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EFFECTS OF SOME ENVIRONMENTAL PARAMETERS ON RESPIRATORY METABOLISMS OF *DOTILLA MYCTIROIDES* (M-EDWARDS) OF MITHBAV CREEK

ABSTRACT

The study deals with the rate of oxygen consumption in *Dotilla myctiroides* of Mithbav Creek during the period 1991-92. A dense population of these crustacean has high rate of tolerance. The rate of oxygen consumption uptake was increased along with lowering the salinity. The rate of oxygen uptake did not change between 28 - 32.5‰. Below normal pH of 7.4 the rate of oxygen uptake was increased but above it decreased. The rate of oxygen consumption increased stepwise with the rise in temperature from 25 to 37°C, but decreased sharply between 38°C to 40°C.

SEVERAL environmental parameters are known to influence the respiratory metabolism of crabs. The rates of oxygen uptake under various environmental conditions are well documented by many investigators in estuarine shellfishes (Read, 1962, Helm and Trueman, 1967, Bayne, 1971, Deshmukh, 1972, Mane, 1975). Many other workers like Rao (1958) and Gopalakrishnan (1957) have shown that temperature is the major controlling environmental factor influencing the metabolic rates and rate of oxygen consumption. The present investigation was undertaken to study the influence of various environmental factors on the rate of oxygen uptake in *Dotilla myctiroides* and the variation in the respiration in relation to starvation and diurnal rhythm. The estuarine soldier crab is very much sensitive to these drastic changes especially the respiration and osmoregulation.

MATERIAL AND METHODS

The crabs *D. myctiroides* were collected from Mithbav creek (Lat. 16° 20'N; Long 73° 25'E) at Sindhudurg district, on the west coast of India. The crabs were brought to the laboratory, cleaned to remove the mud and sand particles and were kept in larger aquaria containing sea water (32.5‰). The test salinities were approximated with the collection salinities over the crab beds. The animals were kept for 2-3 days for acclimatization in laboratory.

The respirometer was used to determine the oxygen consumption of crabs. The respiratory jars were wrapped with black cloth to provide natural habitat. The oxygen content of water samples was determined before and after the experiment by the standard Winkler's method. The results of each experiment are based on five determinations and expressed as Oxygen uptake ml/gm/hr.

RESULTS

Effect of low salinity

The batches of crabs were subjected to different low salinities (8.1, 11.5, 15.3, 20.6, 25.2, 28.8, 31.2, 32.5‰) for five hours before the start of experiment. The normal sea water (32.5‰) was diluted with distilled water to obtain low salinities; keeping temperature (30.2°C) and pH (7.4) constant. The oxygen consumption in each salinity was determined. The results presented in Table-1, show that the rate of oxygen uptake was gradually increased from 8.1‰ to 15.3‰ but in 20.6‰ suddenly increased to maximum and then respiratory rate was decreased from 25.2‰ and remain stable between 28-32.5‰.

TABLE 1. *Oxygen consumption (ml/gm/hr) in relation to Salinity in Dotilla myctiroides.*

Salinity (S ‰)	ml/gm/hr.
8.1	0.521 ± 0.03
11.5	0.515 ± 0.02
15.3	0.501 ± 0.01
20.6	0.614 ± 0.04
25.2	0.561 ± 0.03
28.8	0.527 ± 0.01
31.2	0.527 ± 0.02
32.5	0.527 ± 0.002

Effect of temperature

Batches of crabs were exposed to six different temperatures (20.3, 25.4, 30.7, 32.2, 35.1 and 40.2°C) for 3 to 4 hours before the start of experiment. The respective temperature of the experimental media was thermostatically adjusted and kept constant. The salinity and pH were kept constant (32.5‰ and pH 7.4). The experiment was also performed at normal room temperature (30.2°C). The results presented in Table 2 show that the rate of oxygen uptake increased with increase in temperature upto 32.2°C and then suddenly decreased at 35.1° and 40.2°C, these temperatures are near the lethal temperature of the crabs. The lethal limit of temperature is 41.5°-42°C.

TABLE 2. *Oxygen consumption (ml/gm/hr) in relation to temperature (°C) in Dotilla myctiroides*

Temperature °C	ml/gm/hr.
20.3	0.412 ± 0.02
25.4	0.438 ± 0.01
30.7	0.513 ± 0.06
32.2	0.618 ± 0.01
35.1	0.405 ± 0.03
40.2	0.317 ± 0.07

Effect of pH

The rate of oxygen uptake was determined at 5 different pH. To obtain the required pH of the medium, dilute HCl or NaOH was added to normal sea water having pH 7.4. The results in Table 3 show that the rate of oxygen consumption was increased in low pH and decreased in high pH compared to the rate at normal pH of sea water.

