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VARIATIONS IN THE RATE OF OXYGEN CONSUMPTION, AMMONIA EXCRETION AND O:N RATIO OF FRESHWATER BIVALVE, *INDONAIA CAERULEUS* (PRASHAD, 1918) IN RELATION TO BODY SIZE DURING SUMMER

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ABSTRACT
Considering the size specific variations in metabolic rates of bivalve shell-fishes we report here the size dependent variation in the O: N ratio in freshwater bivalve molluscs, *Indonaia caeruleus* from the banks of Godavari River at Paithan, near Aurangabad. The freshwater bivalves with specific size *i.e.* small (42-48mm in shell-length) and large (56-63 mm in shell-length) were selected for determination of changes in the rate of oxygen consumption, rate of ammonia excretion and O:N ratio on April and May during summer. The adult bivalves with small size, showed high values of O:N ratio (29.5547 ± 3.7473) on April and (32.2309 ± 3.2949) on May during summer compared to larger sized animals(20.5216 ± 1.2097) on April and (17.5520 ± 2.8302)on May. The values of O:N ratio were found to be greater in large sized bivalves on May during summer season. The results are discussed in the light of metabolic processes in fresh-water bivalve molluscs.

INTRODUCTION

The respiration rates could be used to evaluate mussel stress and over all fitness for survival and reproduction. The O:N ratio is an index of protein utilization in energy metabolism. O:N ratio are useful for assessing the relative contribution of protein to total catabolism (Bayne and Widdows, 1978). The body weight or body size of the bivalve mollusc is an important parameter, which influencing the pattern of metabolic responses. In aquatic animals, particularly in bivalve molluscs, regulation of chemical composition of the body fluid is an important function of the ionic and somatic regulation and of excretion which helps in the elimination of wastes and conservation of useful metabolites for growth, maintenance and reproduction. In bivalve molluscs, several workers have studied nitrogenous excretory products and their reports reveled that ammonia is the dominant products and large amount of amino- nitrogen are lost (Bayne, 1976). Bayne and Scullard (1977) reported that, amount of nitrogen lost as amino acids relative to ammonia varied with season and location of collection. The held in laboratory and the feeding regiment. Segawa (1991) observed increased oxygen consumption and ammonia excretion linear with increase in weight and decreases with period of starvation in *abalone, sulculus diversicolar*. Ganzalo and Cancino (1988) reported that oxygen consumption and ammonia excretion of bivalve is a function of body weight. While, Navarro and Torrijos (1994) reported that, energy utilized in oxygen uptake and ammonia excretion was depending on the season, temperature, rationand physiological status of the animal. A number of investigator have studied oxygen consumption, and ammonia excretion according to enviromental factors, turbidity (Grants and Thorpe, 1991), sized (Bhagde and Mane, 2005), time (Vitale and Friedl, 1984), growth (Bacon and McDonald, 1991).

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

MATERIALS AND METHODS

The freshwater bivalve molluscs, *Indonaia caeruleus* with vary in body size were collected from banks of Godavari of river at Paithan, 45 km away from Aurangabad during summer (April-May). The animals with small (42-48 mm shell length), and large size (56-63 mm shell length) were selected. Immediately after 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 size groups of shell length viz. small (42-48) and large (56 -63 mm). Each group comprises 15 animals. After measuring length, they were only allowed to defecation and depuration for 12-13 hr (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 Wrinklers modified method Golterman *et al.,* 1978). Four closed respiratory jars 1.0 litre capacity each with an inlet and outlet were used to determination of oxygen consumption of individual bivalve. They were kept in continuous circulation of water inside the chamber in order to open their valves. Once they opened their valves, the flow of water was cut off and sample of water from it was drawn for determination of oxygen consumption and ammonia excretion. After one hr, 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 from the chamber was also drawn and processed for analysis of ammonia according to phenol-hypochlorite method suggested by (Solorzano, 1969). To integrate the data on oxygen consumption and ammonia excretion and 0: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 (Widdows, 1978; Bayne and Newell, 1983).

The mean values of four individual bivalves from each group were used for statistical analysis. Rate of oxygen consumption of individual bivalve represented mg O_2/L/h/g body weight and rate of ammonia excreted expressed in mg NH_3-N/L/h body weight.

