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Habitat Dependent Variations in The Rate of Oxygen Consumption, Rate of Ammonia Excretion and O: N Ratio of Freshwater Bivalve, *Lamellidens marginalis* From Lotic and Lentic Water of Godavari River at Paithan, During Summer.

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Abstract: Considering the site (habitat) specific variations in the metabolic activities in the freshwater bivalves, we reported here the changes in the rate of oxygen consumption, rate of ammonia excretion and O: N ratio in the freshwater bivalve mollusc, *Lamellidens marginalis (*Lamark) from lotic and lentic water habitats on April-May during summer season. The adult freshwater bivalves, *Lamellidens marginalis* (82-84 mm shell length) from lotic and lentic water near Jayakwadi dam on Godavari river was selected for determination of rate of oxygen consumption, rate of ammonia excretion and O: N ratio. The adult bivalves from lotic water habitat showed high rate of oxygen consumption and low rate of ammonia excretion. The O: N ratio showed higher values in bivalves collected from lotic water than lentic water during summer season.
The results of study are discussed in the light of possible physiological processes in freshwater bivalve molluscs.

Keywords: Oxygen consumption, Ammonia excretion, O: N ratio, Habitat specificity, Freshwater, bivalve, *Lamellidens marginalis*

1 Introduction

The location and meteorological conditions has profound effect on the metabolic activities in all organisms. Relatively very few habitats affect the animals with constant environmental conditions, especially temperature. In response to this relativity, the animal at all levels of habitats changes its physiology by developing a mechanism to meets the normal ecological factors. Temperature rise on specific habitat above the optimum requirement can affect the physiology of bivalves (Bayne, 1976). One major reason for changes in the metabolic activities often used is the rate of oxygen consumption, which is affected by food availability and water temperature. The animals from different habitats experiences

different environment conditions. At given point of time at specific habitat, the factors like temperature, transparency of water, nutrient load, biomass of autotrophs affect the metabolic activities of the bivalves.

The O: N ratio is an index of protein utilization in energy metabolism and it is an important tool useful for assessing the relative contribution of protein catabolism (Bayne and Widdows, 1978). It provides an indication of the relative catabolic balance between carbohydrates, lipid and protein and it has been used to describe physiological state of bivalve molluscs (Bayne and Scullard, 1977 and Widdows, 1978). In mussel, individuals with O:N ratio greater than 50 are considered physiologically "healthy" while individuals with ratio less than 30 are considered under "stress" and they catabolize internal protein (Bayne et.al., 1985). The habitat of the bivalve molluscs is an important parameter which influencing the pattern of metabolic responses. In bivalve molluscs, the relationship between habitat and oxygen consumption, ammonia excretion and O: N ratio can be variable due to a disproportionate reliance of protein catabolism for energy production. In aquatic animals, particularly in bivalve molluscs, regulation of chemical composition of waste and osmotic conservation of useful metabolites for growth, maintenance and reproduction is very important. In bivalve molluscs, several workers have studies nitrogenous excretory product and their reports revealed that ammonia is the dominant product and large amount of amino-nitrogen are lost (Bayne, 1976). Segava (1991), observed that increased oxygen consumption and ammonia excretion linear with increase in weight and decrease with period of starvation in abalone *Sulculus diversicolor*. According to Ganzalo and Cancino (1988), oxygen consumption and ammonia excretion in bivalve is a function of the body weight. According to Barkai and Griffths (1988) in abalone, 63% of energy content of the food consumed was lost as faeces and 32% expenditure on respiration. Energy losses in the form of ammonia excretion were negligible. While, Navarrow and Torrijos (1994) reported that, energy utilized in oxygen uptake and ammonia excretion was depending on the season, habitat, temperature and ration. Proteins ingested through food are hydrolyzed in the digestive system to their constitutive amino acids by proteolytic enzymes. This amino acid then accumulated for carbon and nitrogen catabolism. A number of investigators have studied oxygen consumption and ammonia excretion, according to environmental factors, that is turbidity (Grants and Thorpe, 1991), size (Bhagde and Mane, 2005), time (Vitale and Friedl, 1984), growth (Bacon and MacDonald, 1991).

Review of literature revealed the very little information is available on habitat related variations in rate of oxygen consumption, ammonia excretion and O: N ratio from freshwater bivalve molluscs from India. The Howkins *et al.,* (1986) reported O:N ratio in *Perna viridis* and *Perna indica* from Cochin backwaters and Mathew and Menon (1993) reported heavy metal stress induced variation in O:N ratio in *Perna indica* and *Domax incarnates*. Considering the abundant distribution of bivalve molluscs from both the habitats near Jayakwadi dam on Godavari River at Paithan and paucity of information on O:N ratio in relation to habitats in freshwater bivalves, the present study was undertaken on *Lamellidens marginalis* during summer season.

