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# ECOPHYSIOLOGICAL RESPONSE OF *NERITA ORYZARUM* (RECLUZ), A GASTROPOD, TO VARIATIONS IN TEMPERATURE, pH AND SALINITY

**M. K. Thakur, B.G. Kulkarni and A.K. Jaiswar***

*The Institute of Science, 15 Madam Cama Road, Mumbai - 400 032*
**Central Institute of Fisheries Education, Versova Mumbai - 400 061*

## ABSTRACT

**During ecophysiological investigations on an intertidal gastropod, *Nerita oryzarum* (Recluz), of Mumbai shore, various biochemical changes could be recorded. Glycogen and lipid contents of *N. oryzarum* were found to decrease, whereas, water content increased with decreasing salinity. The rate of oxygen consumption declined with the decrease in salinity and also in highly acidic (pH 2) as well as highly alkaline (pH 10) sea water. The observed variations in the rate of oxygen consumption and changes in biochemical composition in the animal with changes in salinity, pH and temperature are probably the process of physiological and biochemical adjustments to the fluctuating environmental conditions in the intertidal region.**

**Key words: Ecophysiology, *Nerita oryzarum*, oxygen consumption**

## INTRODUCTION

The intertidal ecosystem around Mumbai was environmentally clean and rich in faunal composition, but today, it is disturbed and imbalanced due to ever increasing anthropogenic discharges from the city. In spite of its continuously deteriorating conditions, a large variety of diversified fauna is still found to occupy the intertidal niche (Muni and D'Silva, 1985; Katkar, 1995).

*Nerita oryzarum* is an important gastropod among other contributors to the biomass of intertidal molluscs in and around Mumbai. It is a primitive prosobranch that grazes upon the thin film of algae, diatoms and detritus that covers the rocks (Huges, 1971). Although found abundantly in the intertidal region around Mumbai and utilized as a cheap source of food by coastal population, no attention has been paid to know the reasons for abundance, *i.e.*, mechanism present in *N. oryzarum* to adjust to the stressful environmental conditions of this ecosystem, though a lot of research work has been carried out on various organisms associated with stressful conditions and changes taking place in their physico-chemical activities (Broekhuysen, 1940; Frankel, 1960; Dunken and Klekowski, 1967; Kulkarni, 1983,1989). Therefore, an attempt was made to understand the mode of adaptations to tolerate highly fluctuating environmental conditions surrounding this intertidal organism. The investigations included the study of tolerance of the animal to varied environmental conditions such as temperature, pH and salinity. In the study, metabolic rate was selected as an indicator of the internal state of the organism to study the impacts of environmental changes on the animal.

## MATERIAL AND METHODS

Standard methods were followed for measuring salinity, temperature and pH (APHA, 1989). Active and healthy *N. oryzarum* were collected during low tide from Nariman Point area of Mumbai for various experiments. These animals were acclimatized in glass aquaria for 24 hours under laboratory conditions. The animals were exposed to pH between 2 and 10, and from fresh water to 100% (33.0‰) sea water, separately, under laboratory conditions to study their physiological response to altered environmental conditions. Sea water collected from Nariman Point area was graded in to 25% (8.25‰), 40% (13.5‰), 50% (16.5‰), 60% (19.8‰) and 75% (24.75‰) salinity of sea water using normal tap water after storing it for 12 hours in separate containers. The experimental medium was renewed every 24 hours with the addition of freshly prepared water of different salinities and pH gradients. Animals were exposed to different temperatures between 30 and 34°C with an interval of 2-3°C to study temperature tolerance following Frankel's (1960) method. To study the biochemical changes that occurred, animals were dissected for estimation of muscle glycogen, protein and fat contents after exposure for 96 hours to varying grades of salinity and pH, separately. Glycogen, protein, fat and moisture contents were estimated following Seifter *et al.* (1950), Lowery *et al.* (1951) and Folch *et al.* (1951).