RESULTS AND DISCUSSION

The results of the experiments were shown in Table 1. The physico-chemical characteristics of the water on the habitat were temperature, 29.0º-30.0ºC on April and 29.5º-32.5ºC on May, pH,8.2-8.6 on April and 7.97-8.14 on May, water hardness 88-100 ppm on April and 97-108 ppm on May and dissolved oxygen 6.156 mL /L/h on April and 6.483 mL /L/h on May during summer season. The rate of oxygen consumption of individual animal in small size (42-48 mm shell length) and in large size (56-63 mm shell length) were ranged from 0.4982-0.5807 mL O_2/L/h (on April), 0.5284-0.6391 mL O_2/L/h (on May) and in large size were ranged from 0.2978-0.3658 mL O_2/L/h (on April), 0.2815-0.3212 mL O_2/L/h (on May), during summer season. The ammonia excretion of individual animal were ranged from 2.1-2.6 μg NH_3-N/L/h (on April) and 1.9-2.4 μg NH_3-N/L/h (on May) in small size and 1.8-2.2 μg NH_3-N/L/h (on April) and 1.8-2.4 μg NH_3-N/L/h (on May) in large sized animal during summer season. The calculations of O:N ratio after determining the atomic equivalent of oxygen and nitrogen were ranged from 29.5547-32.2309 in small and 17.5520-20.5216 in large sized animal. The values of rate of oxygen consumption were 0.7732 ± 0.0492 mg O_2/L/h (on April) and 0.8297 ± 0.06936 mg O_2/L/h (on May) in small sized bivalve and 0.4666 ± 0.03918 mg O2/L/h in (on April) and 0.44 ± 0.02662 mg O_2/L/h (on May) in large sized bivalves. The rate of ammonia excretion in small and large sized animal were 0.02306 ± 0.00236 μg NH_3N/L/h (April), 0.02267 ± 0.002458 μg NH_3-N/L/h (May) in small sized and 0.01995 ± 0.0021 μg NH_3-N/L/h (April), 0.02222 ± 0.002515 μg NH_3-N/L/h (May) in large sized animals respectively. The O:N ratio showed higher values 29.5547 and 32.2309 on (April and May) respectively in small sized bivalve and lower values 17.5520 and 20.5216 on (April and May) respectively in large sized

Table 1: Size specific changes in the rate of oxygen consumption, ammonia excretion and O:N ratio in fresh water bivalves *Indonaia caeruleus* on during summer season

Month	Animal No.	Size of the animals (mm shell length)	Weight of the animals (g)	Oxygen consumption (mL O_2/L/h)	Oxygen consumption (mg O_2/L/h)	Ammonia excretion (mg. NH_3-N/ L/h)	Ammonia excretion (mg. NH_3-N/ L/h)	Atomic equivalent of Oxygen	Atomic equivalent of Nitrogen	O:N ratio
April	I	44	6.750	0.5482	0.7828	0.0026	2.6	0.0493	0.000191	26.5053
	II	45	6.260	0.5348	0.7636	0.0023	2.3	0.0477	0.00017	28.0558
	III	48	7.200	0.4982	0.7114	0.0021	2.1	0.0444	0.000155	28.648
	IV	44	5.980	0.5807	0.8292	0.0020	2.0	0.0518	0.000148	35.00
					0.7732		2.25			29.5547
					$\pm$0.0492		$\pm$0.2645			$\pm$3.7473
	I	56	8.200	0.3497	0.4993	0.0021	2.1	0.0312	0.00015	20.8066
	II	58	9.400	0.3217	0.4594	0.0018	1.8	0.0287	0.00013	22.0769
	III	58	9.475	0.3658	0.4938	0.0022	2.2	0.0308	0.00016	19.2875
	IV	61	10.370	0.2978	0.4142	0.0018	1.8	0.0258	0.00013	19.9154
					0.4666		1.975			20.5216
					$\pm$0.03918		$\pm$0.2061			$\pm$1.2097
May	I	42	5.980	0.6391	0.9126	0.0022	2.2	0.0570	0.00016	35.6444
	II	44	6.810	0.5998	0.8565	0.0024	2.4	0.0535	0.000175	30.3885
	III	46	7.100	0.5284	0.7545	0.0019	1.9	0.0471	0.000137	34.2307
	IV	46	7.080	0.5569	0.7952	0.0024	2.4	0.0497	0.000175	28.46
					0.8297		2.225			32.2309
					$\pm$0.06936		$\pm$0.2362			$\pm$3.2949
	I	60	9.540	0.3212	0.4586	0.0023	2.3	0.0288	0.00017	16.8588
	II	62	9.610	0.3008	0.4581	0.0018	1.8	0.0286	0.000135	21.2074
	III	63	11.270	0.2815	0.4019	0.0024	2.4	0.0251	0.000175	14.3485
	IV	58	9.060	0.3019	0.4414	0.0021	2.1	0.0275	0.000155	17.7935
					0.44		2.15			17.5520
					$\pm$0.02662		$\pm$0.2645			$\pm$2.8302