2 Materials and Methods

The freshwater bivalve molluscs, *Lamellidens marginalis (*Lamark) of 82-84 mm in shell – length were collected from lotic and lentic habitats separated by distance 9 km. away from each other's near Jayakwadi dam on Godavari River at Paithan 45km. away from Aurangabad during summer season. The animals collected from both geographically different habitats were selected for experiment. Immediately, they were brought to

the laboratory, the shells of the animals were brushed and washed with freshwater in order to remove the algal biomass, mud and other waste materials. The cleaned animals were divided into two groups. Each group comprises 10 animals. The animals from both the groups were allowed from for defaeciation or depuration for 12 to 13 hours in laboratory conditions under constant aeration. The physico – chemical parameters of water that is temperature, pH, and hardness and dissolved oxygen contents were also measured.

The rate of oxygen consumption of individual animal was determined according to Winkler's modified technique (Golterman *et al.,* 1978). Four closed respiratory jars of 1 liter capacity each with an inlet and outlet were used to measurement of oxygen consumption of individual bivalve. They were kept in continuous circulation of water inside the chamber in order to open there valves. Once they opened their valves, the flow of was stopped and sample of water from each jar was drawn for determination of oxygen consumption and ammonia excretion. After one hour, 50 ml of sample of water from the chamber was drawn to find out the dissolved oxygen content. At the same time 10 ml of sample from each jar was also drawn and processed for analysis of ammonia by according to Phenol- hypochlorite method suggested by Solórzano (1969). To integrate the data oxygen consumption and ammonia excretion and O: N ratio was calculated for each individual bivalve used in these experiments by dividing its oxygen consumption rate in moles O_2 and by its ammonia excretion rate in moles N (Widdows, 1978 and Bayne and Newell, 1983).

The mean values of four individual animals from each group were used for statistical analysis. Rate of oxygen consumption bivalve represented mg O_2 per hour per gram body weight and rate of ammonia excretion represented µ NH_3-N per hour per gram body weight.

3 Results and Discussion

The physico-chemical characteristics of the water on lotic habitat were temperature 28.5^0 C to 29.5^0 C; pH 7.68 to 7.79, hardness 118 to 125ppm and dissolved oxygen content 5.68 to 6.39 ml/lit /hr. and lentic habitat were temperature 30.0^0 C to 31.0^0 C, pH 7.6 to 7.9, hardness 85 to 90 ppm and dissolved oxygen content 6.9918 ml/lit/hr. The results of the experiments were shown in Table-1.

The rate of oxygen consumption of individual animal collected from lotic and lentic habitats were ranged from 0.2679 to 0.3119 ml/l/h/gm. and 0.2371 to 0.2853 ml/l/h/gm. respectively. The ammonia excretion of individual animal from lotic habitat was ranged from 2.8 to 3.2 µg NH_3-N/l/h. and from Lentic habitat was 3.6 to 3.8 µg NH_3-N/l/h. during summer season. The calculations of ratio of oxygen consumption to Nitrogen release (O: N ratio) after determining the atomic equivalent of oxygen and nitrogen were ranged from 116.91 to 121.2 in lotic water and from 80.346 to 97.923 in lentic water animals.

The values of rate of oxygen consumption were 0.4190 ± 0.02959mg O_2/l/h/gm. in bivalve from lotic habitat and 0.3708 ±0.03245mg/l/h/gm in bivalves, from lentic habitat. The rate of ammonia excretion in bivalve collected from lotic water and lentic water habitat were 3.075 ±0.1893 µg NH_3-N/l/h/gm. and 3.701 ±0.0816 µg NH_3-N/l/h/gm respectively. The O: N ratio showed higher values 119.056 ±1.7559 in animals collected from lotic water and lower values 89.252 ±9.2515 from lentic water habitats in bivalves.

The present study on fresh water bivalve mollusc, *Lamellidens marginalis* collected from two ecologically different habitats that are lotic and lentic water revealed that, the rate of oxygen consumption found more in bivalve collected from lotic water habitat at which possibly showed reliance of mussels on carbohydrates and protein metabolism. In the effect of habitat dependent variations, the rate of oxygen uptake increases in bivalves

collected from lotic water habitat due to high temperature of flowing water, small glycogen reservoir increase considerably their protein catabolism (Bayne, 1973).

Table-1 Habitat specific changes in the rate of oxygen consumption, rate of ammonia excretion and O: N ratio of *Lamellidens marginalis* from lotic and lentic environment near Nathsagar Dam during summer season.

