J. Mar. Biol. Ass. India, **49** (1) : 100 - 102, January - June 2007

Note

Metabolism in the baby clam *Marcia opima*

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Abstract

Oxygen consumption and ammonia excretion in different size groups of clam, *Marcia opima* collected from Tuticorin Bay in Tamil Nadu was studied. Oxygen: Nitrogen ratio was calculated by using atomic equivalents and ranged between 133 - 175 for small, 97 – 117.2 for medium and 63.5 – 75.8 for large clams on day one. After day 3, the range was 238.4 – 282.1, 160.9 – 189 and 100 - 137.5 respectively. During starvation, a decline in excretion rate has been observed, which can be proposed as an index of stress. The study supports interaction of oxygen consumption and nitrogen excretion, which can provide a better understanding of the oxidative and nitrogen metabolism in the clam.

Exogenous factors such as temperature, salinity, humidity and dissolved oxygen, and endogenous factors such as body size, activity, gametogenic stage and sex, and also interaction of all these could affect the metabolic energy expenditure in marine invertebrates (Newell and Bayne, 1973). Oxygen consumption by molluscs had earlier been explained by Bayne (1973), Mace and Ansell (1982) and Strickle and Bayne (1982). This aspect has been studied in relation to temperature and body size at low salinity and low tide under starvation by Deshmukh (1979) in the clam *Meretrix meretrix*. Investigators such as Paine (1971) and Bayne (1976) have detailed nitrogen excretion in molluscs. Excretion rates of molluscs have been known to be a function of body size (Emerson, 1969), temperature (Bayne and Scullard, 1977), physiological state (Widdows and Shick, 1985), environment of the organism (Feng *et al*., 1970) or season (Navarro and Torrijos, 1994).

Proteins ingested through food are hydrolysed in the digestive system to amino acids by proteolytic enzymes. These amino acids are then accumulated for carbon and nitrogen catabolism. The energy content of excreta is significant in total energy loss. Nitrogenous excreta form a majority in excretory loss, the composition of which varies among species as a result of environmental conditions. Ammonia is assumed to be the dominant end product of protein metabolism in most marine molluscs. Bayne (1976) reported that ammonia comprises 60% to 90% of total measured nitrogen in a variety of bivalves. Bayne and Scullard (1977) reviewed that primary amines comprise a significant component of total measured nitrogen in certain bivalves.

Information on the O: N ratio of marine molluscs from India is scanty. The ratio of atomic equivalents of oxygen consumption to nitrogen excretion can provide indices of the balance in animal tissues between the rates of catabolism of proteins, carbohydrate and lipid substrates. Howkins *et al.* (1986) studied this in *Perna viridis* and *P. indica* from Cochin waters where impact of eutrophication is pronounced. Variation in this ratio due to heavy metal stress was reported by Mathew and Menon (1993) in *P. indica* and *Donax incarnatus*. Yennawar (1997) and Patare (1998) also reported this ratio in the oyster *Saccostrea cucullata* and *Meretrix meretrix* respectively. The present study is to determine O:N ratio for different size groups of baby clam, *Marcia opima* from Tuticorin Bay, Tamil Nadu and also makes an attempt to understand the effect of starvation on the same.

Materials and methods

Thirty clams collected from the Tuticorin Bay were washed and divided into three size groups of shell length, *viz.*, small (13 to 23 mm), medium (28 to 35 mm) and large (41 to 46 mm). Each group comprised of 10 animals. The length and weight of each clam were measured. Ten closed respiratory chambers of one –litre capacity each with an inlet and outlet were used for determination of oxygen consumption of individual clam. They were kept in continuous flow of filtered seawater inside the chamber so that the clams would open their valves. Once they opened their valves, the flow of water was stopped and sample of seawater was drawn for determination of initial oxygen content and ammonia. After one hour, 100 ml of water was drawn from the chamber to determine the oxygen content and 50 ml was collected and processed for the analysis of ammonia by Phenol-hypochlorite method (Zolorzono, 1969).

