Size dependent variation in the rate of oxygen consumption, ammonia excretion and O:N ratio of freshwater bivalve, *Indonaia caeruleus* from Yedgaon Dam during monsoon season (M.S.) India

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**ABSTRACT**

Study O: N ratio in freshwater bivalve molluscs, *Indonaia Caeruleus* is reported here by considering the size dependent variation. Freshwater bivalve molluscs were collected from the banks of Kukadi River at Yedgaon dam, near Junnar (Pune). The freshwater bivalves with two different size i.e. small (46-50 mm shell length) and large (56-60mm in shell-length) were collected for determination of changes in the rate of oxygen consumption, rate of ammonia excretion and O:N (oxygen : nitrogen) ratio, during monsoon on July and August. The small size bivalve showed high values of O:N ratio than that of large sized one. The results are discussed in the light of metabolic processes in freshwater bivalve molluscs.

**Key words** - Ammonia excretion, *Indonaia Caeruleus*, oxygen consumption.

**INTRODUCTION**

The O:N ratio is an index of protein utilization in energy metabolism. This ratio is also useful for assessing the relative contribution of protein catabolism [1]. The respiration rates could be used to evaluate mussel stress and over all fitness of animal for survival and reproduction.
The body size of the bivalve mollusc is an important parameter for influencing the pattern of metabolic responses. The relationship between the rate of ammonia excretion and the body size can be variable due to a disproportionate reliance of protein catabolism for energy production in bivalve molluscs. Regulation of chemical composition of the body fluid is an important function of the ionic and somatic regulation and of excretion. This helps in the elimination of waste and conservation of useful metabolites for growth, maintenance and reproduction. Bayne and Scullard [3] reported that amount of nitrogen loss as amino acids relative to ammonia varied with season as well as location site of collection. In bivalve molluscs, several workers have studied nitrogenous excretory products and their reports revealed that, ammonia is the dominant products and large amount of amino-nitrogen are lost in excretion. Segawa [4] observed that, increased oxygen consumption and ammonia excretion is linear with increase in weight and decreases with period of starvation in abalone sulculus diversicular. Gonzalo and Cancino [5] reported that, oxygen conception and ammonia excretion of bivalve Guimordia bahamondei is a function of body weight.

According to Barkai and Griffiths [6], 63% of energy content of the food consumed was lost as faces and 32% expended on respiration in abalone. Navarro and Torrijos [7] reported that, energy utilized in oxygen uptake and ammonia excretion was depending on the season and temperature of the water body. A number of investigator have studied oxygen consumption and ammonia excretion according to envirmental factors, turbidity [8], size [9], time [10] and growth [11]. Howkins et al. [12] reported O:N ratio on Perna Viridis and Perna indica from Cochin backwaters. Mathew and Menon [13] reported heavy metal stress induced variation in O:N ratio in Perna indica and Donax incarnates.

Review of literature revealed that, very little information was available on fresh water bivalve molluscs from India. By considering the abundant distribution of bivalve molluscs along the banks of kukadi river and paucity of information on O:N in fresh water bivalves, the present study was undertaken on Indonania caeruleus.

**METHODOLOGY**

During monsoon (July - August) freshwater bivalve molluscs, Indonania caeruleus were collected from banks of Kukadi river at Yedgaon. Animals with two different shell length i.e. small size (46-50mm shell length) and large size (56-60 mm shell length) were selected. After collection, bivalves were brought to the laboratory immediately. In order to remove the algal biomass, mud and other waste materials, the shells of the animals were brushed and washed with freshwater. The cleaned animals were divided into two size group's viz. small size (45-52) and large size (57-64 mm) according to their shell length. Each group comprises 15 animals. Then, they were allowed to defeation and depuration for 12-13 hrs (not acclimatization) in laboratory conditions, under constant aeration.