TABLE 3. *Oxygen consumption (ml/gm/hr) in relation to pH in Dotilla myctiroides*

pH	ml/gm/hr
5.4	0.611 ± 0.001
6.1	0.523 ± 0.002
7.4	0.472 ± 0.002
8.2	0.316 ± 0.003
8.6	0.285 ± 0.008

Effect of starvation

In this experiment, the first precaution was taken not to give any chance to feed on

any type of food items. The crabs were kept for starvation in the normal sea water (32.5‰) filtered through whatmann filter paper. From second day onwards the crabs were kept in double filtered sea water which was changed thrice a day, In the initial stage of starvation the crab making very speedy movement to get food. On each day the oxygen uptake of the crabs were determined for a period of four days. After fifth days the crab reached to the lethal limit because of smaller size with less musculature. The results are presented in Table 4 show that the rate of oxygen consumption slowly decreasd as the duration of starvation period increased and after fourth day it is too less that animal can not perform their normal activities also.

In relation to diurnal rhythm

During night, due to less disturbances, these crabs are freely stable at their burrow and take free atmospheric oxygen for metabolic activities. They feed actively during night and consume more oxygen compare to day time. During day time, human disturbances are more, therefore rate of feeding is less and expenditure of energy more. They spend more time in burrowing as well as upward and downward movement. It is necessary to find out actual uptake of oxygen throughout the day period.

TABLE 4. *Oxygen consumption (ml/gm/hr) in relation to starvation in Dotilla myctiroides*

Starvation period (in day)	ml/gm/hr
1	0.382 ± 0.03
2	0.278 ± 0.02
3	0.129 ± 0.04
4	0.038 ± 0.02

The experiments were performed in morning, noon, evening and night (fullmoon and new moon day) to see the rate of oxygen uptake of these crabs. The results are presented in Table 5 show that the crabs consumed maximum oxygen in afternoon and minimum in early morning time. It is also noted that the uptake of oxygen also disturbed by fullnoon day and new moon day time. During fullmoon day time even the crabs exposed to the share, did not feed but new moon day time, they spend more time on feeding hence consumption rate goes on increasing stepwise.

TABLE 5. *Diurnal rhythm of oxygen uptake in Dotilla myctiroides in summer (Temperature 26.4°-30.2°C, Salinity 32.5‰)*

Time	Oxygen uptake ml/gm/hr
7.0 a.m.	0.302 ± 0.001
10.0 a.m.	0.392 ± 0.004
1.0 p.m.	0.435 ± 0.002
4.0 p.m.	0.485 ± 0.001
7.0 p.m.	0.512 ± 0.006
10.0 p.m. (Fullmoon)	0.434 ± 0.003
10.0 p.m. (Newmoon)	0.591 ± 0.004

DISCUSSION

Changes in salinity, pH, temperature, starvation etc. are known to affect the rate of oxygen consumption in an aquatic poikilothermic animals. In a number of euryhaline invertebrates, the rate of oxygen uptake varies inversely to the changes in the salinity of the external medium. Schwade (1933) showed the rate of oxygen consumption of *Carcinus maenus* increased in hypotonic media.

The salinity of the sea water affects the oxygen uptake in marine animals. At several instances it was noted that the decrease in salinity of the external medium caused increase in metabolism of animals (Schlieper, 1929, 1935, Winkren, 1953, Gross, 1957). In the

present study the oxygen consumption of *Dotilla* increased upto 20.6‰, and then it decreased but 28.8‰ onwards upto 32.5‰ the oxygen uptake remain constant.

The rate of metabolic activity is mostly seen to increase with increase in temperature. Increase in oxygen uptake of *Mytilus edulis* with increase in temperature from 3° to 20°C was observed by Read (1962). In *Martesia striata* a little increase in oxygen uptake with the rise in temperature, from 24°-33°C was recorded by Nagabhushanam (1966). Deshmukh (1972) in *M. meretrix* reported a steady increased in the oxygen uptake with rise in temperature from 21° - 35°C. In the present study the oxygen uptake of *Dotilla* increased along with increase in temperature upto 32.2°C but latter on sharply decreased.

Powers (1930) observed that fishes are affected directly by increase or decrease in the pH of the medium due to the influence of pH of the external medium. Nagabhushanam (1966) observed in *M. striate* that if there is slight change in oxygen uptake with the change in the pH of the external medium. Gopalakrishnan (1957) also found that in *Metapenaeus monoceros* the oxygen consumption was not directly affected by the changes in pH. In present investigation the oxygen uptake increase gradually by lowering the pH 8.6 to 5.4.

Oxygen uptake of the animals decrease rapidly in the initial periods of starvation observed by Roberts (1957), Berg *et al.* (1958) also noted that 3/5th reduction in the inital rate of oxygen uptake by the limpet, *Ancylus* after 96 hours of starvation. In *Dotilla* similar type of reduction noticed by the end of 4th day of starvation.

Webb and Brown (1959) observed that oysters consumed more oxygen in the late morning and early noon than at midnight. *In Dotilla* it has been observed that the maximum oxygen uptake was afternoon upto midnight and then decreased upto morning. It is also observed that during full moon day time oxygen uptake was less than that of new moon day. During full moon day, the crabs directly exposed to moon light, hence food and feeding totally stop, while during new moon day night the crabs spend more and more time in feeding with increased oxygen uptake.

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