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# INVASION OF *CLIONA MARGARITIFERA* DENDY AND *C. LOBATA* HANCOCK ON THE MOLLUSCAN BEDS ALONG THE INDIAN COAST*

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ABSTRACT

In the recent past the invasion of two new sponge pests *Cliona margaritifera* Dendy and *C. lobata* Hancock on the molluscan beds of the southwest coast of India is reported. These two new pests made their first appearance on cultured pearl oysters on raft at Vizhinjam in 1980 and thence started spreading to the economically important molluscan beds in and around Vizhinjam. The spreading of these pests along the southwest coast of India was rather fast and from this coast *C. margaritifera* could migrate to the raft-cultured pearl oysters at Tuticorin and *C. lobata* to the chank beds off Thiruchendur (southeast coast) within two years *i.e.* by 1982.

When these two new pests started spreading to molluscan beds off Vizhinjam there was a sudden spurt in the general incidence and infection pattern in every bed either through their own activity or through triggering the activities of others (conventional species) that are in the various beds. The initial hike in their incidence subsided gradually in natural beds and reached a level very close to that seen prior to invasion. But such a regulatory trend was not at all discernible in the culture systems indicating that the ecological equilibrium which is at play in the natural beds is no longer in operation in the man-made system *viz.* culture rafts.

The conventional boring species competed with the new invaders in all the beds and culture systems and in this competition the new invaders proved to be more adaptable. But in final analysis when species from each group (conventional and new invaders) is considered individually, it could be noticed that *C. celata* Grant from the conventional and *C. margaritifera* from the new invaders are more adaptable. In some beds the adaptability shifted from *C. celata* to *C. vastifica* Hancock which is another widespread and coextensive native species. The reason for this behaviour though not clear, may be attributed to their historical dominance in that particular bed.

It is also suggested in this paper that *C. margaritifera* is capable of devastating any molluscan bed as was seen in the Ceylon (Sri Lanka) pearl banks in 1902. The reappearance of *C. margaritifera* at Tuticorin after a lapse of several years might pose a serious threat to the entire molluscan population in the Gulf of Mannar. A continuous monitoring of the activities of *C. margaritifera*, hence, is necessary on a long term basis.

## INTRODUCTION

MANY SPECIES of sponges are capable of boring into shells of molluscs, both live and dead, causing considerable damage or even death to molluscs. As no trophic relationship is involved in this association, the mollusc merely providing the calcareous substratum for the invaders to bore into, the death of the mollusc will never affect the well being of the sponge adversely.

Gregarious molluscan beds of the Indian waters are infected by various species of boring

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sponges. Since no calcareous material, other than the shell of these molluscs, is available in the beds the competition for space becomes acute. Unfortunately, no data on the intensity of boring, the various species of sponges which compete with each other for space, the success and failure of component species both in time and space, are available except for some data of 'wormed' chanks maintained by the Fisheries Department of Tamil Nadu for the period 1931 to 1966 (Table 1). But this too is rather insufficient to throw any light on the species composition of the various boring sponges.

Though there have been several publications on boring sponges in the past, these have helped only in a qualitative assessment of the boring sponges of the Indian Seas. The first report on *Cliona margaritifera* Dendy, as a major pest of the pearl oyster of Ceylon (presently Sri Lanka), requires special mention in this context as it dealt with an epidemic which devastated the pearl banks of Sri Lanka in 1902. The entire collection made by Prof. Herdman from the pearl banks was later worked out by Dendy (1905) and he recorded no species other than *C. margaritifera*. Probably the first attempt at studying both the quantitative and qualitative aspects of such infestation is that of Thomas (1979) on the boring sponges infesting the coral reefs and molluscan beds. In this study, made in 1969-70, 32 species of boring sponges were recorded, of which only a few were moderately active and these, in the order of abundance were *Cliona celata* Grant, *C. vastifica* Hancock and *C. carpenteri* Hancock on chanks and edible oysters; *C. vastifica* and *C. celata* on pearl oysters. The possibility of a future change in this pattern and the importance of this 1969-70 study as a basis for a latter comparison were also stressed in the above paper.

Since the 1969-70 survey the senior author could study boring sponges from Goa, the southwest coast of India and the Lakshadweep Archipelago. Apart from these, the senior author could also study collections from different areas of the Indian Ocean such as the Seychelles Bank, Mozambique Channel, Zanzibar, Mombasa, Gulf of Kutch, Andamans, etc. Based on these studies it may be stated that a major event that took place in the molluscan beds of the Indian seas is the invasion by both *C. margaritifera* and *C. lobata* on the molluscan beds of the southwest coast. The present account highlights this, against the changes that have taken place in the various molluscan beds of the Indian seas after the first assessment in 1969-70.

