SIZE SPECIFIC CHANGES IN THE RATE OF OXYGEN CONSUMPTION, AMMONIA EXCRETION AND O:N RATIO OF FRESHWATER BIVALVE MOLLUSC, *LAMELLIDENS MARGINALIS* (LAMARK) FROM JAYAKWADI DAM AT PAITHAN DURING WINTER SEASONS

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ABSTRACT

Considering the size specific variations in metabolic rates of bivalve shell-fishes reported here the size dependent variation in the O: N ratio in freshwater bivalve molluscs, *Lamellidens marginalis (*Lamark) from Jayakwadi dam at Paithan, near Aurangabad. The freshwater bivalves with specific size i.e. small (61-67mm in shell-length) and large (70-78 mm in shell-length) were selected for determination of changes in the rate of oxygen consumption, rate of ammonia excretion and O:N (Oxygen : Nitrogen) ratio on December and January during winter season. The adult bivalves with small size, showed high values of O:N ratio compared to large ones. The values of O:N ratio were found greater in large sized bivalves on January during winter season. The results are discussed in the light of metabolic processes in fresh-water bivalve molluscs.

KEYWORDS: Size specificity, oxygen consumption, ammonia excretion, O:N ratio, bivalve molluscs freshwater

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 mollusk is an important parameter, which influencing the pattern of metabolic responses. In bivalve mollusks, 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 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 waste and conservation of useful metabolites for growth, maintenance and reproduction. In bivalve molluscs, several workers have studies 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 diversicular*. According to Ganzalo and Cancino (1988) reported that oxygen conception and ammonia excretion of bivalve is a function of body weight. According to Barkai and Griffths (1988) in abalone, 63% of energy content of the food consumed was lost as faces and 32% expended on respiration. Energy losses in the form of ammonia excretion were negligible. While, Navarro and Torrijos (1994) reported that, energy utilized in oxygen uptake and ammonia excretion was depending on the season, temperature. A number of investigator have studied oxygen consumption, and ammonia excretion, according to envirmental factors, turbidity (Grants and Thorpe, 1991), sized (Bhagde and Mane, 2005), time (Vitale and Friedl, 1984) growth (Bacon and MacDonald, 1991).

Review of literature reveled that very little information was available on fresh water bivalve molluscs from India, Howkins *et; al.* (1986) reported O:N ratio on *Perna viridis* and *Pernaindica* from Cochin backwaters and recently Mathew and Menon (1993) reported heavy metal stress induced variation in O:N ratio in *Pernaindica* and *Donax incarnates*. Considering the abundant distribution of bivalve molluscs along the banks of Godavari river and paucity of information on O:N in fresh water bivalves, the present study was undertaken on *Lamellidens marginalis*.

MATERIALS AND METHODS

The freshwater bivalve molluscs, *Lamellidens marginalis* (Lamark) with vary in body size were collected from Jayakwadi dam at Paithan, 45 km away from Aurangabad during winter (Dec-Jan)2010-11. The animals with small (61-67 mm shell length), and large size (70-78 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 (61-67) and large (70-78 mm). Each group comprises 15 animals. After measuring length, they were only allowed to defecation 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 Wrinklers modified method Golterman *et al*. (1978). Four closed respiratory jars 1.0 lit 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 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 from the chember 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/gm body weight and rate of ammonia excreted represented mg NH_3-N/l/h body weight.

RESULTS

The results of the experiments were shown in Table-1. The physico-chemical characteristics of the water on the habitat were temperature, 23.0^{O}-24.0˚C on December and 29.5^{O}-32.5˚C on January 2010-11, pH,7.2-7.6 on December and 8.00-8.14 on January, water hardness 96-100 ppm on December and 97-108 ppm on January and dissolved oxygen 5.156 ml /l/h on December and 6.001 ml /l/h on Januaryduring winter season. The rate of oxygen consumption of individual animal in small size (67-67 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 December), 0.5284-0.6391 ml O_2/l/h (onJanuary), and in large size were ranged from 0.2978-0.3658 ml O_2/l/h (on December), 0.2815-0.3212 ml O_2/l/h (on January), during winter season. The ammonia excretion of individual animal were ranged from 2.1-2.6 µg NH_3-N/l/h (on December) and 1.9-2.4 µg NH_3-N/l/h (on January) in small size and 1.8-2.2 µg NH_3-N/l/h (on December) and 1.8-2.4 µg NH_3-N/l/h (on January) in large sized animal during winter 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 December) and 0.8297±0.06936 mg O_2/l/h (on January) in small sized bivalve and 0.4666±0.03918 mg O_2/l/h in (on December) and 0.44±0.02662 mg O_2/l/h (on January) 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 (December), 0.02267±0.002458 µg NH_3-N/l/h (January) in small sized and 0.01995±0.0021 µg NH_3-N/l/h (December), 0.02222±0.002515 µg NH_3-N/l/h (January) in large sized animals respectively. The O:N ratio showed higher values 29.5547 and 32.2309 on (December and January) respectively in small sized bivalve and lower values 17.5520 and 20.5216 on (December and January) respectively in large sized bivalves during winter season.

