SALINITY TOLERANCE OF SOME BIVALVES OF ENNORE ESTUARY

ABSTRACT

The clam *Meretrix meretrix*, the green mussel *Perna viridis* and the oyster *Crassostrea madrasensis* exist in the Ennore Estuary. The 'bar' is open throughout the year and as a result except during the Northeast Monsoon period when there is significant fall in salinity, higher salinity as in the inshore waters are prevalent. The present investigations were designed and aimed at studying the salinity tolerance of the above mentioned bivalves. In the experiments conducted they were subjected to a series of salinity changes ranging from 0 to 35‰. The rates of mortality of the animals in different salinity media were noted at the end of 24 hours for a consecutive period of ten days. It was found that the bivalves were tolerant to the salinity change of the experimental media when the survival rate was 50% and above at the close of this period. The results obtained show that *Crassostrea madrasensis*, *Meretrix meretrix* and *Perna viridis* can tolerate an approximate low salinity of 7, 13 and 16‰ respectively under laboratory conditions.

ALTHOUGH the molluscan resources along the Indian Coast are enormous, investigations on salinity tolerance, which is an essential prerequisite for aquaculture, are very few (Abraham, 1950 ; Ranade and Kulkarni, 1973 ; Rao, 1951 a). Estuarine animals are subjected to various biotic changes, the chief factor being salinity. The inhabitants of the estuary are mostly recruited from the sea and it is well known that the distribution pattern of bivalves is correlated with salinity. The salinity factor has been studied from various angles by several workers from different parts of the world (references in Vern berg and Vern berg, 1972).

The object of the present work was to study the low salinity tolerance under laboratory conditions of the commercially important bivalves *viz.*, *Meretrix meretrix*, *Crassostrea madrasensis* and *Perna viridis* of the estuary of the Kortalliar River at Ennore (Ennore Estuary). This estuary had no permanent communication with the Bay of Bengal till the end of 1972. The intermittent closing and opening of the 'sand bar' at the mouth of the river has resulted in great fluctuations in salinity of the waters of the estuary. Enormous quantity of water has been pumped from the estuary into the Ennore Thermal Station for cooling purposes and this has resulted in high mortality of bivalves due to continuous exposure. Recently the Tamilnadu Electricity Board has taken up a project for keeping the bar mouth open permanently. The bivalve beds, thinned out some years ago have reestablished since the opening of the bar permanently from January 1973. More or less marine conditions prevail in the estuary throughout the year except during the NE monsoon period (October-December).

Material and methods

Collections of adult clams, oysters and mussels were made from Ennore Estuary near Madras. The bivalves were brought to the laboratory, cleaned and stored in the water

collected from the estuary for two days. Required experimental salinities were made by diluting sea water (36‰) collected from Marina Beach, Madras, with distilled water. In each experiment ten 'healthy' animals were used. The animals were directly transferred to the various gradations of experimental salinity. The experiments were conducted in rectangular enamel trays of 4.5 litres capacity by filling them with 4.0 litres of respective media. Artificial aeration was provided in all experiments. The temperature was maintained between 25° and 28°C (room temperature). Water was changed every 48 hours and the dead animals were removed periodically. No food was provided to the bivalves while under storage and experimental period. The experiments were conducted from July to October 1974. Salinity of the sea water was determined by titration with silver nitrate using potassium chromate as indicator. The experiments were repeated three times in all cases. The length of clams, mussels and oysters used in the experiments varied from 40-50, 70-80 and 70-100 mm respectively. Observations were made at the end of 24 hours from the commencement of the experiment and the mortality rate and behaviour of the bivalves were recorded for a consecutive period of ten days. The animals were considered dead if they gaped and failed to respond to external stimuli. When the survival rate was 50% or abve at the end of the experimental period, the animals were regarded as tolerant to the salinity changes of the experimental media.