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## Conventional Species and Their Incidence

The composition of species inhabiting (conventional) the molluscan beds of Nagapattinam, Lakshadweep, Andamans, Ceylon (Sri Lanka), Gulf of Kutch, Gulf of Mannar and Palk Bay were investigated by Thomas (1979). Both gregarious and other species totalling 21 were analysed during the 1969-70 survey. The number of boring sponge species infesting the above molluscs was 6 and these in the order of abundance were *Cliona celata* (67%), *C. vastifica* (27.5%), *C. carpenteri* (4%), *C. orientalis*, *C. annulifera* and *Aka minuta* (0.5% each). The last mentioned three species had very rare occurrence and that too in shells which are economically not important and also on corals. No specimens of either *C. margaritifera* or *C. lobata* could be noted in the above 21 species of molluscs.

The picture that emerged after a bed-wise survey of the pearl and chank populations There were only two species of boring sponges infesting the pearl oyster population and they

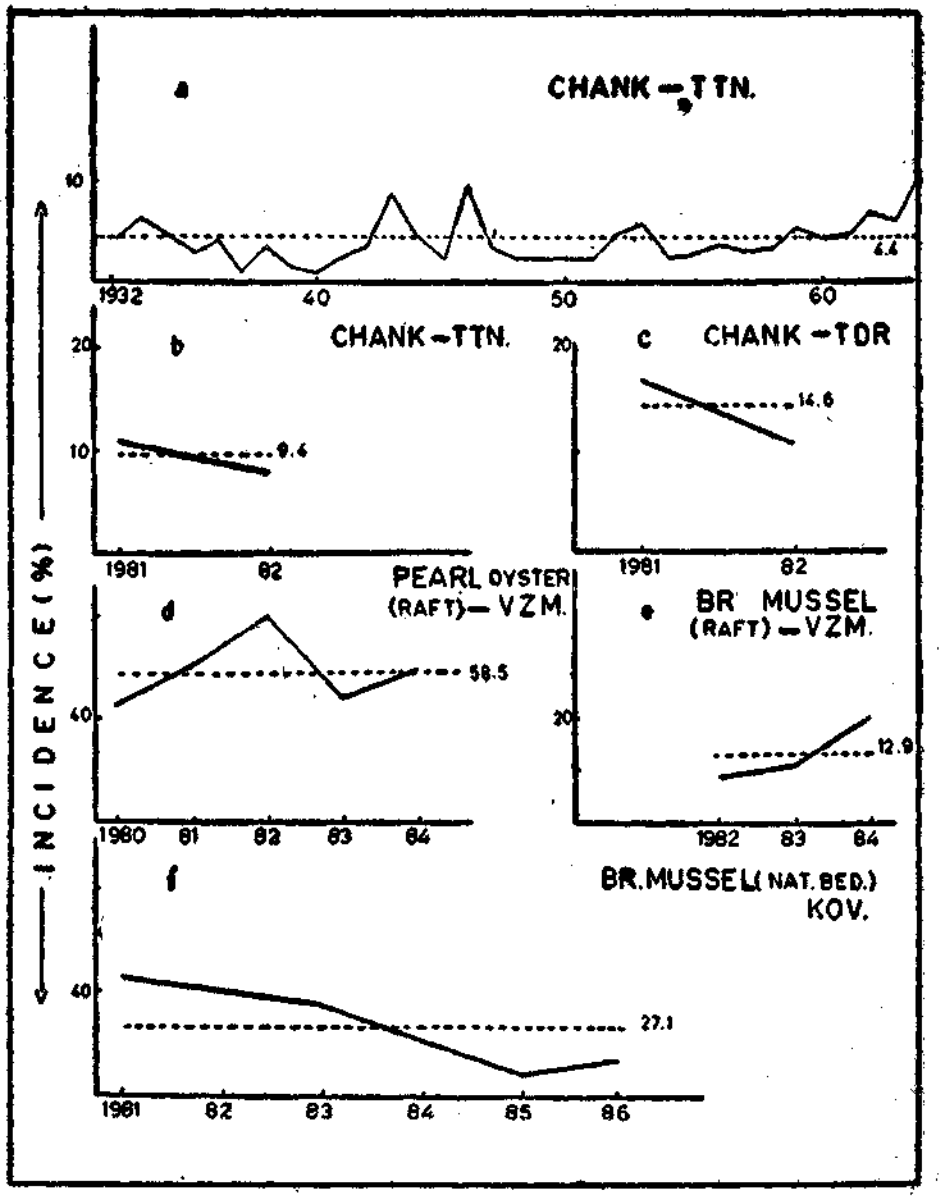


FIG. 1. The incidence (%) of boring sponges on : A. Chank bed, Tuticorin for the period 1932-60 ; B. Chank bed, Tuticorin for 1981 and 1982 ; C. Chank bed, Thiruchendur for 1981-82 ; D. Raft cultured pearl oysters at Vizhinjam for the period 1980-84 ; E. Raft cultured brown mussel for the period 1982-84 and F. Brown mussel from natural bed, Kovalam for the period 1981-86. The average incidence is indicated by broken line.

