 34‰ salinity, over a thin layer of sand. Under these conditions, the eggs hatched into zoea I within 24 hours. The zoea I moulted into zoea II after 72 hours. During this period, the larvae were not given food. Zocal stages were identified based on the description by Sankolli (1967).

Before the analyses, the eggs and larvae were washed with distilled water to remove any adhering material and salt. The test materials were then blotted, counted, weighed and dried in an oven at 70°C to constant weight. The dried materials were then ground into a fine powder and stored in glass tubes in a desiccator.

Carbohydrate was estimated by the method of Dubois *et al* (1956), total protein by biuret method of Raymond *et al* (1964) and lipid according to Folch & Stanley (1956). The method of Karzinkin and Tarkovskaya (1964) was employed for the estimation of energy content. In each estimation, the result gives the average of 3 readings. From the biochemical values of the samples the caloric values were calculated using the following conversion factors as given by Prosser and Brown (1961); for carbohydrate 4.2 cal mg<sup>-1</sup>; for protein 4.19 cal mg<sup>-1</sup> and for fat 9.5 cal mg<sup>-1</sup>. As it was not possible to account for the energy lost through the egg membrane, moults,

etc., following equation was used to calculate the gross efficiency of energy conversion.

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

#### RESULTS

The changes in the biochemical composition of the egg stage I to III and zoea I and II of *Emerita holthuisi*, based on dry weight, are given in Table I. Water content increased progressively during development and mean dry weight decreased. The total loss in dry weight was 5.7 µg during the whole embryonic development, i. e. from egg stage I to first zoea. Similarly protein, carbohydrate, lipid and energy contents decreased.

From the values presented in Table I, average changes in chemical composition and caloric content of a single egg from stage I to zoea II were calculated and the values are given in Table II.

Cumulative yolk utilisation efficiency of the total development has been calculated according to Gray (1928). The formula used was as follows:

Body formed/body formed + yolk used for metabolism.

The efficiency of utilisation of dry weight, carbohydrate, protein, lipid and total energy values were calculated using this formula and the values derived were 28.75%, 17.94%, 17.55%, 28.71% and 12.79% respectively. The differences in these values indicate that the efficiency of utilisation of different components of the yolk varies considerably.

TABLE I—*Changes in Chemical Composition of Developing Eggs and Freshly Hatched Zoea of Emerita holthuisi*

	Egg			Zoea	
	I	II	III	I	II
No. per mg	31	42	46	52	63
Water content (%)	74.79	76.10	81.47	82.82	88.18
Carbohydrate (%)	4.89	3.94	3.40	3.02	4.51
Lipid (%)	12.60	12.57	12.57	12.44	11.35
Protein (%)	80.57	76.93	58.15	48.56	39.48
Energy (cal/g dry wt)	4288	4115	2717	1987	992

TABLE II—*Changes in Chemical Composition and Caloric Content of a Single Egg of Emerita holthuisi during Embryonic Development*

	Egg			Zoea	
	I	II	III	I	II
Dry weight ( $\mu$ g)	8.0	5.7	4.1	2.3	1.9
Carbohydrate ( $\mu$ g)	0.39	0.22	0.14	0.07	0.08
Lipid ( $\mu$ g)	1.01	0.82	0.52	0.29	0.21
Protein ( $\mu$ g)	6.44	4.38	2.38	1.13	0.75
Energy (cal)	0.0344	0.0228	0.0111	0.0044	0.0019

DISCUSSION

During the embryonic development of *Emerita holthuisi* water content increased from 74.79% in the egg stage I to 82.82% in zoea I. A net increase of 6.68% in the water content of the egg from stage I to III was reflected from the increase in egg diameter from 1.2 mm to 1.8 mm. This agrees with the findings of Needham and Needham (1930) who recorded 20.4% increase in water content in *Emerita analoga*. Such an increase is probably a common feature of developing crustacean eggs (Pandian & Schuman, 1967; Pandian 1967).

While the protein content of the eggs of *E. holthuisi* was found to be higher than the reported values for other crustaceans such as *Eupagurua barnhardus* (Pandian & Schuman, 1967), *Crangon crangon* (Pandian, 1967), *Homarus gammarus* (Pandian, 1970a) and *Ligia oceanica* (Pandian, 1972), the lipid content was found to be relatively low. This feature was similar to that observed in *Macrobrachium idella* (Sumitra & Easterson—In Press).

The primary source of energy for the development of *E. holthuisi* was protein oxidation. Of the total 0.0344 cal. lost during the development, 74% (5.31 µg protein or 0.0222 cal) was supplied by protein and 23% (0.72 µg or 0.0068 cal) by lipid and 4% (0.32 µg or 0.0013 cal) by carbohydrate. This is similar to the findings reported for *M. idella* (Sumitra & Easterson—In Press.) During the development of a number of marine crustaceans lipid is the main source of energy: 66.6% of energy is from lipid in *E. barnhardus* (Pandian & Schuman, 1967), 66.4% in *C. crangon* (Pandian, 1967), 87.7% in *H. gammarus* (Pandian, 1970a) and 80.9% in *L. oceanica* (Pandian, 1972). The present findings support the concept of Needham (1950) that in aquatic animals, the source of energy for the development comes from the oxidation of protein.

In *E. holthuisi* gross efficiency was 46.15% and the energy loss was 53.85%. The data of Pandian (1967, 1970a, & b & 1972) and Pandian and Schuman, (1967) were used for calculating the gross efficiency and energy loss in different

TABLE III — Percent Gross Efficiency and Energy Loss in Some Marine Crustaceans during Embryonic Development

Species	Gross Efficiency	Energy Loss	Reference
1. <i>Eupagurus barnhardus</i>	83.94	16.06	Pandian & Schumann (1967)
2. <i>Crangon crangon</i>	82.05	17.95	Pandian (1967)
3. <i>Homarus americanus</i>	64.68	35.32	Pandian (1970b)
4. <i>Homarus gammarus</i>	85.62	14.38	Pandian (1970a)
5. <i>Ligia oceanica</i>	97.96	2.04	Pandian (1972)
6. <i>Macrobrachium idella</i>	44.00	56.00	Sumitra & Easterson (In press)
7. <i>Emerita holthuisi</i>	46.15	53.85	Present work

marine crustaceans and these values together with the present values are given in Table III. It is evident from this table that these values differ widely. These differences are important in crustaceans as they indicate the capacity with which the stored food is utilised.

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