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Effect of change in pH on Rate of Respiration and Survival of the Fiddler Crab, *Uca (Celuca) Lactea Annulipes* (milne- edwards, 1837) in different Seasons, Thane Creek, Navi Mumbai, India

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Abstract

The present study was undertaken to study the effect change in the pH of the medium on survival of fiddler crab Uca (Celuca) lacteal annulipes from Thane creek, Navi Mumbai. Marked fluctuation in pH under different seasons occurs in study are due to various reasons such as industrial effluent runoff and sewage disposals etc. Fiddler crabs are exposed to significant fluctuation in pH change because their habitat is intertidal zone of costal and estuarine marine water. To overcome this stress effect their rate of respiration increases in exited state and tolerance levels decreased in extreme pH change. The wider pH tolerance present in these animals might be useful for combating the adverse condition arising due to sudden release of effluent of higher pH in their environment.

Keywords: Oxygen consumption, industrial effluent, fluctuations in pH, pH tolerance, intertidal zone.

Introduction

Due to increasing pressure of urbanization and industrialization, intertidal marine water in Navi Mumbai and Mumbai is deteriorating due to influence of human being. Pollution in intertidal area and habitat destruction causes displacement of the species from the intertidal area of Mumbai. Among the intertidal benthos, fiddler crabs are an important constituents of intertidal ecosystem.

Since fiddler crabs inhabit the uppermost part of littoral zone, they are more susceptible to anthropogenic pressure. These crabs can be looked upon as an indicator of the deterioration in intertidal ecosystem[1]. *Uca annulipes* is a fairly resistant species to these toxicants. Devi investigated tolerance of *Uca annulipes* and *Uca tringularis* inhabiting at Visakhapatnam on the east coast of India, to heavy metals viz, copper, cadmium, zinc and mercury[2]. When animals are exposed to change in different environmental parameters like temperature variation, pH variation etc. stress effect on animal can be evaluated as change in consumption of oxygen by the animal to survive under changed environmental condition.

It is well known that the hydrogen ion concentration in upper layers of the open ocean varies within rather narrow limits. However, in shallow coastal waters and rock pools the range is greater which is also within the tolerable limits by marine organisms. The temperature and salinity of sea water also contributes to variation of pH in the medium. Although the pH variation in marine environment is in narrow limits, the anthropogenic input of innumerable pollutants including acids and alkalis into the coastal waters are likely to alter the normal pH range in the intertidal ecosystem. Therefore, it is worthwhile to study the pH tolerance limits of intertidal animals. Except few studies very little attention has been given to know the tolerance of intertidal organisms to sea water of different pH[3-5]. Thakur has reported that gastropod found in uppermost littoral zone could tolerate wide range of pH[6]. Oxygen consumption rates can be used to evaluate the amount of energy an organism is using to maintain a stable concentration of the internal fluids[7].

Subsequently considerable amount of data has been generated on effect of ecological variables like salinity, temperature and pH on intertidal benthos like molluscs and crustaceans[8-10]. In India meager data is available on biology and consequences of salinity, temperature and pH on fiddler crabs. Further, reports on *U. annulipes* in and around Mumbai coast with respect to effects of salinity, pH and temperature variation are not available.

Material and Methods

During low tide, *Uca annulipes* were collected at Vashi shore intertidal area and brought to the laboratory for acclimatization of 48 hours. During acclimatization, the fiddlers were kept in glass aquaria (size 20 X 15 X 15 cm), containing sufficient seawater. The seawater used during acclimatization had oxygen (5.3 – 6.2 ml/l), pH (8.0 – 8.3), and temperature 25 – 26^{0}C). The acclimatized group of fiddlers, which did not show any mortality, was used for various experiments like measurement of oxygen uptake and analysis of tissue metabolites, after exposure to different pH viz pH 5.5, 8.2 and 9.5 in different seasons.

Experimental setup consisted of covered glass tanks each with fifteen fiddler crabs and equal volume (four liters) of seawater of different experimental pH. The water was aerated continuously and changed every 24 hours to prevent the build-up of toxic wastes. Measurement of initial oxygen consumption as well as after the exposure period of four days and again after one month was carried out. The acute response of oxygen consumption to pH change was measured in all the experimental pH. The experiment was repeated in three seasons viz. pre monsoon, monsoon and post monsoon.

