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SOME OBSERVATIONS ON THE PROBLEM OF MARINE TIMBER DESTROYING ORGANISMS OF INDIAN COASTS

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(In India the chief marine timber boring organisms are 2 species of *Martesia*, 28 species of shipworms, 4 species and a variety of *Sphaeroma* and 9 species of *Limnoria* besides bacteria and fungi. The occurrence, abundance and activity of the various species of borers show remarkable variations and fluctuations in the different harbours of India, each harbour or area having its own dominant set of species and an assemblage of less important forms. These species have their own characterestic preferences, life history and seasons of attachment and a scheme evolved for one locality may prove ineffective for another. Through a delicate and complex ecological adjustment the borers occurring in a locality have reached an interrelationship reducing interspecific and intraspecific competition. The seasons of settlement of the dominant borers in the different harbours of India are indicated. The need for a detailed biological enquiry is stressed.)

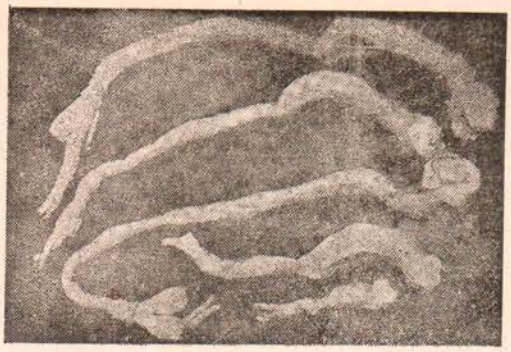
Introduction

In India the cost of periodic replacement of fishing crafts alone due to marine timber destroying organisms is estimated to be 25,00,000 rupees (Becker 1958). This does not include the damage done to the numerous waterfront structures, the estimation of which is not easy and therefore, the total property damage caused by these pests each year must be enormous. Waterfront structures and crafts suffer damage chiefly from the hazards of decay and marine borers. Decay is not serious if the timber is continusly submerged but then the marine borers become a menace Thus timber in sea water exposures is threatened by borers below the water, decay above the water and both do damage in the inter-tidal zone. Deterioration of wood in sea water is caused chiefly by three groups of organisms, the

molluscs, the crustaceans and the fungi. The molluscs are represented by three genera of shipworms namely *Bankia Nausitora* and *Teredo* and one genus of pnolads *Martesia*. The crustacean wood borers are mainly confined to the order Isopoda nad are represented by the two well kown genera *Sphaeroma* and *Limnoria*. The amphipod borers are not very important in the Indian waters. Nearly 28 species of shipworms and 2 species of *Martesia* are known to be active in the warm waters of our coasts destroying wood and reducing the useful life of timber in the sea, in the brackish water and even in fresh water (Nair 1961). 4 species and a variety of *Sphaeroma* and 9 species of *Limnoria* also have been reported from India.

