STUDIES ON THE SALINITY TOLERANCE OF THE VENERID CLAM, *PAPHIA MALABARICA* (CHEMNITZ)

ABSTRACT

Salinity tolerance, lethal lower salinity and mortality rates in different salinity treatments of the small (15-20 mm APM) and large (30-35 mm APM) venerid clam, *Paphia malabarica* were studied. The studies revealed that on sudden exposure from a pre-acclimation salinity of 22 ppt, both the size groups could tolerate a salinity range of 12 ppt to 40 ppt. The lethal lower salinity was determined based on 50% mortality. It was seen that larger clams are more tolerant to lower salinities. Between 20 ppt and 30 ppt both the size groups recorded no mortality. Observations on the conditioning time showed the fastest conditioning between 20 ppt and 30 ppt. Large clams conditioned faster in lower salinities and *vice versa* in higher salinities.

CLAMS are by far the most widely distributed and abundant among the exploited bivalve resources of India. These heterodont bivalve molluscs form subsistant fisheries in the rivers, estuaries and in hore waters all along the Indian coast. Clam meat is a nutritious and cheap source of protein-rich seafood. There has been considerable demand for the meat of certain species, both in domestic as well as international markets. Clam culture is practised in several countries on a commercial or semi-commercial scale and India is yet to take off in this respect.

Salinity is considered as unique factor initiating functional responses in marine and estuarine animals. It is well known that estuaries and adjoining marine realms in general, are subjected to wide variations in salinity under the impact of tidal and seasonal changes. Since bivalves are mostly estuarine or nearshore in nature, they are highly influenced by these salinity variations, especially dilutions.

A good deal of work has been carried out on salinity and its ecophysiological impact on clams. Clams like *Meretrix casta* (Abraham, 1953; Durve, 1963; Salih, 1978; Rao, 1988); *M. meretrix* (Sundaram and Shafee, 1989), *Villorita cyprinoides* (Nair and Shynamma, 1975; Panikkar, 1989), *Katelysia opima* (Ranade and Kulkarni, 1973; Mane, 1974) *P. laterisulca* (Mane and Dhamne, 1980), *Donax cuneatus* (Talikhedkar and Mane, 1976) and *Sunetta scripta* (Thampuran *et al.,* 1982) have been studied in this regard.

The clam *Paphia malabarica* is one of the most important venerid clam species sought after from the point of view of commerical fishery and culture. This clam supports a very good fishery in Ashtamudi Lake of Kerala *(Appukkuttan et al.,* 1988). As salinity highly influence the fishery and culture of this species, an attempt has been made to investigate through laboratory experiments, the optimum tolerable levels of salinity for two size groups, small and large, of *P. malabarica* and their percentage of mortality at different salinity levels.

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MATERIAL AND METHODS

Sea water collected was settled, filtered and used for preparing experimental dilutions, with aged, filtered tap water. The dilution were made using the formula.

$$V = \frac{\text{Required salinity (ppt)}}{\text{Known higher salinity of sea water (ppt)}} \times 1000$$

where 'V' gives the volume of sea water

of known salinity to be taken and diluted with freshwater to make up 1 litre of solution of desired salinity. Higher concentrations were made by dissolving the required amount of common salt in sea water of known salinity, then settled, filtered and used. All the saline solutions made were checked for accuracy following Mohr's method. The experiments were conducted at a water temperature of 28 ± 2°C. The dissolved oxygen and pH levels showed least variation.

Two size groups, small (15-20 mm APM) and large (30-35 mm APM) *P. malabarica*, were selected for the study. The test animals were collected from the natural bed in Ashtamudi Lake at Kollam in Kerala. The animals were acclimated at habitat salinity for 48 hours in 40 litre capacity plastic tubs and fed with pure laboratory raised culture of *Chaetoceros* spp.

8 litre capacity plastic tubs were used for conducting the experiment. Volume of the prepared salinity solutions were kept at a constant level of 4 litres per container.

The salinity tolerance experiments were conducted in two parts:

(i) To determine the approximate highest and lowest salinity levels tolerated by the clams and the mortality rates in between, on sudden transfer from acclimation salinity to different test salinities. The dilution were given at 5 ppt intervals such as 0.5, 10, 15, 20, 25, 30, 35 and 40 ppt. A control was set at the habitat salinity of 22 ppt. All the sets were taken in triplicate, stocking 10 animals each from two size groups in each tub. The experiment lasted 10 days, during which no feeding was done, but provided constant aeration. Complete water exchange was done every 48 hours. The salinity treatments in which atleast 50% of the test animals in each size groups survived at the end of 10 days exposure were considered to be within the tolerable range and the rest as lethal. Observations were also made on the *conditioning time of the test animals to different* salinities on the basis that 50% of animals of each size group start their activity by opening the shell. Dead animals were removed immediately and water was changed.

(ii) On the basis of result obtained from the first experiment, the second experiment was conducted for determining the lowest lethal salinity of both size groups where 50% mortality sets in. The stocking pattern and other conditions were kept same as the first experiment. The salinity treatments given were at 1ppt intervals such as 11, 12, 13 and 14 ppt, run in duplicate. The conditioning time with respect to these salinities were also recorded.

The data of salinity tolerance studies were subjected to probit analysis to obtain the ED-50 value of salinity for the two different size groups.

Results and Discussion

a. Salinity tolerance

(i) Mortality was not recorded in the salinity treatments of 20, 25 and 30 ppt, along with the control salinity of 22 ppt, for both the size groups of *P. malabarica*. So the range of 20-30 ppt salinity could be considered as optimum for both the size groups of this species. Whereas, 100% mortality was recorded for both small and large size groups in 0 and 5 ppt treatments.