The rate of oxygen consumption of fiddler crab was determined by taking the difference between initial oxygen content and final oxygen content obtained after the exposure of the crab for one hour. Results were expressed as oxygen consumed per gm. of body weight per hour.

Results and Discussion

Effect of pH variation on oxygen consumption of *Uca annulipes* in different seasons: Oxygen consumption response to sea water of acidic and alkaline pH found to be consistent in all three seasons table-1 and figure-1. In sea water of pH 8.2, a slight variation in oxygen consumption was noted after 4 and 30 days in all the three seasons. However, oxygen consumption rates were lower in post monsoon as compared to oxygen consumption rates in pre monsoon and monsoon. When crabs were exposed to sea water of acidic pH, remarkable elevation was noted after 30 days of exposure in pre monsoon whereas, in monsoon significant elevation was noted that of 4 and 30 days exposure. In monsoon it was found that at acidic pH, effect after 30 days of exposure on oxygen consumption was not remarkable as compared to after 4 days exposure. During post monsoon at acidic pH initially after 4 days of exposure oxygen consumption found to be elevated and then decreased after one month.

In alkaline sea water of pH 9.5 effect on oxygen consumption of fiddler crabs was more of less consistent in all three seasons. After 4 days of exposure, oxygen consumption found to be depleted significantly throughout the year. Then after 30 days of exposure oxygen consumption found to be elevated in comparison with oxygen consumption after 4 days exposure.