Results

Meretrix meretrix: The clams were subjected to the following salinities; 0, 2, 4, 6, 9, 11, 13.5 and 17.5‰. The results are presented in Table 1. The data show that there was 100% mortality at the end of the 7th day in the first six media. In 13.5‰ saline water the mortality was reduced to 40% and in 17.5‰ and above

TABLE 1. *Percentage of mortality of* Meretrix meretrix *in different salinities*

No. of days	Salinity (‰)							
	0	2	4	6	9	11	13.5	17.5
1 ..	—	—	—	—	—	—	—	—
2 ..	20	50	—	—	—	—	—	—
3 ..	50	30	40	20	20	—	—	—
4 ..	30	20	30	50	20	20	—	—
5 ..	—	—	30	20	40	20	—	—
6 ..	—	—	—	10	20	40	10	—
7 ..	—	—	—	—	—	20	10	—
8 ..	—	—	—	—	—	—	10	—
9 ..	—	—	—	—	—	—	—	—
10 ..	—	—	—	—	—	—	10	—
	100	100	100	100	100	100	40	0

100% survival was noticed. The valves of the clams were tightly closed on all days in 0 to 6‰ saline water after 48 hours of the commencement of the experiment. The siphons and foot were slightly protruding out. But the animals were responding to external stimuli at a very slow rate. From 11‰ salinity onwards clams were found active. The siphons and foot were withdrawn into the shell cavity at the slightest disturbance.

Crassostrea madrasensis: The animals were subjected to the following salinities: 0, 2, 4, 6, 7, 9, 11, 12, 13.5, and 17.5‰. The results are given in Table 2. From 0 to 4‰ salinities 100% mortality occurred within five days. From 7‰ salinity onwards 100% survival had been observed. The oysters tightly closed their valves and showed no activity in 0, 2 and 4‰ salinity. They gaped open their valves when mortality occurred. In 6‰ salinity from the sixth day onwards the live oysters exhibited slight activity. In 7‰ salinity there was no activity till the end of the third day and activity was noticed from the fourth day onwards.

Perna viridis: The mussels were subjected to the following experimental salinities: 0, 4, 8, 11, 12, 13.5, 16 and 17.5‰.

TABLE 2. *Percentage of mortality of* Crassostrea madrasensis *in different salinities*

No. of days	Salinity (‰) 0	2	4	6	7	9	11	13.5	17.5
1 ..	—	—	—	—	—	—	—	—	—
2 ..	50	40	20	—	—	—	—	—	—
3 ..	20	—	20	40	—	—	—	—	—
4 ..	—	40	—	20	—	—	—	—	—
5 ..	30	20	60	—	—	—	—	—	—
6 ..	—	—	—	—	—	—	—	—	—
7 ..	—	—	—	—	—	—	—	—	—
8 ..	—	—	—	—	—	—	—	—	—
9 ..	—	—	—	—	—	—	—	—	—
10 ..	—	—	—	—	—	—	—	—	—
	100	100	100	60	0	0	0	0	0

The results are given in Table 3. Hundred per cent mortality occurred in 0, to 11‰ salinity within four days of the commencement of the experiments. The mussels were found to be slowly tolerating the salinity from 12‰ onwards. At the close of the experiments 10, 20 and 50% survival was noticed in 12, 13.5 and 16‰ salinities respectively. Hundred per cent survival was noticed in 17.6‰ salinity onwards. Upto 11‰ salinity mussels showed no activity and the valves were kept tightly closed. From 12‰ salinity the mussels produced byssal threads and attached themselves on to the sides of the trays.

TABLE 3. *Percentage of mortality of* Perna viridis *in different salinities*

No. of days	Salinity (‰) 0	4	8	11	12	13.5	16	17.5
1 ..	—	—	—	—	—	—	—	—
2 ..	100	70	60	40	10	—	—	—
3 ..	—	30	40	40	10	20	—	—
4 ..	—	—	—	20	20	—	—	—
5 ..	—	—	—	—	30	30	10	—
6 ..	—	—	—	—	—	10	30	—
7 ..	—	—	—	—	10	10	—	—
8 ..	—	—	—	—	10	—	10	—
9 ..	—	—	—	—	—	—	—	—
10 ..	—	—	—	—	—	—	—	—
	100	100	100	100	90	70	50	0

Discussion

Salinity is one of the important factors that affect the distribution of a species in an ecosystem. Knowledge of minimum salinity tolerance of commercially important bivalves such as clams, oysters and mussels will be of prime importance for taking up culture experiments along the shallow coastal areas.

It could be deduced from the experiments conducted that *Crassostrea madrasensis* is more tolerant to low salinities surviving in as low as 7‰ salinity. This finding agrees with the results of most of the field observations carried out on the American oyster *Crassostrea virginica* (Vernberg, *et al.*, 1963; Loosanoff, 1952; Andrews, 1953; Chanley, 1958; Davis, 1958). Rao (1974) has also recorded that *Crassostrea madrasensis* of Athankarai Estuary tolerate salinity as low as 7.13‰. During the present study some of the oysters kept at 0 to 4‰ of salinity closed their valves tightly and survived upto five days. This adaptation of closing the valves very tightly is quite helpful for these animals to tide over the unfavourable conditions during monsoon period.