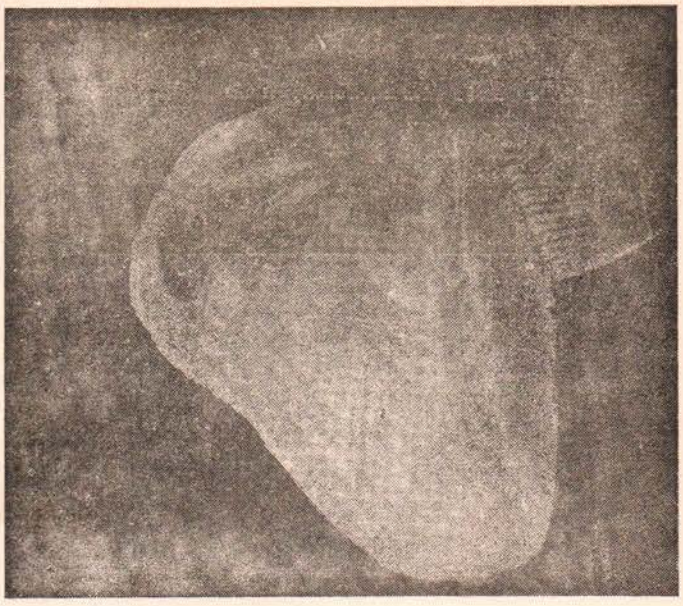
The Shipworms

Shipworms are related to clams, mussels and oysters but unlike them they have long, slender and almost naked bodies (Photo 1) and a few species can attain a length of nearly 3 feet. These borers spend their adult life entombed in wood and the growth is effected by lengthening the burrow by the abrasive action of the bivalve shell. The shell valves are small, highly specialised and cover only a small portion of the anterior end of the body. Armed with ridges of microscopic rasp-like teeth and powered by the adductor muscles these modified shell valvee function as the main organ for the excavation of the burrow (Photo 1 A). The foot is discoidal and occupies the anterior most portion in relation to its use as an organ for holding the shell in position while boring. The soft body of the ship-worm fills the burrow completely and is in close contact with the wooden walls separated only by a thin calcareous lining secreted by the mantle of this mollusc. Two siphons are present formed by the fusion of the mantle edges at the posterior end and are the only visible soft parts of the body in the *natural habitat*. These can be seen displayed through the entrance hole as two translucent tubes one for the entry and the other for the exit of the physiological current of water (Photo 2). For these creatures contact with the aquatic environment is maintained only through these siphons. Shipworms are essentially protandric, nearly all females passing through a preliminary male phase before reaching the female stage. A remarkable hermaphrodite stage is present between the active male and females phases. In some species propagation is through external fertilisation while in others fetilisation takes place in the branchial chamber and the larvae are liberated as late veligers, which represent the infective, free living, larval life. While some animals bore into timber for protection only, the shipworms digest and metabolise the cellulose of the wood into which they bore and exploit it as a source of nourishment. This remarkable and rare ability is attented with several morpho-logical and physiological adaptations to suit the new conditions of habitat and food, making this one of the supremely specialised animals among the inver-tebrates. The morphology of the animal and its relation to the burrow demand that all wood removed by the shell in growth be passed to the outside by way of the digestive system. During its slow passage through the elaborate alimentary canal the tough woody fibres are reduced to soluble, assimilable products with the help of a complex carbohydrase enzyme system including a powerful cellulase (Nair 1955, 1955 a, 1956, 1956 a, 1957). After settling on wood the shipworm larva transforms into a tiny boring mollusc and grow with remarkable rapidity (Nair 1960) Since the rate of growth is proportional to the destruction of timbet



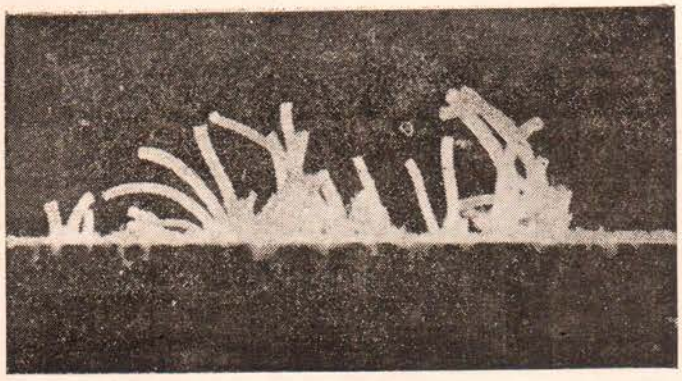
P. 1

Shipworms have long, slender and almost naked bodies. The shell valves are small highly specialised and cover only a small portion of the anterior end of the body



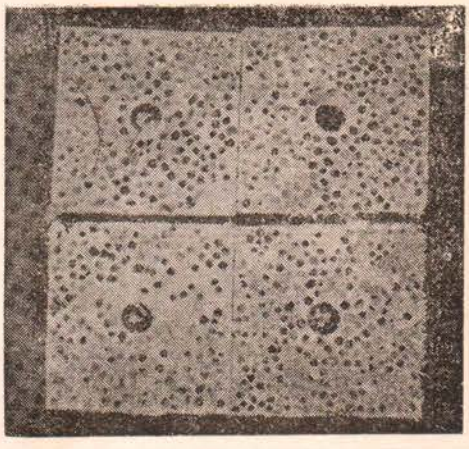
P. 1 A.