in the Gulf of Mannar is not much different from that given in the above paragraph. The chank population during this period, were *C. vastifica* (60%) and *C. celata* (40%).

was infested by 3 species of sponges *viz.* *C. celata* (68.7%), *C. vastifica* (27.9%) and *C. carpenteri* (3.4%).

Besides the results of the above survey, some information on the incidence (% of infection) of boring sponges is available on the sacred chank (*Xancus pyrum*) shells fished along the coast off Tuticorin, Districts of Ramanathapuram, Sivaganga, Thanjavur and Kanyakumari (Nagappan Nayar and Mahadevan, 1974). Of the above beds the data pertaining to Tuticorin alone are available for a longer period (1931-66), while the same for other beds are only for a shorter period (Fig. 1 a). Details regarding the beds, range and mean of incidence are given in Table 1.

TABLE 1. *Incidence (%) of boring sponges in different beds*

| Beds off | Period | Range | mean |
|---|---|---|---|
| Tuticorin | .. 1931-1936 | 1.31-13.8 | 4.48 |
| Thanjavur Dt. | .. 1952-1966 | 1.20-24.47 | 11.00 |
| Ramanathapuram Dt. | .. 1954-1958 | 1.92- 8.42 | 5.8 |
| Sivaganga Dt. | .. 1954-1957 | 2.28-19.75 | 15.67 |
| Kanyakumari | .. 1957-1963 | 0.02-21.24 | 9.12 |

The above Table indicates that sponge infection in different chank beds fluctuated considerably. But the average incidence (%) was found to be low in regularly fished beds (Tuticorin) and high in occasionally fished beds (off Thanjavur Dist.) with an overall range of 0.02 to 24.47%.

## INVASION OF *C. MARGARITIFERA* AND *C. LOBATA* ON INDIAN BEDS

Investigations were initiated in 1980 on the boring sponges infecting the economically important molluscs of the southwest and southeast coasts of India, such as the sacred chank, mussel (both green and brown), cultivated pearl oysters, rock oysters, *Thais* spp., *Spondylus* sp., and *Pseudochama* sp.

The cultivated pearl oysters (both *P. fucata* and flat oysters) at Vizhinjam in 1980, revealed the presence of both *C. margaritifera* and *C. lobata* and this prompted a thorough investigation of the nearby centres where gregarious populations of molluscs flourish. This revealed the presence of these two species in some of the other beds also in stray numbers. Hence, it is difficult to say when and where these two new invaders appeared first. There is every possibility that some specimens in their quiescent stage occurring in deeper areas got reactivated and spread into the molluscan beds along the southwest coast.

Some information on the past history of these two species is worth recording in this context. *C. margaritifera*, after its first report from the pearl banks of Ceylon (Sri Lanka) in 1905 by Dendy who considered it instrumental in destroying the pearl banks of Sri Lanka, was absent in subsequent surveys from the Gulf of Mannar or from the other parts of the Indian seas. The reemergence of the species in the Indian seas after a long interval of about 80 years is interesting. There is every likelihood that this species might repeat its destructive phase again in the Indian molluscan beds.

*C. lobata* is a common oyster pest in the Atlantic Ocean and is also common in the western central Pacific infesting dead corals. The only record of the species from the Indian seas is that of Burton (1937) from the Gulf of Mannar. The presence of this species now, in alarmingly high proportion, in the molluscan beds of the southwest coast of India, hence, would pose a serious threat to the molluscan beds of the Indian seas as a whole. This could also cause epidemics in the molluscan beds at times.

In almost all beds the new invaders outdid the conventional species and this, in turn

resulted in a sudden hike in the percentage of their incidence. The sudden spurt in the incidence pattern of new invaders declined in the natural beds, but in artificial beds (*i.e.* on culture rafts) the upward trend was retained for a longer period. The interaction of the various boring species effecting both in the natural beds and culture systems was carefully followed and the salient findings that emerged are as follows :

*Cultured pearl oysters at Vizhinjam*

As a part of the pearl culture experiments both *P. fucata* and flat oysters were reared on rafts at Vizhinjam from 1975 onwards. Unfortunately, no data are available on the composition of boring sponges infesting these cultured stocks prior to the initiation of the project on 'boring sponges' in 1980 except for some information given by Appukuttan (1987) indicating that the sponge infection noted on the farm-grown pearl oyster was 3-8% during 1977-80 period. According to him no serious destruction was caused by boring sponges.