Habitat of the animals	Animal number	Weight of animals (gms)	Oxygen consumption (ml/l/h/gm)	Oxygen consumption (mg/l/h/gm)	Ammonia excretion ($mgNH_3$-N/l/h)	Ammonia excretion (μgNH_3-N/l/h)	Atomic equivalent of Oxygen	Atomic equivalent of ammonia	O:N ratio
Lotic habitat	I	13.216	0.3073	0.4388	0.0032	3.2	0.02742	0.00023	119.21
	II	14.080	0.2883	0.4116	0.0031	3.1	0.02572	0.00022	116.91
	III	14.964	0.2679	0.3804	0.0028	2.8	0.02378	0.00020	118.90
	IV	13.800	0.3119	0.4453	0.0032	3.2	0.02783	0.00023	121.2
				0.4190 ± 0.02959		3.075 ± 0.1893			119.056 ± 1.7559
Lentic habitat	I	13.064	0.2488	0.3552	0.0038	3.8	0.0222	0.00027	82.22
	II	14.227	0.2853	0.4074	0.0037	3.7	0.02546	0.00026	97.923
	III	12.021	0.2705	0.3862	0.0036	3.6	0.02413	0.00025	96.52
	IV	14.380	0.2371	0.3342	0.0037	3.7	0.02089	0.00026	80.346
				0.3708 ± 0.03245		3.701 ± 0.0816			89.252 ± 9.2515

The rate increases in shell valve activity because the oxygen consumption is proportional to ventilation and shell valve activity has been noted by several authors (Galtsoff, 1964). Many authors have shown that the ammonia in general is a major nitrogenous excretory product of bivalve and there occurs profound difference in loss of nitrogen between different habitats and seasons (Mahale, 2009 and Nagwanshi, 1997). The present study showed that the O: N ratio showed increased value in bivalve collected from lotic habitat. The rate of oxygen consumption of individual animal collected from lotic and lentic habitat. The oxygen uptake was mainly dependent on ecological conditions mainly temperature and also on reproductive conditions during summer season.

The energy utilization in oxygen consumption and ammonia excretion was significantly different, depending upon habitat, food, temperature and season. But being food and temperature important factors which affect the overall fitness of the animals (Bayne, 1973). Changes in the O: N ratio correlated

seasonally with gross biochemical changes in tissues (Gabbott and Bayne, 1973).

In the present study on *Lamellidens marginalis* the habitat related rate of oxygen consumption followed a general trend of acceptance that is higher values for bivalves from lotic habitat than lentic. Mane (1975) stated that, ecological conditions on the habitat of bivalve molluscs have important implication. Rate of ammonia excretion found increased in bivalve from lentic habitat, it is understood in index of physiological energetic and nitrogen balance when related to overall metabolic rate by means of O: N ratio. This ratio when calculated by atomic equivalents may be used to indicate the proportion of protein catabolised to carbohydrate and lipid. In *Thias lapillus* (Strickle and Bayne, 1982), the O: N ratio did not alter with size that is exponent for rate of oxygen consumption and ammonia excretion against body weight. However, in *Mytilus edulis*, the O: N ratio varied considerably with habitat and complex interactions with season and temperature (Bayne and Scullard, 1977). Bayne (1976) stated that, if the amino acids which results from proteins catabolism are dominated and the resultant ammonia excreted, carbon skeleton of amino acids are completely oxidized. Higher values of O: N ratio indicates increased catabolism of carbohydrate or lipids.

The increases or decreases of O: N ratio in bivalves on different habitats, noticed that the individual group belong to a specific habitat which showed the significant change could be due to the state of gonadal development and level of metabolic activity of the bivalve molluscs. Further study needed to evaluate habitat specific seasonal variation in the O: N ratio among the bivalve molluscs.

4 Conclusions

In the present study on freshwater bivalve, Lamellidens marginalis collected from both different habitats, showed that the O:N ratio showed increased value in the bivalve collected from lotic habitat. The rate of oxygen consumption of individual animal collected from lotic and also found increased values. The oxygen uptake was mainly dependent on ecological conditions mainly temperature and also on reproductive conditions during summer season. While rate of ammonia release showed decreased values in animals from lotic habitat compared to lentic one. The increased rate of oxygen may be due to temperature difference, with summer animals upto 30% nitrogenous waste is lost as amino acid nitrogen and the remainder as ammonia (Bayne and Scullard,1977).

The O: N ratio (based on atomic equivalents of oxygen and nitrogen) can provide indices of balance in animal tissues between the rate of catabolism of protein, carbohydrate and lipid substances. The changes in the nitrogen excretion (conversion of ammonia) are best

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