A shell-valve of shipworm magnified to show the ridges of microscopic rasp-like teeth.



P. 2

An underwater photograph of a test panel to show shipworms in their natural habitat. The siphons are the only visible soft parts of the body and are displayed through the entrance holes. Contact with the aquatic environment is maintained only through these siphons.

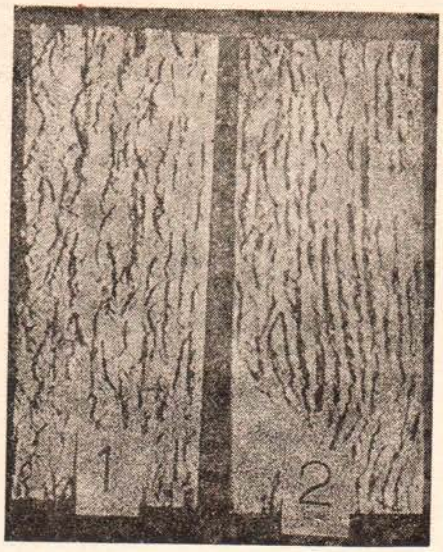


P. 2 A

Test panels sectioned to show the demage by shipworms.

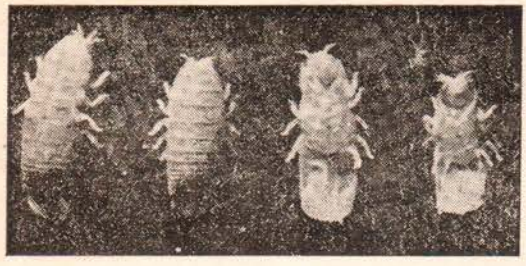
P. 2 B

A piece of timber showing the damage by shipworms. Hundreds of these molluscs may settle on a fresh piece of timber and virtually honeycomb its interior.



P. 3

Characteristic damage by *Limnoria*. Innumerable small holes produced by the borer give the wood a sponge-like texture and a lace-like appearance.



P. 4

Limnoria. This small isopod is capable of effecting a progressive tunnelling action on wood and can make a burrow many times the length of its body. The eggs are carried by the female in a brood pouch.

P 5

A pile sector showing the nature of damage by crustaceans and moliuscs. The crustaceans work from the outside and the molluscs particularly the shipworms penetrate deep into the heart of timber.

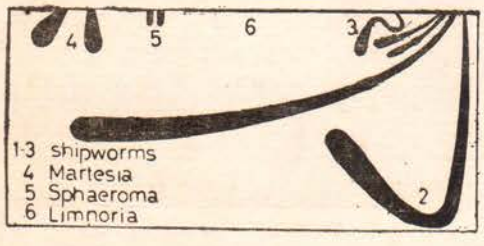


Fig. I

Showing the nature of damage on timber by the different borers.

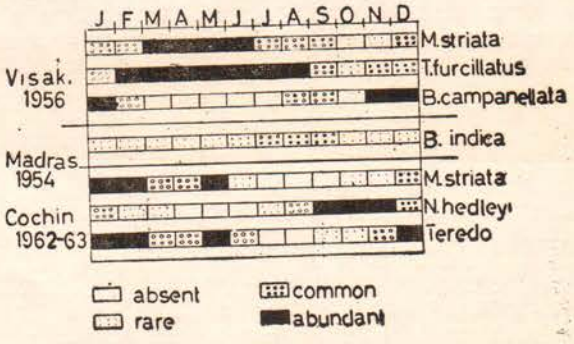


Fig. II

Illustrating the seasons of settlement of the dominent species of mollucan borers at Visakhapattanam (Visak.), Madras & Cochin

eech shipworm during its life time destroys a column of wood of the same dimension as its largest size Shipworms spend their adult life within the confines of the timber in which they have penetrated. Hundreds of these may settle on a fresh piece of timber and virtually honeycomb its interior (Photo 2 A and 2 B) and the only external evidence of their presence will be the very tiny entrance holes marring the surface of the timber