The incidence rate noted subsequently at Vizhinjam pearl culture rafts was high : during 1980 it was 47% and from then onwards it showed an increasing trend reaching 60% by 1981 and 80% by 1982. During 1983 there was a downward trend (48%), but it again went upto 57.7% by 1984, the average incidence for the period 1980-84 working out to 58.5% (Fig. 1 d).

Infection by sponges has been observed to make the oysters susceptible to damage by polychaetes and other infestors (Alagarswami and Chellam, 1976). The recent work carried out at Vizhinjam indicates that 10% of *P. fucata* and 3% of flat oysters cultured in 1980 were infected with the polychaete *Polydora* sp. In 1981 the rate increased to 23% and by 1983 it reached a very high level of 53. In 1984, however, the incidence declined to 40%. The infection rate of pests (sponges and polychaetes) increased gradually in the culture systems both at Vizhinjam and Tuticorin alike and the rate was well above that in the natural beds.

During the investigations there were only four species of boring sponges infecting raft-cultured pearl oysters. Of these, *C. vastifica* and *C. carpenteri* were common species on the Indian molluscs, and *C. margaritifera* and *C. lobata* were new invaders. During 1981, *C. celata*, another common species, made its appearance on the farm-grown oysters making the total number of boring species 5. The composition of *C. margaritifera* was found to be the highest *i.e.* 50% followed by that of *C. vastifica* (22.2%). *C. lobata* occupied the third position (16.6%) while the composition of both *C. carpenteri* and *C. celata* were rather insignificant (5.6% each).

The interaction of the various species of sponges and the resultant changes in their incidence and percentage composition in the pearl culture system at Vizhinjam are presented in Table 2.

TABLE 2. *Species of boring sponges, their yearwise incidence and percentage composition at Vizhinjam*

| Species | 1980 | 1981 | 1982 |
|---|---|---|---|
| *C. margaritifera* .. | 50.0 | 50.0 | 50.0 |
| *C. lobata* .. | 20.0 | 16.6 | 16.6 |
| *C. celata* .. | Nil | 5.6 | 25.0 |
| *C. vastifica* .. | 25.0 | 22.2 | Nil |
| *C. carpenteri* .. | 5.0 | 5.6 | 8.4 |
| Incidence .. | 47.0 | 60.0 | 80.0 |

The Table 2 indicates that the percentage composition (*i.e.* the percentage of each species in the total number infected) of the two new invaders on rafts fluctuated from 66 to 70 for the period 1980-82. Of the two new invader

*C. margaritifera* was more abundant indicating that this species is more adaptable than *C. lobata* to this specific system.

*C. vastifica*, though at first dominant among the native species, declined by 1981 and finally disappeared by 1982. The sudden increase in the infection of *C. celata* in 1982 could be the prime reason for the exclusion of *C. vastifica* from the raft system. It may also be assumed that the exclusion of *C. vastifica* further helped the proliferation of the third conventional species *C. carpenteri*. A comparison of the relative strengths of the various species noted during 1980 with that of 1982 indicates the following:

1. There has been severe competition between the two new invaders and in this struggle *C. margaritifera* proved more adaptable and hence more successful in the pearl oyster culture system at Vizhinjam.

2. Competition among conventional species also was very acute and *C. celata* took the lead in this competition.

*Cultured pearl oysters at Tuticorin*

As a part of the studies on fouling and boring organisms on culture rafts, Alagarswami and Chellam (1976) reported from Tuticorin that polychaetes, sponges, molluscs and isopods are the major pests. The first authentic report on *Polydora* infection on farm-grown pearl oysters was by Alagarswami and Chellam (1976) and according to them the infection rate noted at Tuticorin rafts was 20.7 initially. But this rate increased considerably after keeping the oysters on rafts for about a year. Dharmaraj *et al.* (1987) found that boring of pearl oyster by polychaete was rather insignificant in natural beds, while their number increased on the oysters reared for a prolonged period and as compared to the open sea farm at Veppalodai near Tuticorin, the incidence was more in sheltered bay farm (at Tuticorin). According to the above authors 78.4% of shells examined by them contained blisters and among the infected shells 28.3% had single blister while the rest, more than one. As at Vizhinjam culture rafts (given in the above section) here also the rate of incidence of polychaetes increased gradually.