In 35 and 40 ppt, the smaller clams recorded 3.33% and 9.99% mortality respectively while larger clams recorded a mortality of 6.69% and 13.32% respectively. The mortality rates at 10 and 15 ppt for small and large clams were 69.98%, 23.32% and 66.63%, 19.99% respectively, indicating that the critical lethal lower salinity is between 10 ppt and 15 ppt, where 50% mortality occurs.

(ii) Lethal lower salinity for both the size groups were determined from the second experiment. Since 50% mortality was recorded by small clams in 12 ppt and 13 ppt and by large clams in 12 ppt, these salinities can be considered as critical lower salinity the species can tolerate, under laboratory conditions. All the salinity levels below 12 ppt was recorded lethal for both the size groups. (Fig. 1).

From these results, it could be considered that the small (15-20 mm APM) and large (30.35 mm APM) size groups of *P. malabarica* can survive at salinities ranging from 12-40

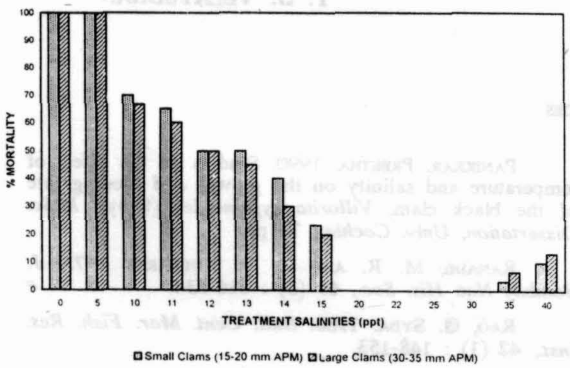

FIG. 1. *% mortality of clams at different salinity treatments.*

ppt with a best tolerable range between 20 and 30 ppt. Probit analysis shows that ED-50 value for small clams is 11.6787 ppt and that for large size group is 11.3915 ppt, which is very close to the observed.

Similar observations were made by Sundaram and Shafee (1989) in *Meretrix meretrix*, limiting the lower tolerable salinity to 13 ppt under laboratory conditions. According to Salih (1978), small *M. casta* can tolerate 15 to 35 ppt. adjudged by 50% survival, where as medium sized and large clams could tolerate 20-35 ppt. *Katelysia opima* could tolerate a lower range upto 14 ppt under laboratory conditions (Ranade and Kulkarni, 1973). Here also, it is found that *M. meretrix* tolerates lower salinity even upto 10.5 ppt on sudden transfer. According to Mane and Dhamne (1979) *Paphia latrisulca* tolerates dilution upto 19.2 ppt. The range of salinity tolerance documented for these clams stands very close to that obtained for *P. malabarica.*

TABLE 1. *Conditioning time of clams to different experimental salinities (hrs)*

ppt / Size group	12	13	14	15	20	22	25	30	35	40
Small clams (15-20 mm APM)	64	40	17	11	1	1/4	2	2	6	12
Large clams (30-35 mm APM)	36	14	9	7	1	1/4	3	4	11	18

b. Conditioning time

The conditioning time varied with the size groups as well as salinity treatments (Table 1). It was observed that large clams conditioned faster to lower salinity treatments. The lowest conditioning time was recorded in 22 ppt solution for both the size groups. Both the size groups got conditioned within 1 hr. when introduced to 20 ppt salinity. The small clams took around 2 hrs. to get conditioned to 25 and 30 ppt saline solutions, while the large clams took 3 hrs. and 4 hrs. for conditioning respectively in the same salinities. At 35 and 40 ppt, the conditioning time was 6 hrs and 12 hrs. respectively for small clams and the large one took more time, 11 hrs and 18 hrs. in the respective media. None of the animals opened their shells till death in 0 and 5 ppt. It is worth mentioning that the survived small and large clams in the 10 ppt treatment started activity after 148 hrs and 172 hrs respectively. A similar observation was also made in 11 ppt. where the survived small and large clams resumed their activity after 112 hrs and 88 hrs. respectively.

At lethal lower salinity, the large clams took considerably lower time (36 hrs) than small clams (64 hrs) for conditioning. Similar trend was observed in 13, 14 and 15 ppt too. The conditioning time and lethal salinity experiments clearly reveal that larger clams are more tolerant to lower salinity levels than smaller ones, which get adapted faster to higher salinity ranges of 35 and 40 ppt.

A progressive delay in shell opening and activity with higher and lower salinities has been recorded in *Donax cuneatus* (Talikhedkar and Mane, 1976), *Meretrix casta* (Durve, 1963), *M. meretrix* (Randea and Kulkarni, 1973). *Katelysia opima* (Renade and Kulkarni, 1973; Mane, 1974) and *P. laterisulca* (Mane and Dhamne, 1980). By closing the valves indefinitely, the animal isolates itself from the unfavourable environment. The indefinite closure of valves beyond critical salinity was observed in the present study at 0 and 5 ppt treatments. However, the animal is unable to ensure complete closure for a prolonged period, which proves detrimental.

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TERRESTRIAL INSECTS IN FLOTSAM IN INDIAN OCEAN

ABSTRACT

Pleuston samples from Arabian Sea, Bay of Bengal and Indian Ocean contained a number of terrestrial insects/insect parts. The deposition of terrestrial insects in these regions varies from as low as 0.462 kg/km^2/yr. in Indian Ocean to 3.224 kg/km^2/yr. in Arabian Sea, values which are less than 0.01% of the phytoplankton productivity.

Transport of insects by wind from terrestrial to marine environments is well recognised now (Bowden and Johnson, 1976). However, much remains to be done to know the frequency with