## RESULTS AND DISCUSSION

*N. oryzarum* was found to tolerate salinity as low as 8.25‰ during monsoon as well as summer. No mortality was recorded in 25% to 100% sea water during both the seasons (Table 1). Total mortality occurred within 72 hours of exposure to tap water in summer. However, only 30% mortality was observed during the same period in monsoon. In 10% sea water, *N. oryzarum* had shown 30 and 20% mortality in summer and monsoon, respectively, within 72 hours. Similarly, 60 and 40%

**Table 1 : Mortality (%) in *N. oryzarum* exposed to various concentrations of sea water in monsoon and summer seasons**

| Exposure period (h) | Monsoon | | summer | |
|---|---|---|---|---|
| | 0% Sea water | 10% Sea water | 0% Sea water | 10% Sea water |
| 24 | - | - | - | 10% |
| 48 | - | - | 90% | - |
| 72 | 30% | 20% | 10% | 30% |
| 96 | 30% | 40% | - | - |
| Total mortality | 60% | 60% | 100% | 40% |

mortality occurred in 96 hours of exposure in summer and monsoon, respectively, and 100% mortality within seven days. As *N. oryzarum* is distributed in the intertidal region, it is regularly exposed to fluctuating environment during ebb and flow tides, which is responsible for their adaptive power to tolerate such low salinity of 8.35‰ during the experiments. The present findings are in agreement with various other workers (Broechuysen, 1940; Davis, 1967; Balaparameshwar *et al.*, 1971; Wolcott, 1973; Yeragi, 1979). In addition, a long-term exposure of animals to low salinity during monsoon due to influx of fresh water may also be responsible for tolerating low salinity during the experiment in monsoon. Katkar (1995) has recorded salinity reduction as low as 10‰ in Nariman Point area during monsoon season.

*N. oryzarum* was found to tolerate temperature as high as 37°C and becoming inactive when exposed to 40°C. Micaff (1966) has also reported that molluscs living in intertidal zones tolerate higher temperature than those living in sub-tidal zones. The power to tolerate higher temperature is possibly an adaptation by the animal to overcome the adverse conditions prevailing on exposure to higher temperature during low-tide periods.

Oxygen consumption of *N. oryzarum* was reduced significantly (0.45 ml/l) in 40% sea water in comparison to that (4.7 ml/l) in 100% sea water. It was elevated again when exposed to more than 50% sea water. Respiration rate was also elevated to its maximum (8.7 ml/l) on exposure to sea water of 35°C, whereas, rate of oxygen consumption decreased to 2 ml/l when exposed to 40°C. Rate of oxygen consumption was significantly low (0.58 ml/l) on exposure to lower pH (6) and it reached its maximum (2.9 ml/l) at pH 8; however, it declined (2 ml/l) again on exposure to pH 10 (Fig. 1).

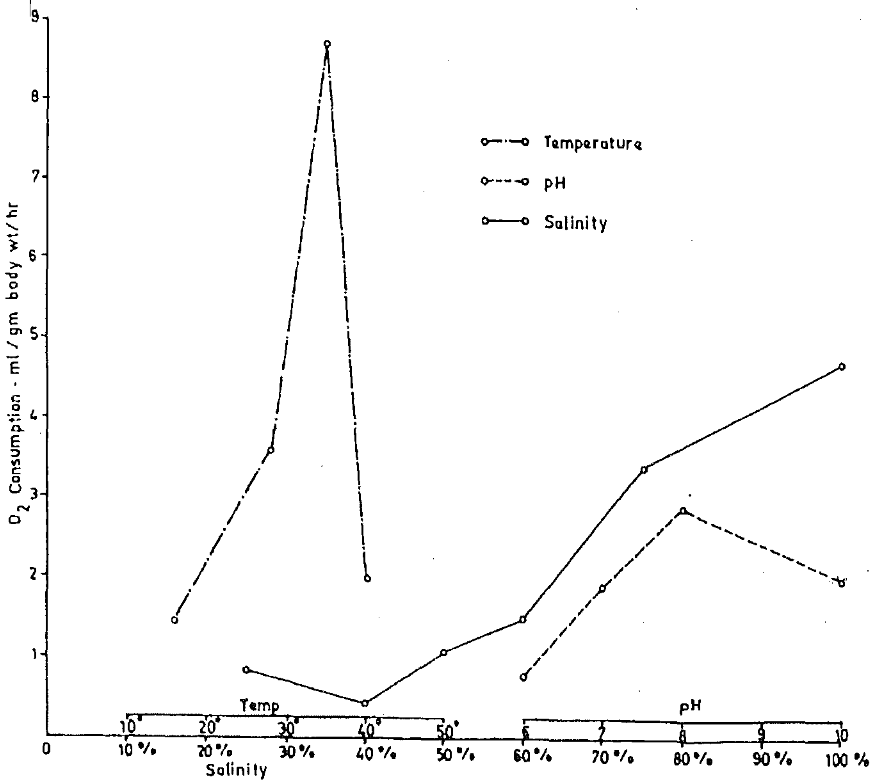


*Fig. 1 : Oxygen consumption by Nerita oryzarum (Recluz) on exposure to different temperature, pH and salinity*

