

Marine Wood Boring Molluscs of the Lakshadweep Archipelago

N BALAKRISHNAN NAIR & K DHARMARAJ

Department of Aquatic Biology & Fisheries, University of Kerala, Trivandrum 695 007

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Some aspects of the ecology of nineteen species of pholadacean bivalves, 16 belonging to the family Teredinidae and 3 to the family Pholadidae in the Lakshadweep sea are reported. Notes on biofouling, associated fauna of shipworms, crustacean wood borers, nature of the biodeterioration of vessels and the destruction of submerged stationary wooden objects are presented. Dominant species highly destructive in the Lakshadweep sea are *Teredo fulleri*, *T. clappi* and *Lyrodus massa*. Species such as *Teredora palauensis*, *Teredo aegypos*, *T. somersi* and *Pholas chiloensis* are new records for Indian waters and, *Teredo triangularis*, *T. fulleri*, *Uperotus clavus* and *U. rehderi* are reported for the first time from the Arabian sea territorial waters of India.

Incidence of marine borers along the shores of the Indian mainland has been reported¹⁻⁷. Very little is known regarding the wood boring organisms of the islands of India. Brief systematic surveys of the marine wood borers of the Andaman and Nicobar islands have recently been attempted⁸⁻¹¹. This paper reports marine timber boring organisms from the Lakshadweep archipelago and deals with some aspects of the ecology of molluscan wood borers belonging to the superfamily Pholadacea. Wood boring community of the Lakshadweep sea is likely to reflect to some extent the nature of distribution of various species by human activities in addition to the natural dispersal by oceanic currents and drift wood.

Lakshadweep archipelago comprising 10 inhabited and 12 uninhabited atolls along with a few adjoining islets (Fig. 1) is the smallest Union Territory of India. The atolls lie scattered in the Arabian Sea about 200 to 400 km off the coast of Kerala between lat. 8-12°N and long. 74-76°E (Table 1) and are comparatively unpolluted except for oil pollution and tar deposition along the beaches. The total land area of the archipelago is only 32 km²; the largest atoll (Androth) occupies 4.8 km² and the smallest inhabited atoll (Bitra) occupies 0.1 km² area.

Materials and Methods

Collections were made during the premonsoon period (May 1982) from 6 inhabited (1-6) and 3 uninhabited (7-9) atolls (Fig. 1). Criteria defined for the valid record of endemic teredinids in a particular locality^{12,13} were followed. Samples of borer infested wood collected were divided into 3 groups: fixed wood (jetty beams, piles, pillers, dead stumps of *Cocos nucifera* and semi submerged portions of shrubs and trees growing along the coasts); drift wood (trash wooden pieces, dry fruits and nuts, twigs etc.); and portions of vessels. The locality of initial settlement of

borers could not be ascertained from samples of drift wood and portions of vessels although reasonable assumptions could be made from the latter category.

Samples of wood along with the borers were preserved at the collection spot after preliminary observations and removing representative specimens for taxonomic studies. In the laboratory all the samples were reexamined for the relative abundance of different species of borers and the values were expressed per kg of wood. Identifications were based on Turner^{14,15} except in very rare cases. Observations

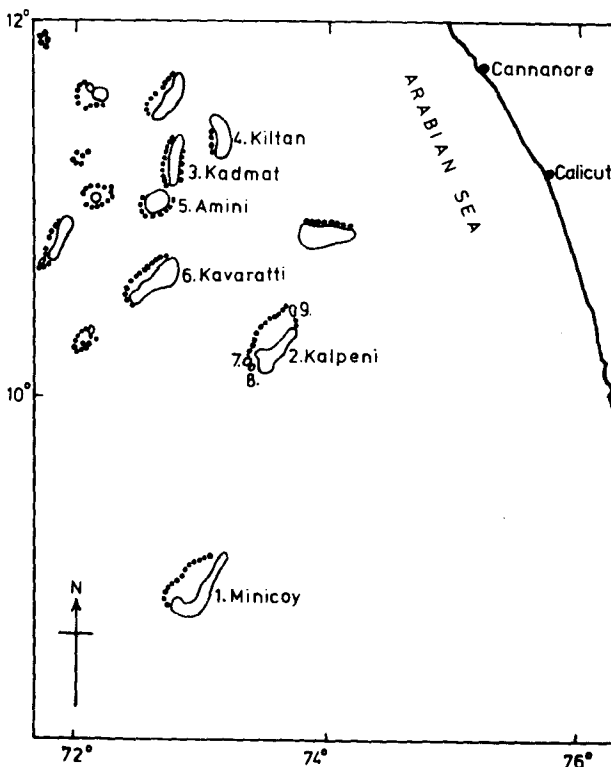


Fig. 1—Lakshadweep archipelago and location of the atolls surveyed (1-9)

on crustacean borers, biofouling, fauna associated with shipworms and the nature of destruction of wooden materials were made. Temperature and salinity of the area surveyed were also noted.