DISCUSSION

In the present study on freshwater bivalve molluscs, *Lamellidens marginalis (*Lamark) from Jayakwadi dam at Paithan, during winter season, the rate of oxygen uptake was increased in small sized bivalves, compared to large sized ones.

Table-1 Size specific changes in the rate of oxygen consumption, rate of ammonia excretion and O:N ratio in fresh water bivalves

Month	Animal No.	Size of the animals (mm shell length)	Weight of the animals (gms)	Oxygen consumption (ml O_2/ l/h)	Oxygen consumption (mg O_2/ l/h)	Ammonia excretion (mg.NH3-N/ l/h)	Ammonia excretion (µg.NH3-N/ l/h)	Atomic equivalent of Oxygen	Atomic equivalent of Nitrogen	O:N ratio
Dec	I	60	6.750	0.5482	0.7828	0.0026	2.6	0.0493	0.000191	26.5053
	II	62	6.260	0.5348	0.7636	0.0023	2.3	0.0477	0.00017	28.0558
	III	62	7.200	0.4982	0.7114	0.0021	2.1	0.0444	0.000155	28.648
	IV	66	5.980	0.5807	0.8292	0.0020	2.0	0.0518	0.000148	35.00
					0.7732 ±0.0492		2.25 ±0.2645			29.5547 ±3.7473
	I	71	8.200	0.3497	0.4993	0.0021	2.1	0.0312	0.00015	20.8066
	II	73	9.400	0.3217	0.4594	0.0018	1.8	0.0287	0.00013	22.0769
	III	71	9.475	0.3658	0.4938	0.0022	2.2	0.0308	0.00016	19.2875
	IV	74	10.370	0.2978	0.4142	0.0018	1.8	0.0258	0.00013	19.9154
					0.4666 ±0.03918		1.975 ±0.2061			20.5216 ±1.2097
Janu	I	60	5.980	0.6391	0.9126	0.0022	2.2	0.0570	0.00016	35.6444
	II	62	6.810	0.5998	0.8565	0.0024	2.4	0.0535	0.000175	30.3885
	III	63	7.100	0.5284	0.7545	0.0019	1.9	0.0471	0.000137	34.2307
	IV	67	7.080	0.5569	0.7952	0.0024	2.4	0.0497	0.000175	28.46
					0.8297 ±0.06936		2.225 ±0.2362			32.2309 ±3.2949
	I	77	9.540	0.3212	0.4586	0.0023	2.3	0.0288	0.00017	16.8588
	II	74	9.610	0.3008	0.4581	0.0018	1.8	0.0286	0.000135	21.2074
	III	74	11.270	0.2815	0.4019	0.0024	2.4	0.0251	0.000175	14.3485
	IV	73	9.060	0.3019	0.4414	0.0021	2.1	0.0275	0.000155	17.7935
					0.44 ±0.02662		2.15 ±0.2645			17.5520 ±2.8302

Lamellidensmarginalis on December and January during, 2010-11winter season

The rate of ammonia excretion also found more increased in large sized bivalves on December and January during winter seasons. 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 bivalve molluscs of different sizes as well as inter-species belong to same species or different.

In the present study on *Lamellidens marginalis*, 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) and Bayne (1976) 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 bivalve particularly during winter because it is known that, the oxygen uptake was mainly dependent on reproductive condition of bivalves in winter 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 (Nagawanshi, 1996) (Salve, 2008.) In the present study on *Lamellidens marginalis*, the rate of ammonia release showed more increase large sized bivalves on December and January during winter seasons, because it is known that small size 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 seasion 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.

ACKNOWLEDGEMENT

The authors express their sincere thanks to the authorities of UGC, New Delhi for generous grants under Major Research project given to Dr. A. N. Vedpathak.

LITERATURE CITED

Bacon CS and Mac Donald BA, 1991. Food quality, feeding activity and energy balance in the sea scallop, *Placopecten megelanicus J*. *shell-fish. Res.***10**:1-37.

Barber BJ and Blake NJ, 1985. Substrate catabolism related to reproduction in the Bay Scallop, *Argopectenirradians* as determined by O: N ratio and RQ physiological indexes. *Mar. Biol*. **87:** 13-18.