The physico-chemical parameters of water i.e. Temperature, pH, hardness and dissolved oxygen contents were also measured. The rate of oxygen consumption of individual animal was determined according to Wrinkler’s modified method [14]. For determination of oxygen consumption of individual bivalve, four closed respiratory jars 1.0 litre capacity each with an inlet and outlet were used. In order to open their valves, they were kept in continuous circulation of water inside the chamber. After opening their valves, the flow of water was cut off. A sample of water from it was drawn for determination of oxygen consumption and ammonia excretion. After one hour, 50 ml of sample water from the chamber was drawn to find out the oxygen content. At the same time 10 ml of the sample water from the chamber was also drawn and processed for analysis of ammonia according to phenol-hypochloride method suggested by Solorzano, [14]. Data on oxygen consumption, ammonia excretion and O:N ratios were calculated for each individual bivalve used in this experiments, by dividing its oxygen consumption rate in moles O and by its ammonia excretion rate in moles N [15-16]. The mean values of four individual bivalves from each group were used for statistical analysis. Rate of oxygen consumption of individual bivalve represented mg O2/l/h/gm body weight and rate of ammonia excreted represented mg NH3-N/l/h body weight.
RESULTS AND DISCUSSION

The physico-chemical characteristics of the habitat water were temperature 26.5˚C - 29.5˚C on July and 25.5˚C - 28.0˚C on August, pH 8.08 - 9.27 on July and 8.78 - 8.83 on August. Hardness of water is 104 - 115 ppm on July and 97 - 111 ppm on August and dissolved oxygen 6.870 - 7.300 mg /l/h on July and 6.980 - 7.280 mg /l/h on August during monsoon season.

The rate of oxygen consumption during monsoon was found maximum in small sized animal as compared to large sized animal. It was found to be to be (0.7275 ± 0.0866 mg/l/h) on July and on August it was (0.7525± 0.0486 mg/l/h) in small animals. While in large sized animal oxygen consumption was found to be (0.5625 ± 0.0117 mg/l/h) on July and on August it was (0.5628 ± 0.0063 mg/l/h).

The rate of ammonia excretion was found maximum in large sized animal as compared to small sized animal, during monsoon .On July it was found to be (0.0119 ± 0.0006 μg NH₄-N/l/h) and on August it was (0. 0140 ± 0.0003 μg NH₄-N/l/h) in small sized animal. While in large sized animal it was (0.0186 ± 0.0010 μg NH₄-N/l/h) on July and on August it was (0. 0158 ± 0.0007 μg NH₄-N/l/h).

The calculation of O: N ratio revealed high values in small sized animals than large sized one during monsoon on July and on August. On July, the O:N ratio was found to be (53.5740 ± 4.1653) and on August it was (48.3229 ± 2.9219) in small sized animals. And in large sized animals the O: N ratio was (26.5243±1.7791) on July and on August O: N ratio was (31.2318 ± 1.6214).

Table 1: Size dependent variation in the rate of oxygen consumption, rate of ammonia excretion and O:N ratio of freshwater bivalves, *Indonaia caeruleus*, during monsoon season

<table>
<thead>
<tr>
<th>Month</th>
<th>Size</th>
<th>Specific Group</th>
<th>Animal No.</th>
<th>Body Size (mm)</th>
<th>Body weight (gms)</th>
<th>Oxygen consumption ml/lit/hr</th>
<th>Oxygen consumption mg/lit/hr</th>
<th>Ammonia excretion mg-NH₄-N/L</th>
<th>Atomic equivalent of oxygen</th>
<th>Atomic equivalent of ammonia</th>
<th>O: N ratio</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Small size</td>
<td>1</td>
<td>50</td>
<td>7.821</td>
<td>0.5795</td>
<td>0.8275</td>
<td>0.0125</td>
<td>0.0517</td>
<td>0.00809</td>
<td>58.0898</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>47</td>
<td>7.228</td>
<td>0.4738</td>
<td>0.6765</td>
<td>0.0113</td>
<td>0.0422</td>
<td>0.00800</td>
<td>52.7500</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>46</td>
<td>7.204</td>
<td>0.4752</td>
<td>0.6785</td>
<td>0.0120</td>
<td>0.0424</td>
<td>0.00805</td>
<td>49.8823</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Large size</td>
<td>4</td>
<td>47</td>
<td>7.227</td>
<td>0.5640</td>
<td>0.8053</td>
<td>0.0138</td>
<td>0.0503</td>
<td>0.00998</td>
<td>51.3265</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>49</td>
<td>7.702</td>
<td>0.5202</td>
<td>0.7428</td>
<td>0.0144</td>
<td>0.0464</td>
<td>0.00102</td>
<td>45.4901</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>50</td>
<td>7.805</td>
<td>0.4968</td>
<td>0.7094</td>
<td>0.0138</td>
<td>0.0443</td>
<td>0.00092</td>
<td>48.1521</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Small size</td>
<td>1</td>
<td>58</td>
<td>9.560</td>
<td>0.3951</td>
<td>0.5642</td>
<td>0.0150</td>
<td>0.0352</td>
<td>0.00107</td>
<td>32.8971</td>
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</tr>
<tr>
<td></td>
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<td></td>
<td>2</td>
<td>59</td>
<td>9.803</td>
<td>0.3894</td>
<td>0.5600</td>
<td>0.0165</td>
<td>0.0347</td>
<td>0.00117</td>
<td>29.6858</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>57</td>
<td>8.491</td>
<td>0.3981</td>
<td>0.5684</td>
<td>0.0160</td>
<td>0.0355</td>
<td>0.00114</td>
<td>31.1403</td>
<td></td>
</tr>
</tbody>
</table>