The pholads

The pholads though not so specialised as the shipworms are important wood boring bivalves and are represented by 2 species of the genus *Martesia* namely M. *striata* and M *fragilis*. Martesia striata is economically more important than M. *fragilis* and is commonly found on all types of both fixed and floating structures near the coast. **M. *fragilis*** is a rare species found in soft timber in off shore waters. Though the bore holes of Martesia are much smaller than those of shipworms (Fig. 1, 4) being about or a little more than their body size, their rapid rate of reproduction and their ability to penetrate deeper and deeper in each generation cause speedy destruction of timber. Studies on the activity of M. *striata* show that it is capable of performing normal activities in low salinities (Nagabhushanam 1956), which accounts for its occurence in waters of very low salinity of the back waters of the Kerala coast. These widely distributed borers are of great economic importance because of the density of their attack, quick development, rapid succession of generations and great tolerance to low salinities. In this bivalve fertilisation is external and within 24 hours the veliger stage is reached (Nagabhushanam 1955).

The pill bugs

Among the crustacean borers that occur along the Indian coasts the genus *Sphaeroma* is by far the most important since they can effect more damage to timber due to their large size Four species and a variety of *Sphaeroma* have so far been recorded from India (Pillai 1961). Of there *S. terebrans* has the widst distribution and is the most important from the point of view of timber destruction. One female produces 10 to 30 eggs in a brood and the development takes place inside the protection of a brood pouch and the young ones are released in an advanced stage of development. The young matures and produces a new brood in about 6 months. Breeding is continuous and hence every adult female produces more than one brood each pear (Pillai 1961). Its cylindrical burrow may be about twice as long as its body and is at right angle to the surface of the wood (Fig. 1, 5). Their dense settlement, gregarious habits and the rapid rate of reproduction contribute to deeper and deeper pentration resulting in the rapid deterioration of timber. Attack is heaviest in the inter-tidal zone the maximum intensity being at half tide level, giving a heavily infected pile the shape of an hour-glass. Further down the intensity decreases and stops about 3 feet below the surface (Pillai 1955) Attack on fresh surface is effected by migrating juveniles or adults during a distinct period of the year at Cochin Harbour. Observations along the west coast show that Sphaeromids constitute a very serious threat to every available piece of timber from small twigs to semi submerged tree stumps which are all readily attacked and riddled.

The gribbles

The genus *Limnoria* which is a dangerous timber borer in the higher latitudes is not a very serious pest in the Indian waters though 9 species have so far been recorded. This small isopod is capable of effecting a progressive tunnelling action on wood and can make a burrow many times the length of its body. Innumerable small holes produced by this borer give the wood a sponge-like texture and a lace-like appearance (Photo 3). The burrows usually follow the grain and are near the surface of the wood (Fig. 1, 6). Their attack is also reported to be more intense in the inter-tidal zone though in higher latitudes the attack may show increase towards the bottom (Nair and Leivested 1968) to given the pile a characterestic pencil shape *Limnoria* usually lives in pairs, the female occupying the blind, burrowing end of the tunnel. The eggs are carried by the female in a brood pouch as in *Sphaeroma* (Photo 4). Fresh attack on wood takes place during a period of migration.

The nature of damage

It is a not worthy fact that the nature of attack of the molluscs and crustaceans is very different producting different effects on timber. This enables them to effectively snare without serious competition this common substratum which is limited in extent as a habit. The crustaceans work from the outside and the molluscs particularly the shipworms penetrate deep into the heart of timber (Photo 5). The combined action of these two groups of borers conver the wood into a highly porous, weak and fragile mass. The crustaceans have the added ability to enter even the creosoted shell of treated timber which the shipworm larvae are unable to do.