Only one species of sponge (*C. celata*) was recorded in 1974 and the rate of incidence was found to be 20% (Dharmaraj *et al.*, 1987). This rate is quite high as compared with that observed by Thomas (1979) in the natural beds off Tuticorin. Subsequent studies made by Thomas (unpublished data) indicated the presence of only one species *viz. C. vastifica* in the same system during 1978. By 1981, *C. celata* could be noted in stray numbers (12%) along with *C. vastifica* which constituted the bulk. In 1982, *C. celata* formed the dominant species (83%) making *C. vastifica* a minor constituent with a composition of 15%. During this year the infection by *C. margaritifera* was low (2%). The appearance of *C. margaritifera* on the pearl culture rafts at Tuticorin during the period when this was not available in any of the other molluscan beds of the Gulf of Mannar is quite interesting. A possible explanation for this may be that a consignment of pearl oysters was transported to Tuticorin from Vizhinjam in 1981 and a few specimens infected by *C. margaritifera* might also have been unknowingly included in this lot. Dharmaraj *et al.* (1987) also recorded the presence of *C. margaritifera* on raft-cultured pearl oysters at Tuticorin subsequently.

The above facts indicate that in culture systems at Tuticorin it takes about 4 years to get one conventional species replaced by another. Since *C. margaritifera* could successfully colonise the culture system in 1982, the present cycle of dominance (of conventional species) may get altered considerably in future. The reappearance of *C. margaritifera* in the Gulf of Mannar is also significant since this species is capable of devastating the pearl banks as

has happened in 1902 with Ceylon (Sri Lanka) pearl banks. A continuous monitoring of its activities in the Gulf of Mannar is urgently required for ascertaining its spreading pattern in the Gulf of Mannar in future.

*Mussels*

Both green and brown mussels from wild were examined during the present study. Brown mussels reared on rafts at Vizhinjam were also examined periodically.

Green mussels from Mulloor (about 2 km south of Vizhinjam) analysed during 1980 were found infected with both *C. margaritifera* and *C. lobata* in addition to the conventional species *C. vastifica*. *C. lobata* constituted the bulk (60%) while *C. margaritifera* and *C. vastifica* made up the rest equally.

Brown mussel examined from Kovalam (2 km north of Vizhinjam) recorded 48% incidence during 1981, but by 1983 it declined to 36%. There was further decline subsequently, 10% in 1985 and 14.7% in 1986 (Fig. 1 f). Species of boring sponges, their year-wise incidence and the composition of each species are furnished in Table 3.

TABLE 3. *Species of boring sponges, their yearwise incidence and percentage composition at Kovalam*

| Species | *1981 | 1983 | 1985 | 1986 |
|---|---|---|---|---|
| *C. margaritifera* | 16.6 | 33.3 | 45.7 | Nil |
| *C. lobata* .. | 50.2 | 20.0 | 10.0 | 50.0 |
| *C. celata* .. | 16.6 | Nil | Nil | 21.4 |
| *C. vastifica* .. | 16.6 | 46.7 | 42.5 | 28.6 |
| Incidence (%) .. | 48.0 | 36.6 | 10.0 | 14.7 |

* Data not avilable for 1982 and 1984.

Table 3 indicates that the total number of boring species infecting the brown mussel at Kovalam is 4 and both conventional and new invaders are equally represented. There was severe competition between *C. margaritifera* and *C. lobata* on one hand and *C. celata* and *C. vastifica* on the other. Increase in percentage composition of *C. lobata* during 1981 probably resulted in the decrease in the percentage composition of *C. margaritifera*, but a reverse action could be noted both in 1983 and 1985. In 1986, *C. lobata* formed the major pest and no specimen of *C. margaritifera* could be found. Regarding the two conventional species (*C. celata* and *C. vastifica*) both were equally distributed in 1981, but subsequently *C. vastifica* overflourished till 1985. Later in 1986, the reappearance of *C. celata* probably brought down the percentage composition of *C. vastifica* considerably.

As mentioned earlier, the incidence (%) in this bed decreased considerably from 48 (1981) to 14.7 (1986). In order to find out a possible clue to this behaviour the percentage composition of the two new invaders and the conventional species were added separately for each year (Table 4).

TABLE 4. *Percentage composition of both conventional species and new invaders*

| Species | *1981 | 1983 | 1985 | 1986 |
|---|---|---|---|---|
| *C. margaritifera*+ *C. lobata* | 66.8 | 53.3 | 57.5 | 50.0 |
| *C. celata* + *C. vastifica* | 33.2 | 46.7 | 42.5 | 50.0 |

*Data not available for 1982 and 1984.

As seen in Table 4, the percentage composition of the two new invaders decreased considerably from 1981-1986 period, while the same for the conventional species increased. In other words, the initial vigorous activity noted among the two new invaders declined, but at the same time the conventional species increased their activity from a lower level (33.3%) to a higher level (50%). But whether this is sufficient to show a decreasing trend in

the incidence for the whole bed is a matter which cannot be decided at this stage and more data, from similar cases, are required on a long term basis for establishing this point.

