Salinity Tolerance in Four Estuarine Species of Bryozoa

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Abstract: Experimental studies on the salinity tolerance of four bryozoan species revealed their marked euryhalinity. Vesicularia papuensis and Bowerbankia gracilis showed moderate tolerance to 20 to 30 ppt and 25 to 35 ppt respectively. Zoobotryon verticillatum (15 to 35 ppt) and Membranipora tuberculata (20 to 37.5 ppt) showed a wide range of tolerances. Continuous observations on the zooidal responses of the bryozoan species and their morphological changes at various salinities are also discussed.

Aquatic organisms which live in estuarine or mangrove biotopes are subject to changes in salinity. They are physiologically adapted to tolerate osmotic stress and thus can successfully colonize such habitats. The influence of salinity on sedentary organisms like Bryozoa is of great importance to adults since migration to more favourable conditions is impossible for them. There have so far been several studies concerning the salinity tolerance of some fouling bryozoans with a widespread distribution, namely, Victorella pavida (Loppens, 1910; Brattstrom, 1954), Bugula neritina and Watersipora cucullata (Mawatari, 1951, 1952), and Bugula neritina and Watersipora subovoidea (Hastings, 1927). In Indian harbours, Menon and Nair (1970) studied the salinity tolerance of Victorella pavida and Electra crustulenta. All these studies consistently reported that the species concerned showed wide ranges of tolerance to salinity.

In the Vellar estuarine region, south east coast of India, 6 bryozoan species occur despite the fluctuating and harsh environmental conditions (Nair, 1991). In contrast to the rich bryozoan fauna of the Bay of Bengal, it is of interest that the Vellar estuarine region facing the Bay has only a meager number of bryozoans. These species may be expected, a priori, to be euryhaline like the other fouling species cited above. The present study was made to evaluate the tolerance levels to salinity in four species of bryozoans which are abundantly distributed in the Vellar estuarine region.

Materials and Methods
The experiments were carried out during 1988 and bryozoans were collected from three different biotopes, namely, estuary, mangrove and backwater in the Parangipettai (lat. 11°29′N; long. 79°47′E, Fig. 1) environs. Colonies of Zoobotryon verticillatum and Vesicularia papuensis attached to the sea grass Halophila ovalis were collected from the Vellar estuary during the months of April (salinity=29 ppt) and September (salinity=28 ppt) respectively. Colonies of Bowerbankia gracilis were scraped from the stilt roots of the mangrove tree Rhizophora apiculata in the Pitchavaram mangroves (Fig. 1) during March (salinity=28 ppt) and Membranipora tuberculata was collected from oysters, Saccostrea cucullata and Saccostrea madrasensis in the backwater biotope of Parangipettai (Fig.
1) during April (Salinity = 28 ppt). The colonies were brought to the laboratory alive and adapted to laboratory conditions for about 24 hours before experimentation. Different salinities were prepared by diluting filtered sea water. The various salinities used for the experiments were 37.5, 35, 30, 25, 20, 15, 10, 7.5 and 3.75 ppt. These salinities were tested by the Knudsen-Mohr method before and after each experiment. The bryozoan colonies were kept on glass slides and immersed into bowls of 8 cm diameter. The bowls were covered with glass plates in order to avoid evaporation. Care was taken to see that only healthy and uninjured colonies were used in the experiments. In order to minimise the settling of suspended particles on the zooids, the slides with the specimens were slanted. Fresh plankton was provided as food. The test salinities were aerated at intervals of 2 hours. At least 2 colony fragments consisting of 10–30 zooids of each species were used for each salinity. The whole experiment was repeated thrice with an intervening period of one month, and the average values taken. Regular observations were made on the reactions of the zooids by using a stereotype binocular microscope every 2 hours or even earlier whenever warranted. The experiments were concluded after 24 hours. The responses of the zooids in various salinities are categorised as follows:

(a) Very active (almost all zooids actively protrude tentacles)
(b) Occasionally protrude the tentacles
(c) Seldom protrude the tentacles
(d) Torpid zooids (rotation of 'pyloric style'-visible)
(e) Dead (restoration of life unachievable even in optimum saline conditions)

The survivability of each species, expressed as a percentage, was determined by counting zooids still active after successive 2-hour intervals.