The lower oxygen consumption by the animals at low salinities may be a response to the stress of changed salinity because of which animals became inactive. It has already been established by several investigators that low salinity influences metabolic rate by stimulating diminution of locomotory activities of animals (Nagabhushanam, 1962; Duncan *et al.*, 1967; Hiwale and Mane, 1988; Kulkarni, 1989). It is a universal fact that respiratory rates of animals are affected by change in the temperature of their surroundings. But, decline in oxygen consumption at 40 °C, may be due to the inability of animals to tolerate such a high temperature and becoming inactive at that temperature. Powers (1930) observed a similar response in fishes also. He suggested that the change in oxygen consumption in fishes under pH stress is due to the influence of external medium on alkaline reserves of blood. Such changes in pH of body fluid of *N. oryzarum* may also be responsible for change in oxygen consumption under pH stress.

The glycogen and fat contents in *N. oryzarum* exposed to 8.25‰ salinity (25% sea water) to 16.5‰ salinity (50% sea water) are significantly different in comparison to those exposed to normal sea water (33‰). Protein contents did not show any change but a significant increase of water content was noticed when exposed to lower salinity (Table 2). Glycogen, fat and protein contents were found to decline after exposure to acidic sea water, but no significant change in water content of the animal was seen (Table 3).

**Table 2 : Glycogen, protein, fat and moisture contents (mg/g wet wt) in *N. oryzarum* exposed to various salinities for 96 h**

| Salinity (‰) | Glycogen | Protein | Fat | Moisture |
|---|---|---|---|---|
| 08.25 | 0.035 ± 0.005 | 13.02 ± 3.34 | 68.77 ± 12.69 | 726.07 ± 20.08 |
| 13.50 | 0.079 ± 0.008 | 16.22 ± 3.27 | 37.557 ± 3.77 | 712.83 ± 1.52 |
| 16.50 | 0.180 ± 0.030 | 14.99 ± 2.41 | 53.12 ± 7.49 | 635.66 ± 1.54 |
| 19.80 | 0.255 ± 0.04 | 16.52 ± 3.05 | 68.78 ± 5.57 | 689.67 ± 11.71 |
| 24.75 | 0.207 ± 0.020 | 14.97 ± 1.87 | 63.94 ± 7.74 | 630.09 ± 7.63 |
| 33.00 | 0.230 ± 0.020 | 12.55 ± 1.76 | 67.94 ± 8.67 | 642.14 ± 19.54 |

(Values are mean ± SD of 5 determinations)

**Table 3 : Glycogen, protein, fat and moisture contents (mg/g wet wt) in *N. oryzarum* exposed to various pH for 96 h**

| pH | Glycogen | Protein | Fat | Moisture |
|---|---|---|---|---|
| 5 | 0.14 ± 0.02 | 08.27 ± 0.25 | 42.88 ± 5.12 | 799.14 ± 6.87 |
| 6 | 0.17 ± 0.04 | 11.92 ± 1.23 | 54.23 ± 2.91 | 767.12 ± 8.72 |
| 7 | 0.15 ± 0.04 | 13.01 ± 1.65 | 63.95 ± 8.67 | 771.50 ± 7.89 |
| 8 | 0.18 ±0.05 | 14.97 ± 1.87 | 82.01 ± 13.38 | 778.69 ± 18.48 |
| 9 | 0.16 ± 0.04 | 14.94 ±1.77 | 83.43 ±13.48 | 719.49 ± 4.33 |

(Values are mean ± SD of 5 determinations)

The decrease in metabolites may be the result of stress during exposure to low salinity and pH. There is also the possibility of impairment in synthesis of glycogen during stress and at the same time glycogen is being utilized by the animal (Kulkarni, 1983). Fat is also utilized as a primary source of energy during stress; hence, reduced at low pH. The increase in water content of the animal when exposed to low salinity is probably a measure to maintain uniform osmotic and ionic balances in the animal during stress conditions. Changes that occurred in the physiological and biochemical composition of the animal on exposure to altered conditions of temperature, pH and salinity during the experiment suggest the mechanisms of adjustment to the stressful conditions of the intertidal region by the organism in order to survive.

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