*Raft-cultured brown mussel*

No sponge infection could be observed at Vizhinjam among the raft-cultured brown mussel in 1981. But this condition gradually changed by 1982 and 8.2% of them showed the sign of infection. By 1983 the incidence reached 10.6% and by 1984, 20% (Fig. 1 e).

TABLE 5. *Species of boring sponges, their yearwise incidence and percentage composition at Vizhinjam (rafts)*

| Species | 1983 | 1984 |
|---|---|---|
| *C. margaritifera* .. | 33.3 | 57.1 |
| *C. lobata* .. | 33.3 | 28.6 |
| *C. vastifica* .. | 33.3 | 14.3 |
| Incidence (%) .. | 10.6 | 20.0 |

Table 5 indicates that the percentage composition of the three species represented was equal in 1983, but by 1984 *C. margaritifera* increased considerably checking the composition of both *C. lobata* and *C. vastifica*. The percentage composition of *C. margaritifera* increased considerably by 1984, but the same for the other two species registered a decreasing trend. The two new invaders together accounted for 85.7% of the total composition, in 1984.

*Rock oysters*

*Crassostrea* populations distributed along the estuarine and intertidal areas were examined periodically for boring sponges. It was found that 5 species (including the two new invaders) of boring sponges usually infest the beds except in estuarine areas (Ashtamudi Lake) where only *C. vastifica* could be noted. No details on incidence (%) could be collected.

TABLE 6. *Species of boring sponges, their yearwise percentage composition at Vizhinjam during* 1981, 1986 and 1987

| Species | 1981 | 1986 | 1987 |
|---|---|---|---|
| *C. margaritifera* .. | 12.0 | 65.0 | 44.5 |
| *C. lobata* .. | 36.0 | 5.0 | Nil |
| *C. celata* .. | 8.0 | 15.0 | 11.0 |
| *C. vastifica* .. | 40.0 | 15.0 | 44.5 |
| *C. carpenteri* .. | 4.0 | Nil | Nil |

Table 6 indicates that three conventiona species *viz. C. vastifica*, *C. celata* and *C. carpenteri* together shared 52% of the total infection. Among the two new invaders, *C. lobata* (36%) dominated over *C. margaritifera*. The capacity to multiply disproportionately in a limited period attaining dominance over the existing species is very well known from the activities of this species in the Ceylon (Sri Lanka) pearl oyster bed (Dendy, 1905). At Vizhinjam also this species attained dominance over the other species in a short period; by 1986 its dominance reached 65% level resulting in the suppression of both *C. lobata* and *C. vastifica* which were dominant during 1981. The species which affected the most was *C. lobata*. However, the decrease in the percentage composition of *C. margaritifera* noted during 1987 was made good by *C. vastifica* with an increase in its percentage from 15% level (1986) to 44.5% level (1987).

*Crassostrea* population distributed along the estuarine realms (Ashtamudi Lake, Quilon) was found infested only by *C. vastifica*. The reason is that only this species can function properly in lower salinities. Hence this species may pose a serious threat to the future brackish-water molluscan farms along the estuaries of India.

*Pseudochama* sp.: Shells of this species were collected off Vizhinjam and the various boring sponges infesting them were identified. No data on incidence (%) could be collected.

Only two species of boring sponges (*C. margaritifera* and *C. vastifica*) were found infesting these shells. Between these two species, *C. margaritifera* was found dominating (60%) over the other in 1986. During 1987 both these species attained equal importance.

It has been noticed that *C. vastifica* could compete with *C. margaritifera* bringing down the latter's relative composition slightly.

*Spondylus* sp.: Data for 1986 only are available and here also *C. margaritifera* formed the dominant species making up 50% of the total composition of boring sponges, followed by *C. vastifica*. *C. celata* accounted for only 12.5%.

*Xancus pyrum*: The most important among the gastropods of India, in terms of revenue, is the sacred chank and its beds are distributed both along the southwest and southeast coasts of India. Every year a sizable fraction of the total number fished is discarded as 'wormed chanks'. Detailed investigations carried out by Thomas (1979) revealed that all these 'wormed' shells are damaged by boring sponges and not by polychaete worms.

The percentage of damaged shells (wormed) fished in the past from various beds, its range and mean values are given in Table 1. Examination of the past data, presented by Nayar and Mahadevan (1974), reveals that in some years (1959-60) the number of discarded shells went upto 64,857 at Tuticorin, 60,256 in beds off Sivaganga Dt. (1957-58) and 50,394 in beds off Ramanathapuram Dt. As no part of the shell is left intact such 'wormed' shells cannot be utilised by the handicraft industry for making bangles or even buttons. The loss to revenue on account of boring sponges is quite evident from this.