Bayne, BL, 1973. Aspects of metabolism of *Mytilusedulis* during starvation, *Neth. J. sea. Rev. **7:** 399-410*

Bayne BL, 1976. In Marine mussels: Their ecology and physiology. International Biological programme to Cambridge University Press. Cambridge, London, New York, Melbourne, PP.159.

Bayne BL and Newell RC, 1983. Physiological energetics of Marine Molluscs. In: *TheMollusca Physiology*, (Wilbur. K. M.) Part-I Vo1.4, Academic press, New York, 405-515.

Bayne BL and Scullard CS, 1977. An apparent specific dynamic action in *Mytilus edulis,* in the Laboratory, *Helgol. Wiss.*Meersunter, **20:**526-552.

Bayne BL and Thomson RJ, 1970. Some physiological consequences of keeping, *Mytilus edulis* in the laboratory Helgolande Wiss Meersunter, **20:** 526-552.

Bayne BL and Widdows J, 1978. The physiological ecology of two populationsof *Mytilusedulis J*. *Oecolosia*. **37:** 137-162.

Bhagde RV and Mane UH, 2005. A study on the metabolism in Green mussel, *PernaviridisJ. mar*. *Biol. Ass. India* **47** (1): 106-110.

Gabbott, PA 1983. Developmental and seasonal metabolic activities in marinemolluscs, In: Hochachka P. W (ed). The Mollusca.Vol. 2. Academic Press, New York, 165-217.

Gabbott PA and Bayne BL, 1973. Biochemical effects of temperature and nutritive stress on *Mytilus edulis(L) J. Mar. Biol. Ass.* U. K. **53**: 269-286.

Ganzalo BA and Cancino JM, 1988. Physiological characteristics of the brooding bivalve, *Galmardia. bahamondei, MadioAmbiente.* **9:** 13-20.

Golterman HL, Clymo RS and Ohnstad MA, 1978. Physical and chemical analysis of freshwaters, IBP, Handbook, No- 08. Blackwell Scientific Publication, Oxford, London, Edinburgh, Melbourne, 2nd Edn. 172-178.

Grants J and Thorpe B, 1991. Effects of suspended sediments on growth, respiration and excretion of soft- shell clam, *Myaarenariacan J. fish. Agnat. sci*.**48**: 1285-1292.

Hawkins, AJS Bayne, BL Menon NR and Damodharan R, 1986. The mussels' *pernaviridis* and *pernaindica* as transplantable indicator of pollution, comparison of their metabolic responces to reduction of both oxygen tension and salinity.*Nat. Seminars on Mussel Watch, Coachin Univ. Memograph **1**:51-34*

Kreeger DA, 1993. Seasonal patterns in utilization of dietary protein by the mussel, *Mytilus, trossulus. Mar.Ecol*. *Prog. Ser*. 95:215-232.

Kreeger DA and Logdon CJ, 1993. Effect of diatary protein content on growth of juvenile mussels, *Mytilustrossulus*, *Biol*. *Bull* (In press).

ManeUH, 1975. Oxygen consumption of clam, *Katelysiaopima* in relation to environmental conditions. *Broteria*, **64**(1-2): 33-58.

Mathew P and Menon NR, 1993. Heavy metal stress induced variation in O.N. ratio of two tropical bivalves *Pernaindica* and *Donaxincarnatus*. *Indain J.Expt*. *Biol.* **31**: 275-292.

Nagwanshi M, 1996. Reproductive physiology & freshwater bivalve molluscs from Aurangabad, Maharashtra state, *Ph.D*. *Thesis, Dr. B.A. Marathwada University, Aurangabad, India*, PP-364.

Navarro JM and Torrijos R, 1994. Seasonal variation in oxygen uptake and ammonia excretion in the predatory gastropod, *Concholepas concholepas. Comp. Biochem, physiol.* **108**A: 39-49.

Segawa S, 1991. Oxygen consumption and ammonia excretion by the balone *Sulcus diversicolor* in starved condition. *Bull. Jap. Soc .Sci. Fish,* **57**: 2001-2006

Solorzano L, 1969. Determination of ammonia in natural waters by phenol-hypochlorite method. *Limnology and oceanography, **14***: 799-801.

Strickle WB and Bayne BL, 1982. Effect of Temp and salinity on oxygen consumption and nitrogen excretion in *Thias lapillus. J. Expt. Mar. Biol. Ecol*. **58**:1-17.

Vitale MA and Friedl FE, 1984. Ammonia production by freshwater bivalve, *Ellipto buckley* (Lea). Intact and Monovalve preparations *Comp.Biochem. Physiol.* **77**(A):113-116.
Widdows J, 1978. Physiological indices of stress in *Mytilus edulis.* J. *Mar. Biol. Ass*. U.K.**58**:125-142