The present investigations revealed that the clam *Meretrix meretrix* tolerate salinity upto 13.5‰. It is interesting to note that Ranade and Kulkani (1973) found that the above species survived in as low salinity as 10.5‰ in Kalbadevi Estuary. One of the plausible explanations for this difference may be the conditions in the natural environment from which the animals were taken for experiments. Since the lowest salinity observed in Kalbadevi and Ennore Estuaries is 4 and 15‰ respectively. In this connection the statements made by Kinne (1967) and Vernberg *et al.* (1963) that the animals acclamatized to low

salinity have greater resistance to low salinities is significant and in agreement with the present findings.

Perna viridis tolerate upto 16‰ salinity. Water pumping and byssus formation were noted during the experiments at 16‰ and above. Bayne *et al.* (1975) stated that the formation of byssus threads can be a sensitive index of the effects of salinity (and other environmental factors) on mussels. It is also observed that the green mussel seems to show the least tolerance to lower salinities such as 10 to 11‰. The animals died within three days from the commencement of the experiment in the above low salinities. Several workers have also arrived at the same results with mussels like *M. edulis* (Bayne *et al.*, 1975; Castanga and Chanley, 1973; Dodgson, 1958; Motwani, 1956; Schliepier, 1953), *M. californianus* (Bayne *et al.*, 1975) and *M. viridis* (Davis, 1969).

From the above experiments it is seen that *Perna viridis* require higher salinity for survival when compared to other bivalves like *M. meretrix* and *Crassostrea madrasensis* occurring in the Ennore Estuary.

Central Marine Fisheries Research Institute, Cochin-682 031.

K. S. SUNDARAM*
M. SYED SHAFEE

REFERENCES

ABRAHAM, K. C. 1953. *J. Zool. Soc. India*, 5 : 163-190.

ANDREWS, J. D. 1953. *Fouling organisms of Chesapeake Bay*. Chesapeake Bay Inst., Inshore Survey Program, Ref. 53.3, Interim Rept. 17, 16 p.

BAYNE, B. L., R. J. THOMPSON AND J. WIDDOWS 1975. Chapter 5 Physiology : 1 *In IBP* 10 *Marine Mussels : their ecology and physiology*. Cambridge University Press : 200-205.

CASTANGA, M. AND P. CHANLEY 1973. *Malacologia*, 12 (1) : 47-96.

CHANLEY, P. E. 1958. *Proc. natn. Shellfish Assoc.*, 48 : 52-65.

DAVIS, H. C. 1958. *Biol. Bull.*, 114 : 296-307.

DODGSON, R. W. 1958. *Gr. Brit., Min. Agri. Fish. Invest. Ser.*, 2 (10) : 1-498.

KINNE, O. 1967. *In* : G. H. Lauff (Ed.) *Estuaries. Amer. Assoc. Advance. Sci.*, 83, Washington, D.C. p. 525-540.

LOOSANOFF, V. L. 1952. *Proc. natn. Shellfish. Assoc.*, 43 : 135-151.

MOTWANI, M. P. 1956. *Proc. natn. Inst. Sci.* (India) *Biol. Sci.*, 21 (B5) : 227-246.

RANADE, M. R. AND C. V. KULKARNI 1973. *J. Bombay. Nat. Hist. Soc.*, 69 (3) : 616-634.

RAO, K. SATYANARAYANA 1974. *Bull. cent. mar. Fish. Res. Inst.*, 25 : 4-39.

RAO, K. VIRABHADRA 1951 a. *Proc. Indian. Acad. Sci.*, 33 : 231-256.

SCHLIEPER, C. 1953. *Naturwissenschaften*, 40 : 538-539.

VERNBERG, F. J., C. SCHLIEPER AND D. SCHNEIDER 1963. *Comp. Bio. chem. Physiol.*, 8 : 271-285.

VERNBERG, W. B. AND F. J. VERNBERG 1972. *Environmental Physiology of Marine Animals*. Springer-Verag, New York. pp. 346.

* Present Address : Bombay Research Centre of Central Marine Fisheries Research Institute, Army & Navy Building, 2nd Floor, 148 M. G. Road, Bombay-400 001.