Results

The responses of the zooids exposed to various salinities against time are given in Fig. 2. The percentage of zooids surviving for each species is plotted in Fig. 3.

*Bowerbankia gracilis*

Zooids exposed to the highest salinity (37.5 ppt) were initially very active but the activity declined slowly, reaching a mortality rate of 40% by the end of the experiment. In 35 ppt, colonies were active during the first 13 hours and at the end of the experiment the survival rate declined to 90%. In 30 and 25 ppt, colonies were very active and healthy throughout the duration of the experiment, showing 100% survival. Zooids in 20 and 15 ppt were active during the first few hours followed by a decline in survival rate. The mortality rate of zooids in 10 ppt increased during the first hour, reaching 40% after 4 hours, with no active zooids in the colony. In 7.5 ppt, the zooids were very inactive even in the initial hours and the percentage surviving after 24 hours declined to 15%. In 3.75 ppt, mortality reached 90% within 30 minutes and at the end of 5th hour the specimens were found protruded with distorted tentacles.

*Zoobotryon verticillatum*

The highest salinity of 37.5 ppt was not very suitable for survival of the colony. The percentage surviving declined at a slower rate.
reaching 70% at the end of the experiment. In 35 ppt, the colonies responded actively till the 20th hour and the percentage surviving gradually decreased to 90% at the end of the experiment. In 30, 25 and 20 ppt salinity the colonies were found very active and the spread of tentacles was steady and normal throughout the experiment. In 15 ppt, the zooids showed good survival rates till the 15th hour, followed by a gradual decrease in the percentage surviving, reaching 85% at the end of the experiment. The zooids in 10 ppt were inactive after 1 hour exposure and the percentage surviving decreased to 40% at the end of the experiment. Movements in the alimentary canal of some zooids remained visible until the end of the experiment. In 7.5 ppt, zooids were inactive even during the last hour. The mortality rate increased steadily, reaching 75% at the end of the 24th hour. In 3.75 ppt, the organisms could not survive.

_Vesicularia papuensis_

In 37.5 ppt, percentage surviving declined to 70% by the end of 2 hours. Thereafter, there was a gradual decrease in the percentage surviving, reaching 40% after 4 hours exposure, followed by a sudden decrease in survival rate at the 7th hour leaving no zooids alive. In 35 ppt, the percentage surviving decreased gradually from 90% to 80% after 12 hours exposure. Thereafter, the colonies became moderately active with the percentage surviving remaining stable. In 30 ppt, colonies were very active and a 100% survival rate was observed throughout the experiment. In 25 ppt also, mortality was not observed till the end of the 20th hour; thereafter, a slight decrease to 90% in the numbers surviving which was maintained throughout the duration of the experiment. In 20 ppt, no mortality was observed throughout the experiment. In 10 ppt also, mortality was not observed till the end of the 20th hour; thereafter, a slight decrease in survival rate occurred, reaching 90%. In 3.75 ppt, the colonies died immediately after transfer.

_Membranipora tuberculata_

In 37.5 ppt, colonies were very active during the first 15 hours followed by a slight decrease in survival rate to 90% which remained constant for the remainder of the experiment. In 35, 30 and 25 ppt, 100% survival of zooids was observed throughout the duration of the experiment. In 20 ppt, also the colonies tolerated the grade to a substantial extent, however, at the end of the 16th hour, there was a decrease to 90% survival. In 15 ppt, the percentage surviving was 90% by the 4th hour and 80% at the end of the 10th hour.
Thereafter, no decline was noticed for the duration of the experiment. In 7.5 ppt, mortality rate was sudden, reaching 50% at the end of the experiment. In 3.75 ppt, no activity was noticed from the time of transfer.