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The results of the experiments were shown in Table-1.

DISCUSSION

The rate of oxygen uptake was increased in small sized bivalves, as compared to large sized ones during monsoon season. While the ammonia excretion rate was found more increased in large sized bivalves as compared to small sized ones on July and August during monsoon seasons. Increased in the rate of oxygen uptake in small sized animals is due to small size relatively with small glycogen reserves. This increases considerably their protein catabolism, whereas larger ones with large size having large glycogen storage [17]. The metabolic rate is strongly dependent on body size. It is known that weight specific rate of oxygen consumption is lower in larger organisms than in smaller ones. This generalization applies in both intra- species as well as inter-species bivalve molluscs of different sizes. In the present study on Indonaia caeruleus, the size specific oxygen consumption followed a general trend of acceptance i.e. smaller sized bivalve shows higher values of oxygen consumption than larger one. Mane [19] and Bayne [20] revealed that, body size in bivalves is important factor. Hence older and large bivalves have a lowest value than those of small individuals. It is known the oxygen uptake was mainly dependent on reproductive condition of bivalves during monsoon season, hence, the rate of oxygen consumption showed significant increase in smaller sized bivalve particularly during monsoon.

The energy utilization in oxygen consumption and ammonia excretion was significantly different which depending on size, season and temperature, but season being important factor which affect the overall fitness of the animal [6]. Many authors have shown that, in bivalve major nitrogenous excretory product is ammonia. A profound difference occurs in loss of nitrogen between different sizes and seasons [20,21]. In the present study on Indonaia caeruleus, the rate of ammonia excretion is more in large sized bivalves on July and August during monsoon seasons, because small size bivalves catabolise different biochemical substrates to varying degrees, according to season [22]. The O:N ratios can provide indices of balance in animal tissues between the rate of catabolism of protein, carbohydrate, and lipid substrates. This ratio may be used to indicate the proportion of protein catabolised to carbohydrates and lipids. Higher value of O:N ratio indicates increased catabolism of carbohydrates or lipids. The increase or decrease of O:N ratio in bivalves of different sizes, could be due to the state of a gonadal development and level of metabolic activity of the bivalve molluscs. .

CONCLUSION

From this study it was concluded that, the rate of ammonia excretion in Indonaia caeruleus was found to be depleted in small sized bivalves as compared to large sized bivalves particularly on July and August of monsoon seasons. It was found to be weight specific and also dependent upon physiological state of the
organism. The rate of oxygen consumption of *Indonaiia caeruleus* showed seasonal patterns as well as the reproductive activity of the animal. Low rate of oxygen consumption was observed during monsoon in small and large sized bivalves. The rate of ammonia excretion in *Indonaiia caeruleus* was found to be depleted in small sized bivalves as compared to large sized bivalves particularly on July and August of monsoon seasons. It was found to be weight specific and also dependent upon physiological state of the organism. The O:N ratio shows higher value in small sized bivalve than that of larger ones.

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