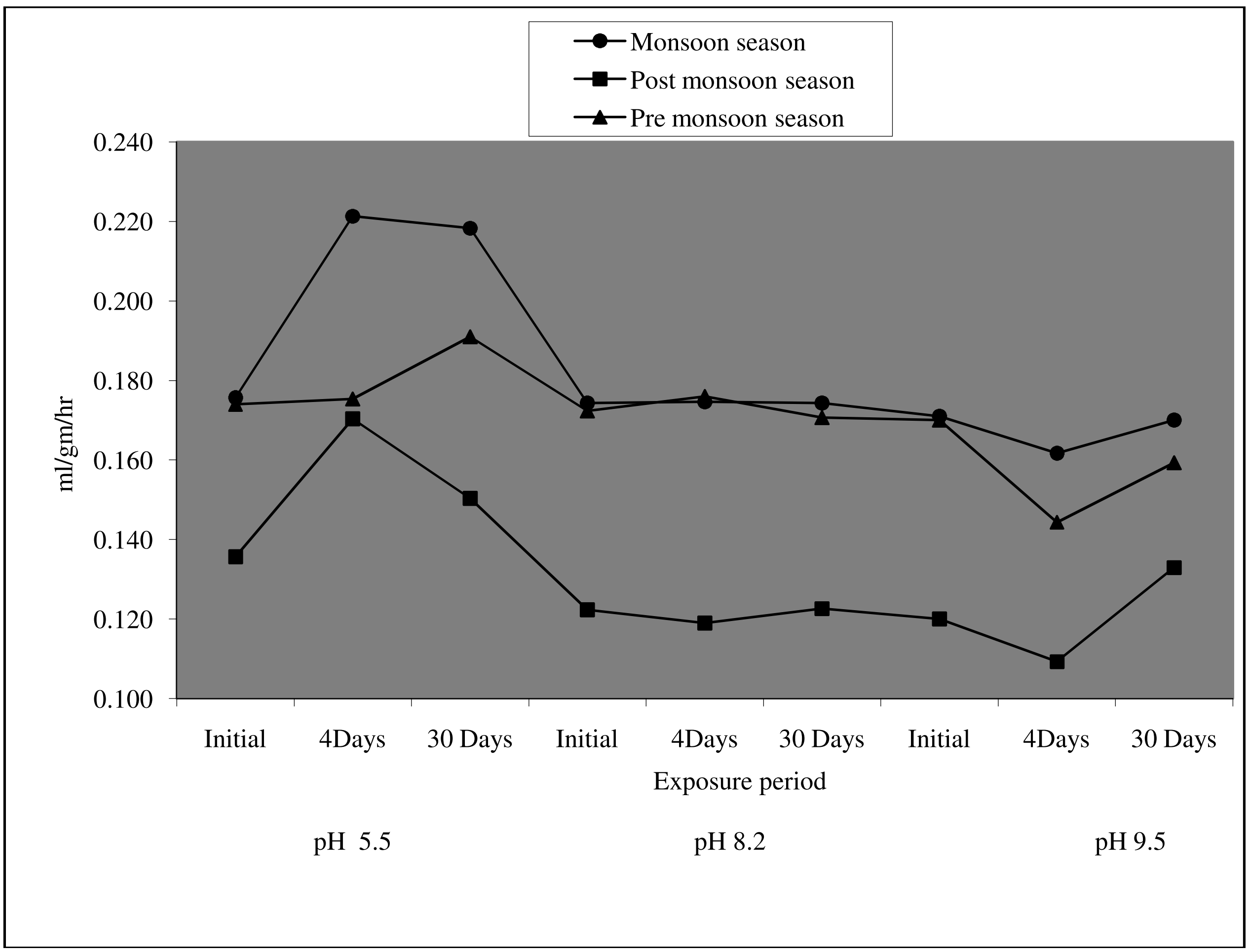

Figure-1
Effect of pH variation on oxygen consumption (ml/gm/hr) in *Uca annulipes* in various seasons

Table-1
Effect of pH variation on oxygen consumption of *Uca annulipes* in various seasons

Season	pH	Exposure period	Oxygen consumption (ml/gm/hr)
Pre Monsoon	5.5	Initial	0.174 ± 0.002 (0.172 – 0.175)
		4 Days	0.175 ± 0.001 (0.175 – 0.176)
		30 Days	0.191 ± 0.001 (0.190 – 0.192)
	8.2	Initial	0.172 ± 0.003 (0.169 – 0.175)
		4 Days	0.176 ± 0.002 (0.174 – 0.177)
		30 Days	0.171 ± 0.002 (0.169 - 0.172)
	9.5	Initial	0.170 ± 0.001 (0.169 – 0.171)
		4 Days	0.144 ± 0.001 (0.143 – 0.145)
		30 Days	0.159 ± 0.001 (0.158 – 0.160)
Monsoon	5.5	Initial	0.176 ± 0.001 (0.175 – 0.176)
		4 Days	0.221 ± 0.001 (0.220 – 0.222)
		30 Days	0.218 ± 0.001 (0.218 – 0.219)
	8.2	Initial	0.174 ± 0.002 (0.173 – 0.176)
		4 Days	0.175 ± 0.002 (0.173 – 0.176)
		30 Days	0.174 ± 0.002 (0.173 – 0.176)
	9.5	Initial	0.171 ± 0.003 (0.168 – 0.173)
		4 Days	0.162 ± 0.001 (0.161 – 0.163)
		30 Days	0.170 ± 0.001 (0.169 – 0.171)
Post Monsoon	5.5	Initial	0.136 ± 0.001 (0.135 – 0.136)
		4 Days	0.170 ± 0.002 (0.169 – 0.172)
		30 Days	0.150 ± 0.001 (0.150 – 0.151)
	8.2	Initial	0.122 ± 0.002 (0.120 – 0.124)
		4 Days	0.119 ± 0.002 (0.117 – 0.121)
		30 Days	0.123 ± 0.001 (0.122 – 0.124)
	9.5	Initial	0.120 ± 0.001 (0.119 – 0.121)
		4 Days	0.109 ± 0.001 (0.109 – 0.110)
		30 Days	0.133 ± 0.001 (0.132 – 0.134)

Values are mean (± SD) of 3 determinations. Values in parenthesis indicate range.

Conclusion

The wide pH range (5.5-9.5) tolerance shown by *Uca annulipes* during present studies can be attributed to distribution of these crustaceans at higher level in the intertidal zone. The wider pH tolerance present in these animals might be useful for combating the adverse condition arising due to sudden release of effluent of higher pH in their environment.

In the present study, the increase in oxygen consumption in *Uca annulipes* with the decrease in pH can be taken as a stress response to adjust to the subnormal and abnormal medium.

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