The role of fungi

The thire group of organisms that deteriorate timber in the sea is the wood inhabiting bacteria and fungi especially the *Ascomycetes* and the *Fungi imperfecti*. These actively participate in a 'conditioning' of the wood preparing it for the subsequent attack by the crustaceans and molluscan borers. This is a very important biological phenomenon. The fungi which are very resistant to preservatives decompose cellulose in the cell walls of the light timber of the dug-out canoes, log-rafts and other fishing crafts and venetrate deep into the interior. The periodical drying of these timbers after fishing hastens the penetration of the fungi (Becker and Kohlmeyr 1958).

The chief types of timbers used in India

Indian fishermen use light timbers such as *Melia composita*, *Albizzia moluccana*, *Bischofia javanica*, *Erythrina* sp., *Mangifera indica* etc. Main timber species now in use for piles, beams, jetties and fishing crafts in Bombay Harbour are *Tectona grandis*, *Terminalia tomentosa* and *Mangifera indica*. Along the Kerala coast *Bombax* sp. *Tectona grandis*, *Xylea xylocarpa*, *Terminalia paniculata*, *Veteria indica*, *Calophyllum* sp., *Lagerstroemia lanceolata* and *noltafies* stem at Madras *Cederia* sp., *Aegle marmalos*, *Tectona grandis*, *Thespesia* sp., *Polyalthia* sp., etc., at Visakhapatanam *Terminalia arjuna*, *Shorea robusta*, *Pterocarpus*

marsupium, Terminalia tomentasa. Dipterocarps sp. *Tectona* sp. *pinus* sp. and *Xylia dolabriformis* etc. are in use.

The protective measures

All these species of timbers in their natural untreated condition are readily attacked and rapidly destroyed by the combined efforts of the marine timber destroying organisms already referred to. The useful life of timber can be prolonged by suitable treatment by preservatives. The best preservative known so far against marine boring animals is impregnation with creosote. In the United States tar is added with a view to prolong its effectiveness Synthetic contact insecticides are found to be toxic to certain species of crustaceans. But all these leach out in time leaving the surface exposed to borer attack. In Australia special creosote felled collars are used around each pile. In Canada a recently tried method to kill shipworms inside timbers consists of detonating charges of explosives near the infected piles to produce powerful vibrations which are lethal. In this context there are two approaches for the borer problem in our country. One is by discarding the home-grown susceptible timbers as a material for sea water exposures and use more expensive materials such as steel and concrete. But even these are not exempt from the ravages of all types of deterioration and each is vulnerable to one or more of the destructive processes. But at present in our country use of steel and concrete is impossible except in a few important harbours. The other approach is use of home grown timbers as building material and try successful ways to prolong their lives. So conservation and protection are integral parts of this approach and research in this field on contribute much towards saving natural resources.

The biological aspect of the problem

The effect of preservatives used in timber can be utilised to the maximum only by a proper understanding of the life cycles of the borers involved and through a proper evaluation of the weakness of their body chemistry both during the time of settlement and thereafter. Replacements, drydocking repainting and piledriving can be carried out at certain specific periods of the year to get the maximum effect through a close scrutiny of the period of settlement of these pests. An understanding of the vertical distribution of the different species of borers will be advantageous for the installation of suitable creosote collars In fact the harbour engineer can device more effective methods and control measures and thus profitably prolong the useful life of timber used in harbour constructions by a proper understanding of the habits and behaviour of the organisms involved. Unfortunately this aspect of the problem is beset with many difficulties An accurate knowledge of the occurrence and distribution of the different species in an area is an essential prerequisite. The taxonomy of some genera is extremely complicated with makes the problem all the more difficult especially for one who is not a biologist. The density of their distribution has fluctuated over long periods and within the same period their attacks have differed considerably in various locations along the same stretch of coast line (Becker 1958). The occurrence, abundance and activity of the borers show remarkable variations and fluctuations