As has been mentioned earlier, the boring sponge species in the different chank beds of India comprised *C. celata* (68.7%), *C. vastifica* (27.9%) and *C. carpenteri* (3.4%) during 1969-70 period. Though the same composition may be reckoned as the overall pattern of distribution of boring species during the above period of survey, there was considerable variation from bed to bed, both in incidence and species composition. *C. celata* was the dominant species in the Gulf of Mannar and Nagapattinam beds, while it was *C. vastifica* in the Andaman beds.

Unfortunately, details on areawise abundance of the component species infecting the chank beds from time to time are lacking. The investigations initiated by the present authors during 1980-82 period have yielded the following information on boring sponges infecting the chank and some other gastropods along the southeast and southwest coasts of India.

*Sacred chank from the southwest coast (Cape Comorin to Quilon)*

In the southern centres along this coast a bispecific composition of boring sponges was noted. At Enayam, *C. vastifica* dominated during 1980 (60%), followed by *C. carpenteri* and at Vizhinjam, *C. celata* dominated (66.8%), followed by *C. vastifica* (33.2%). The incidence was found to be 15% at Enayam (1980). Along the northern Centres a monospecific pattern (*C. celata*) was prevalent both at Angengo and Quilon during 1979-80 period. But this condition changed by 1980-81 when *C. vastifica* made its appearance in stray numbers (13.4%) in these beds. During the next year (1981-82), *C. vastifica* got completely replaced by *C. lobata*, the new invader, with a percentage composition of 20 indicating that the latter is more adaptable.

*Sacred chank from the southeast coast (Cape Comorin to Tuticorin)*

Thiruchendur and Tuticorin are the two major centres along this coast for chank fishing. The chank fishery is regular at Tuticorin, while at Tiruchendur it is rather occasional. The incidence noted at Tuticorin was low, 10% during 1980-81 season and 8% in 1981-82

season (Fig. 1 b). The incidence, on the other hand, was slightly higher (17%) at Thiruchendur in 1980-81 season when the chank fishery resumed after a pause. During the next season *i.e.* 1981-82, the incidence came down to 12.2% (Fig. 1 c).

At both centres a 3 species combination, as was seen during the 1969-70 survey, could be noted initially with the domination of either *C. celata* or *C. vastifica* and *C. carpenteri* occupying the lowest position in the order of abundance. There was absolutely no sign of either *C. margaritifera* or *C. lobata* till 1980-81 season, but by 1981-82 the species composition started changing with the appearance of *C. lobata* in stray numbers. The changes that took place in the past years both at Tuticorin and Thiruchendur beds may be noted from Tables 7 and 8.

TABLE 7. *Species of boring sponges and their yearwise percentage composition at Tuticorin*

| Species | 1977-78 | 1978-79 | 1980-81 | 1981-82 |
|---|---|---|---|---|
| *C. celata* .. | 74.0 | 50.2 | 80.0 | 33.3 |
| *C. vastifica* .. | 20.0 | 33.0 | 20.0 | 60.0 |
| *C. carpenteri* .. | 6.0 | 18.8 | Nil | 6.7 |

TABLE 8. *Species of boring sponges and their yearwise percentage composition at Tiruchendur*

| Species | 1980-81 | 1981-82 |
|---|---|---|
| *C. celata* .. | 40.0 | 13.3 |
| *C. vastifica* | 40.0 | 46.7 |
| *C. carpenteri* .. | 20.0 | 20.0 |
| *C. lobata* .. | Nil | 20.0 |

From Table 7 it may be seen that *C. carpenteri*, which formed only a small fraction among the boring sponges, could occasionally utilise the opportunities arising from the competition of other two species for expanding its rate of infection. Data provided in Table 8 show that the percentage composition of *C. carpenteri* is slightly higher at Thiruchendur beds and this higher rate could be maintained by this species even after the infiltration of *C. lobata* in 1981-82 season. It is also evident from Table 8 that *C. vastifica* infection increased considerably in 1981-82 season while *C. carpenteri* retained its original infection rate and it was *C. celata* which received a set back as its composition came down to 13.3% from 40% in the previous year.

It is possible that *C. lobata* migrated to Thiruchendur beds from the southwest coast of India since these shells enjoy a limited freedom to move about from place to place.

The infiltration of *C. lobata*, both at Thiruchendur and at Quilon chank beds, almost coincided.

*Thais* spp. : *Thais rudolphi* shells were examined off Vizhinjam during 1982 and also in 1986. The incidence (%) was found to be 9.7 and 18 during 1982 and 1986 respectively. Various species of boring sponges infesting the shells, their percentage composition (yearwise) are given in Table 9.