**Discussion**

The present study has shown that a good capacity for survival exists over a wide range of salinity in *Zoobryon verticillatum* (15–35 ppt) and *Membranipora tuberculata* (20–37 ppt). *Bowerbankia gracilis*, a cosmopolitan species tolerated a moderate range of salinities between 25 and 35 ppt. *Vesicularia papuensis* showed a restricted salinity tolerance between 20 and 30 ppt, with the optimum at 25 ppt. The optimum survival capacity of *Bowerbankia gracilis* was found in salinities between 25 and 30 ppt, whereas in *Zoobryon verticillatum*, it was between 20 and 30 ppt. Colonies of *Membranipora tuberculata* tolerated salinities between 25 and 20 ppt, with a 100% survival. The salinity of the localities where the four species were collected was 28 or 29 ppt. Such values are within the range of salinity in which all the four species showed their optimum survival rates. Though the four bryozoan species belong to two different orders (Cheilostomata and Ctenostomata), there were no much variations observed in tolerance capacity.

It is of importance to note the distribution of bryozoan species in the various biotopes in the present study area. Generally the Parangipettai environs, the habitats from which the experimental animals were collected, are subject to wide seasonal fluctuations in water temperature and salinity (NAIR, 1989).

<table>
<thead>
<tr>
<th>Water temperature</th>
<th>Salinity</th>
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<tbody>
<tr>
<td>Postmonsoon (January-March)</td>
<td>25–29°C 15–26 ppt</td>
</tr>
<tr>
<td>Summer (April-June)</td>
<td>29–33°C 26–34 ppt</td>
</tr>
<tr>
<td>Premonsoon (July-September)</td>
<td>27–30°C 18–30 ppt</td>
</tr>
<tr>
<td>Monsoon (October-December)</td>
<td>24–26°C 3–8 ppt</td>
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The bryozoan population in this area was found to increase during summer and premonsoon seasons but showed a decline during the monsoon (NAIR, 1991). Investigation of the seasonal occurrence of Bryozoa in the area revealed that variation in salinity is the most important factor influencing species distribution (NAIR, 1989). The low salinity of the habitats would impose restrictions on the effective recruitment of larvae from the open sea. In the monsoon season, the bryozoan population declines in the areas studied because of the prevailing low salinity. It is assumed that during this season the immigration of bryozoan
larvae from the sea into the estuary and mangroves is not feasible and the initiation of a new colony might be possible only when the favourable environmental conditions recur. The rate of settlement of many fouling organisms has been reported to be very slow during the monsoon when the salinity of the water drops considerably in Indian harbours (Daniel, 1954; Ganapati et al. 1958; Menon and Nair, 1971). The two species of bryozoa which showed a wide range of tolerance to salinity in the present experiments, Membranipora tuberculata and Zoobotryon verticillatum, occur in the varied biotopes of Parangipettai despite environmental fluctuations (Nair, 1991). Hence these species are sufficiently euryhaline to ensure widespread distribution.

Menon and Nair (1970) studied the nature of tolerance to salinity in Victorella pavida and Electra crustulenta from Cochin waters on the south west coast of India. Colonies of V. pavida collected during September tolerated a wide range of salinity from freshwater to 10 ppt whereas colonies occurring in December showed a tolerance range from 16 ppt to 22.4 ppt. In a similar manner, E. crustulenta showed a range of tolerance from freshwater to 21 ppt and 16 ppt to 32 ppt in colonies collected during September and December respectively. Since the present study was carried out only during one season, the variation in tolerance levels at different seasons could not be assessed.

In the estuary, the distribution of organisms is chiefly influenced by abiotic environmental factors (Kinne, 1967). A fluctuating salinity would result in a diminished bryozoan stock (Cook, 1968). The settlement and colonisation of bryozoans in such a highly dynamic estuarine environment depend upon their capacity to withstand environmental stress due to salinity variations and regulate their body volume and osmotic concentrations accordingly.

**Summary**

1. Four species of bryozoans which are potential shallow-water foulers have been tested for their tolerance to various salinities.
2. The salinities used in the experiments ranged from 3.75 ppt to 37.5 ppt and the responses of the zooids in each grade were evaluated.
3. Colonies of Zoobotryon verticillatum (15-37 ppt) and Membranipora tuberculata (20-37.5 ppt) were found to tolerate a wide range of salinities.
4. Colonies of Bowerbankia gracilis (25-35 ppt) and Vesticularia papuensis (20-30 ppt) were found to be moderately euryhaline.
5. The present experimental study supports an earlier ecological inventory on the distribution of bryozoans in the area, demonstrating that the low salinity conditions result in fewer numbers and species.

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**References**