in the different harbours of India, each harbour or area having its own dominent set of species and an assemblage of less important forms. It is wall known that reactions of closely allied species are different and are even those of the same may very according to the peculiar hydrographic conditions prevailing in an area. It is noteworthy that each species has its own characterstic preferences, life history and season of attachment and therefore, generalisations should be made with great caution and a scheme evolved after elaborate study and experimentation for one locality may prove ineffective for another. So it is clear that the problem varies with the species occuring in a locality and also with climatic and hydrographic conditions. It should be realised that vagaries and discriminations of these pests are such that most of the conclusions drawn from any investigation must, for the present, be considered of purely local application. Therefore, experience gained from one locality, cannot without further investigation, be applied to another.

The ecological aspects

Persons interested in waterfront structures should bear in mind that the attack on fresh surfaces is made not by one species but is a concerted effort by a heterogenous group of fungi, crustaceans and molluscs. Through a very delicate and complex ecological adjustment the borers occurring in a locality have reached an amazing interrelationship so that interspecific and intraspecific competitions are deduced to a minimum and effective succession has come into operation. The distribution of borers also seem to be balanced and adjusted. When 2 species compete for the same zone their life histories exhibit different cycles with variations in the breeding season so that the settlement of one species alternates with that of the other without serious overlapping. The timber structures are thus attacked with destructive intensity by successive waves of borers at different characterestic zones.

The pattern of distribution of the borers along the coasts of India

Table 1 presents some of the important species of timber borers reported from the different regions along the east and west coasts of India. It will be seen that nearly 26 species are known from the east coast and 12 from the west coast of India. Our information about these pests from the west coast is comparitively less than that of the east coast. The same is the case for the coasts of Orissa and west Bengal. Though there is general agreement regarding the distribution of the Indo-Pacific forms it is noteworthy that certain regions and localities have their own dominent species.

The seasons of settlement of the dominent species

In figure II is illustrated the seasons of settlement of the dominent species of molluscan borers at 3 localities along the coasts of India. Nagabhushanam (1962) reports 2 species of shipworms *Teredo furcill tus* and *B nkia campanellata* and one species of Pholad *Martesia striata* from Visakhapattanam as the most

abundant molluscan borers though 15 species are known to exist in the area According to the same author *B. campanellata* makes its appearance in test panels during August and continues to be present till February. The blocks were completely free from attack in the summer months, from March to July. The maximum intensity of attack was, however, noticed in November, December and January. *Teredo furcillatus* and *Martesia striata* showed an entirely different type of cycle and the attack was recorded thronghout the year with a maximum intensity in summer months betwen March and June with a peak in May. Nagabhushanam was able to point out a direct relationship between the relative-adundance of mulluscan wood borers to temperature and salinity. The comparatively smaller attack rate by *Teredo* and *Martesia* during the winter months November - January was attributed to biological competition with *B. campanellata* whose intensity of attack is maximum during the winter months.

In Madras the dominant species occurring within the harbour area is not known. Studies using test panels to find out the intensity of borer attack were carried out off San Thome in the open sea. In this location test panels of *Cedrela* sp. were readily attacked by *Bankia indica* which is the most common species in the open off shore waters, though others were also represented on the panels. Based on a detailed study of the frequnecy of occurrence of veliger larvae in the plankton, presence of post settled stages on test panels and the condition of the gonads of the adults Nair (1957 a) came to the conclusion that the period July August is the most conducive for larval development and settling. Nair also observed another peak period spawing in December. But this was not followed either by the presence in great numbers of larvae or by dense settling on test panel during the year of investigation, the reason of which is not understood.