TABLE 9. *Species of boring sponges, their yearwise percentage composition at Vizhinjam*

| Species | 1982 | 1986 |
|---|---|---|
| *C. margaritifera* | 14.3 | 23.1 |
| *C. lobata* .. | 66.7 | 38.5 |
| *C. vastifica* .. | 14.3 | 30.8 |
| *C. carpenteri* .. | Nil | 7.6 |
| *Aka minuta* .. | 4.7 | Nil |
| Incidence (%) .. | 9.7 | 18.0 |

As shown in Table 9, four species of boring sponges were encountered in *Thais rudolphi* shells collected off Vizhinjam in 1982. Apart from the two new invaders, a third one *Aka*

*minuta* which is rather common on corals, could also be collected. *A. minuta* is here recorded outside its known distributional limits (previously known only from the Gulf of Mannar) from a shell. *C. lobata* formed the most dominant species in 1982. But the picture that emerged during 1986 was quite different ; *C. lobata* dwindled in its abundance considerably, while both *C. margaritifera* and *C. vastifica* could improve their position remarkably. *A. minuta* totally disappeared and its position was taken up by *C. carpenteri*. It is also interesting to note that *C. celata*, one of the most common shell borers, was totally absent in both years. But the shells of *T. rudolphi* collected off Angengo (south of Quilon) in 1980, harboured *C. celata* in stray numbers (6.6%). *Thais intermedia* shells collected off Vizhinjam during 1986 also did not harbour *C. celata*. The various species of boring sponges infesting the above shells were *C. margaritifera*, *C. lobata* and *C. vastifica* with a percentage composition of 20, 40 and 60 respectively.

## Discussion and Conclusions

The present study, which is a follow up of the 1969 survey, has brought to light an important event that took place in the interim period. It was the invasion of two highly destructive species *C. margaritifera* and *C. lobata* on our molluscan beds besides the interaction of the new invaders and of the conventional species of boring sponges.

It is well known among boring sponges that some species, after devastating a bed, may enter into a quiescent stage till the conditions become quite favourable to them to multiply again. This interim period, in some cases, may be many years. When conditions become congenial the quiescent specimen may get reactivated and then a destructive phase may ensue. Occasionally it is even possible that such reactivated specimens, without causing any sudden population outburst, may trigger off some conventional species existing in the bed. No such reaction could be noted in any of the beds in Indian waters so far examined. A long-term monitoring on the activities of both *C. margaritifera* and *C. lobata* is necessary to ascertain their future impact.

It is quite difficult to pinpoint when and where these two new invaders appeared first along the southwest coast of India. Some quiescent specimen occurring in deeper waters might have got reactivated and the larvae/gemmules produced might have migrated to culture systems at Vizhinjam for two reasons :

a. Easy availability of substrata (oyster shell) and
b. less competition as compared to the natural beds.

During the previous survey (1969-70 period) the dominant species of boring sponges found infesting the molluscan shells was *C. celata*. Bedwise analyses indicated that *C. celata* was dominant in the chank beds and *C. vastifica* in pearl oyster beds of the Gulf of Mannar. The present survey revealed that the dominant species now, along the southwest coast of India, are *C. margaritifera* and *C. lobata*, the new invaders. Evidences are also there (Thomas *et al.*, 1983) to show that both these species have migrated to the Gulf of Mannar by 1982. Hence, the activities of the above two species in the commercially important molluscan beds of the Gulf of Mannar should be properly monitored.

The percentage of incidence (or infection rate) was quite low in the natural beds upto 1969 (Table 1) and this condition still continues in the Gulf of Mannar beds. But along the southwest coast of India the condition is quite different with the spreading of the two new invaders ; the incidence started increasing among the cultured as well as the wild stocks of molluscs.

It could be noted that the rate of incidence came down considerably within a few years in the natural beds, but such a decrease was not discernible in the case of cultivated stocks of molluscs.

There is severe competition for space between the two groups — native species and new invaders, and also among the constituent species in each group. In this competition it is the new invaders which win initially, but in the competition between *C. margaritifera* and *O. lobata* it is the former which often take the lead.

Since the observations made here are based on data collected soon after the entry of the two new invaders in the southwest coast the ecological impact produced in the various beds are of a violent nature. It is possible that in due course these wild reactions would become less and ultimately a stable equilibrium will prevail in the various beds. In the natural beds, it is seen that the incidence rate, after an initial spurt, shows a declining trend after a period of 2 to 3 years (Table 3). But in the culture system the incidence rate is retained at a higher level for a considerably longer period indicating that the natural beds and culture systems react differently to the same intruder. Continued monitoring on these lines is needed to determining this period.

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