bivalves during summer season.

In the present study on freshwater bivalve molluscs, *Indonaia caeruleus*, the rate of oxygen uptake was increased in small sized bivalves, compared to large sized ones, during summer. The rate of ammonia excretion also found more increased on April and May in large sized bivalves on April and May during summer. The rate of oxygen uptake increased in small sized animals because small individuals with relatively small glycogen reserves, which increases considerably their protein catabolism, whereas larger ones to a great extent on their relatively large glycogen storage (Bayne, 1973). The metabolic rate is strongly dependent on body size, it is necessary to introduce weight specific correlation comparison between animals of different sizes. 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-specific comparisons between bivalves of different sizes as well as inter-specific belong to same species or different.

In the present study on *Indonaia caeruleus*, the size specific oxygen consumption followed a general trend of acceptance *i.e.* higher values of oxygen consumption for smaller sized bivalves than larger sized. Mane (1975), Pandit (2005), Ghodake (2006) and Vedpathak *et al*. (2010) stated that body size in bivalves are important implication, hence, bivalve populations that are dominated by older and large individuals have a lowest value than those composed of small individuals. It is also showed that the energy flow through small individuals of species may be much greater than larger ones. The rate of oxygen consumption showed significant increase in smaller sized bivalves particularly during summer because it is known that, the oxygen uptake was mainly dependent on reproductive condition of bivalves in summer season. 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 (Navarro and Torrijos, 1994).

Many authors have shown that, the ammonia in general considered as major nitrogenous excretory product of bivalves and there occur profound difference in loss of nitrogen between different sizes and seasons (Nagwanshi, 1996; Salve, 2008; Vedpathak and Dhakane, 2008; Vedpathak *et al*., 2008). In the present study on *Indonaia caeruleus*, the rate of ammonia release showed more increase in large sized bivalves on April and May during summer season, because it is known that small sized bivalves catabolise different biochemical substrates to varying degrees, according to season (Bayne and Newell, 1983; Gabbott, 1983).

The O:N ratios can provide indices of balance in animal tissues between the rate of catabolism of protein, carbohydrate, and lipid substrates. The changes in the nitrogen excretion (conversion of ammonia) are best understood in context of physiological energetic and nitrogen balance 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 catabolise to carbohydrate and lipids.

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, carbohydrates and lipid substrates. The changes in the rate of nitrogen excretion (conversion of ammonia) are best understood in contex of physiological energetics 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 carbohydrates and lipids. In *Thias Lapillus* (Strickle and Bayne, 1982), the O:N ratio did not ulter with size that is exponent for rate of oxygen conception and ammonia excretion against body weight. However, in *Mytilus* the O:N ratio varied considerably with size and complex interaction with season and temperature (Bayne and Scullard, 1977). Bayne (1976) stated that, if the amino acid which result from protein catabolism are dominated and the resultant ammonia excreted, carbon skeleton of amino acid are completely oxidized. 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, noticed that individual size group at which the significant level could be due to the state of a gonadal development and level of metabolic activity of the bivalve molluscs. Further study needed to evaluate size specific variation in the O:N ratio among the bivalve molluscs.

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