Observations now in progress at Cochin Harbour with the help of an elaborate and planned system of long-term and short-term test panels have given certain very interesting preliminary results. Three species of shipworms are dominant in the area namely *Nausitora hedleyi Teredo malaccana* and *Teredo furcifera*. Besides these damage of destructive intensity is done by Pholad *Martesia Striata* and the Isopod *Sphaeroma terebrans*. Close examination of the entrance holes of these borers on test panels at three levels one at the intertidal zone, second below the low water mark and the third above the mud line has indicated that the intensity of infestation by the molluscs was more on the panel above the mud line. It would be interesting to make a comparative study of the vertical distribution of these borers in other harbours as well with the aid of a planned system of short-term and long-term test panels. Hitherto, such studies have not been undertaken in India. Observations on the seasonal settlement of borers showed that the different species occurring in the area do not settle on test panels during the same time and thus overlap. The periods of settlement of *Nausitora* and *Teredo* are distinct and one follows the other thereby considerably reducing the competition for settling space. *Nausitora* starts settling on test panels chiefly during the post monsoon (south west) period and during 1963 the first evidence of its settlement came from the long term blocks removed in August after being in water for 30 days. The settlement is intense until about the end of December during a period of rising salinity of the sourrounding water in the lake. Thereafter fresh settlement showed a downward trend and almost ceased by March. As reproted for *Limnoria Tripunctata* (Johnson and Menzies 1956), fresh attack on wood by *Sphaeroma*

terebrans is also found to be during a distinct period of migration in this area. The migration starts soon after the south west monsoon and ends by about March. The problem of space is effectively solved by these two borers by settling at different levels, the crustacean prefering the lower zone of the inter-tidal belt and the mollusc settling at deeper levels. This wave of attack on timber is soon followed by more intense one composed of the larvae of *Teredo* and *Martesia* with a peak of infestation during the pre-monsoon period Test blocks registered the least attack from them during the height of the south west monsoon.

It is interesting to note that the dominant species of shipworms occuring in Bombay Harbour are entirely different from those of either Visakhapatanam or Cochin. According to Bade *et al* (1960-1961), 'out of 3 species of *Baukia* and 4 of *Teredo* hitherto recorded from Bombay, *Bankia minima* and *Teredo manni* are the most common and available in abundance'. Details regarding the seasonal settlement of these are however, not known.

Conclusions

The time of settlement on fresh surfaces by marine timber boring organisms is the most important period from the economic point of view. It is during this period that these organisms come into intimate contact with waterfront structures and experience the effects of preservatives used on timber. Therefore better and more effective types of preservatives can be devised by proper understanding and assessment of the weak points in the body structure and behaviour of thees borers during this period. This is possible by well planned experiments and physiological tests in laboratories leading to the synthesis of effective toxic and / or repulsive compounds. These compounds must be studied thoroughly to determine the formulation most effective and most practical in a particular situation and these must be compared with standard treatment and evaluated on the basis of performance and cost It is again at this period that the effects of contact poisons on living material can be profitably studied since in the case of shipworms, as stated already the saw dust removed by the shell must pass through its alimentary canal and suitable contact poisons can be most effective at this period. These must be followed by a close study of the various influences of the environment on the organism and a proper assessment of the restricting and reducing agents. The effect of temperature, salinity, oxygen tension, turbidity and pollutants on both larvae and adults and the effects of fouling organisms on the settlement of borers must also be properly understood. Effective ways of checking the growth of bacteria and fungi on surfaces which seems to be an essential prerequisite for borer attack must also be given due consideration. Fundamental research on the biology of these organisms, including the structure, habits, life histories and ecology including the possibility of biological control through the exploitation of natural parasites is also essential in order that control measures may be effective and economical. The very heavy ciliate infection observed on the dominat species in this locality, its effect on the host and the rate of mortality both on test panels and on natural populations are being studied in this laboratory. In the haste to obtain results there has been a tendancy to overlook these basic studies and the behaviour of these organisms. Since the settlement is not uniform in the vertical direction and is concentrated at certain definite zones the design engineer can also do much by pro-

per attention to arrangement of parts, selection of materials, choice of optimum shapes and in the correct use of protective applications.

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TABLE 1

Showing the distribution of certain important species of wood borers along the east and west coasts of India.