The oxygen consumption and ammonia excretion were determined. O: N ratio was calculated following the method of Widdows and Johnson (1988). The mean values for ten clams of each group were used for statistical analysis. The estimation of the same was made again after three days of starvation under normal laboratory conditions. Water was changed daily and constant aeration was provided.

Results

The rate of oxygen consumption of the small, medium and large specimens, on day one ranged from 0.266 to 0.392, 0.163 to 0.225 and 0.061 to 0.091 ml/g/h respectively. But on day 3, the ranges were 0.572 to 0.722, 0.296 to 0.398 and 0.122 to 0.147. The rate of ammonia excretion of the individuals on day one ranged from 2.5 to 3.00, 2.1 to 2.4 and 1.2 to 1.5 and after day 3, from 3.00 to 3.2, 2.3 to 2.5 and 1.4 to 1.7 μg/l/g/h. The calculation of O:N ratio after determining the atomic equivalents of oxygen and nitrogen were 133 - 175 for small, 97 – 117.2 for medium and 63.5 – 75.8 for large clams after day one and 238.4 – 282.1, 160.9 – 189 and 100 to 137.5 after day 3.

The Pearson product moment correlation between shell length or body weights and O: N ratio for *M. opima* was determined. The ratio on day one showed significant relationship with the shell length of small clams ($P<0.05$, $r= 0.712$). The same was not significant with the shell length of the medium ($P<0.05$, $r= 0.394$) or large sized clams ($P<0.05$, $r= 0.323$). A similar result was obtained after day 3, when the shell length of small sized clams showed significant relationship ($P<0.05$, $r= 0.805$). When the ratio was calculated against weight, only small sized clams showed significant correlation on day one ($P<0.05$, $r= 0.719$) and after three days ($P<0.05$, $r= 0.775$).

Discussion

From the present experiments it was observed that both oxygen consumption and ammonia excretion were higher in small clams than the medium or large ones, possibly explaining their reliance on carbohydrate and protein metabolism. The O: N ratio increased in the experimental animals after starvation. Bayne (1973) reported that the effect of starvation interact with the seasonal changes. Small individuals with a relatively small glycogen reserve increase their protein catabolism considerably during starvation, whereas larger ones to a greater extent depend on their relatively large glycogen reserve. The author also noted that changes in the O:N ratio had correlated reasonably with gross biochemical changes in the tissue in *Mytilus edulis* due to starvation. The energy utilized in oxygen consumption and ammonia excretion was significantly different depending on the season and temperature. Seasonal changes could affect the overall fitness of the animal (Navarro and Torrijos, 1994).

Metabolic rate is strongly dependent on body size. Weight specific metabolic rate is lower in large organisms than small ones since the energy flow through the latter is high. Populations that are dominated by large or old individuals show a lowest oxygen consumption values than those comprised of small individuals. Bayne (1976) reported that body size and metabolic rate in bivalves are interrelated. Weight specific oxygen consumption of *M. opima* followed a general trend of acceptance showing higher values for small sized clams than large sized specimens.

Changes in the rates of nitrogen excretion are best understood in the context of physiological energetics and nitrogen balance when related to overall metabolic rate by means of the O:N ratio. This, when calculated by atomic equivalents, may be used to express the proportion of protein catabolised compared to carbohydrate and lipid. A low value (~ 10) signifies considerable protein metabolism. According to Bayne (1976), the theoretical minimum for the O:N ratio is about 7, signifying unequal protein catabolism. Higher values indicate increased catabolism of carbohydrate or lipid. A considerable variation was reported in *Mytilus* with respect to size and the complex interaction with seasons and temperature (Bayne and Scullard, 1977). The increase in the ratio for *M. opima* of various sizes after starvation stress and the differences noticed between individual size groups at the significant level (statistical) could be due to the state of gonadal development and level of metabolic activity. Further study is needed to evaluate the seasonal variation in the O: N ratio amongst clams of different sizes.

Acknowledgements

The author is grateful to the Director, Central Marine Fisheries Research Institute, Cochin, for providing the facilities to carry out the study. The financial support given by the Central Institute of Fisheries Education, Mumbai, is greatly acknowledged.

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Received: 26 April 2007
Accepted: 8 July 2007