	Species of borer	Calcutta	Sunder-bans	Visak.	Madras coast	Cochin	Bombay
	SHIPWORMS						
1	Teredo manni	–	-	x	x	x	X
2	Teredo singaporeana	–	-	x	x	–	–
3	Teredo renschi	–	-	–	x	x	–
4	Teredo elongata	–	-	x	x	x	x
5	Teredo furcifera	-	-	x	x	X	–
6	Teredo australasiatica	–	–	-	x	-	-
7	Teredo bensoni	-	–	x	–	–	–
8	Teredo diegensis?	–	–	–	–	x	–
9	Teredo clava	-	-	–	x	–	–
10	Teredo diederichseni	–	-	–	x	x	–
11	Teredo minori	–	–	–	x	-	-
12	Teredo juttingae	-	–	x	x	–	-
13	Teredo vattanensis	-	–	-	x	-	–
14	Teredo malaccana	–	-	x	x	X	–
15	Teredo milleri	–	–	x	-	-	-
16	Teredo indomalaica	-	–	-	x	–	–
17	Teredo thoracites	–	x	x	–	–	x
18	Nausitora dunlopei	x	–	x	x	–	–
19	Nausitora madrasensis	–	–	–	x	–	–
20	Nausitora hedleyi	–	–	-	x	X	–
21	Bankia carinata @	x	–	x	X	x	x
22	Bankia edmondsoni $	–	–	–	x	x	–
23	Bankia campanellata	–	–	X	x	x	x
24	Bankia minima	–	–	–	-	–	X
25	Bankia thielei	–	-	x	–	-	–
26	Bankia lineata	-	–	x	x	–	-
27	Bankia bipalmulata	-	–	-	x	–	–
28	Bankia roonvali	–	x	-	–	–	–
	PHOLADS						
29	Martesia striata	-	-	X	x	X	x
30	Martesia fragils	-	-	-	x	x	-

	Species of borer	Calcutta	Sunder-bans	Visak.	Madras coast	Cochin	Bombay
CRUSTACEANS							
31	Sphaeroma terebrans	–	-	x°	x°	X	–
32	Sphaeromo walkeri	–	–	x	x	x	x
33	Sphaeroma annandalei	-	–	-	x	x	x
34	Limnoria bombayensis	-	-	–	-	–	x
35	Limnoria indica	-	–	–	x	-	-
36	Limnoria tripunctata	-	–	-	x	–	–

* Occurrence of shipworms. Personal communication Smy. M. Saraswathi, Oceanographic Laboratory, Ernakulam.

@ Felix Roch feels that *B Indica* is a synonym of this species.

\+ Felix Roch feels that *T. furcillatus* is a synonym of this species.

o Wrong identification, Pillay (1961), p. 7.

$ Synonym *B. consularis* according to F. Roch.

– Absent.

x Present.

X Dominant species in the area.

ERRATA

Page Nr.	Line Nr.	Read	For	Page Nr.	Line Nr.	Read	For
87	30	continuously	continusly	92	28	distribution	distribution
83	33	fertilisation	fetilisation	92	33	comparatively	comparatively
89	1	each	eech	92	37	dominant	dominent
89	37	panetration	pantration	92	38	dominant	dominent
90	16	noteWorthy	not worthy	92	39	dominant	dominent
90	18	share	snare	92	42	*Martesia striata*	*Martesia striata*
90	20	habitat	habit	93	24	panels	panel
90	41	coconut stem	*noitafies* stem	93	30-31	*Martesiastriata*	*Martesia Striat*
91	38	speeies	speeies	93	44	60 days	30 days
92	1	dominant	dominent	93	47-48	*Limnoria tripunctata*	*Limnoria Tripunctata*
92	3	and even	and are even				
92	5	characterestic	characterstic	94	8	of	af
92	9	occurring	occurig	94	9	interesting	interestidg
92	21	reduced	deduced	94	26	standard	satudard