Results and Discussion

Values of air and water temperature and salinity are presented in Table 1. Some aspects of the oceanography of the Lakshadweep sea have been studied earlier¹⁶⁻²⁰. Water is highly saline with very little fluctuations and highly oxygenated¹⁷. Diurnal

range of temperature is in the order of 5-7°C and annual range as the difference between the mean temperature of the hottest and coolest months is small being 2-4°C only²¹. All the islands being very small there is no freshwater source to dilute the seawater and consequently direct precipitation and very little drainage during the monsoon months may reduce the salinity to a little extent only. Lying within the tropics and extending close to the equatorial belt these islands have a humid and tropical climate. Distinct seasons are not experienced and the southwest monsoon period lasting from June to September is the chief rainy season.

Wood boring molluscs—During the survey, a total of 19 species of molluscan borers; 16 shipworms belonging to 6 genera and 3 piddocks belonging to 2 genera were collected. Occurrence of the species and their relative abundance are presented in Table 2. *Teredora palauensis* originally described under the subgenus *Teredothyra*^{22,23} is shifted to *Teredora* based on careful examination of the soft parts of both young and mature specimens.

The family Teredinidae contains 15 genera of shipworms; among them 12 are represented in Indian waters and 6 have been identified from the

Table 1—Temperature and Salinity Data of the Atolls Surveyed

Name of the atoll	Area km ²	Sal. (× 10 ⁻³)		Temp. °C			
		Lagoon	Sea	Air	Lagoon	Sea	
Minicoy	4.4	35.2	34.7	30.4	30.2	30.0	
Kalpeni	2.3	35.0	34.8	30.2	30.2	29.8	
Kadmat	3.1	34.7	34.2	30.4	30.8	30.2	
Kiltan	1.6	35.0	34.2	29.8	30.0	29.8	
Amini	2.6	34.3	34.7	29.7	30.0	30.0	
Kavaratti	3.6	35.0	34.5	30.6	30.8	30.7	
Pitti	—	35.0	34.7	30.6	30.8	30.6	
Tilakkam	—	34.6	34.4	30.8	30.7	30.6	
Cheryam	—	34.7	34.5	30.5	30.3	30.0	

Table 2—Relative Abundance of Molluscan Borers in Fixed Wood (FW) and Drift Wood (DW) Sampled Along the Shores of Different Atolls

[A = abundant (> 30), VC = very common (20-30), C = common (10-20), MC = moderately common (5-10), R = rare (< 5) and O = not recorded]

Species	Minicoy		Kalpeni		Kadmat		Kiltan		Amini		Kavaratti		Pitti		Tilakkam		Cheryam	
	FW	DW	FW	DW	FW	DW	FW	DW	FW	DW	FW	DW	FW	DW	FW	DW	FW	DW
<i>Teredothyra excavata</i> (Jeffreys)	O	MC	O	MC	O	O	O	O	O	O	O	R	O	O	O	O	O	O
<i>T. smithi</i> (Bartsch)	O	R	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
<i>Teredora palauensis</i> (Edmondson)	R	MC	O	A	O	VC	R	VC	O	VC	R	VC	O	A	O	A	O	A
<i>T. princepsae</i> (Sivickis)	O	C	O	R	O	VC	O	R	O	R	O	C	O	C	O	R	O	R
<i>Uperotus clavus</i> (Gmelin)	O	O	O	O	O	O	O	R	O	O	O	O	O	R	O	O	O	O
<i>U. rehderi</i> (Nair)	R	R	MC	VC	O	VC	O	VC	O	A	MC	A	O	A	R	A	R	A
<i>Teredo fulleri</i> Clapp	A	O	VC	O	VC	MC	A	MC	A	O	A	O	C	R	C	O	C	O
<i>T. clappi</i> Bartsch	A	O	VC	O	VC	O	VC	O	A	R	A	O	MC	O	A	O	A	O
<i>T. furcifera</i> Martens	O	R	O	R	A	MC	R	R	R	O	MC	R	R	O	O	O	R	O
<i>T. somersi</i> Clapp	O	O	O	O	O	O	O	O	O	O	O	O	O	O	R	O	O	O
<i>T. triangularis</i> Edmondson	O	O	O	O	R	O	O	R	O	O	R	O	O	O	O	R	O	O
<i>T. aegypos</i> Moll	O	O	O	O	R	O	O	O	O	O	R	O	O	O	O	O	O	O
<i>Lyrodus massa</i> (Lamy)	VC	O	A	MC	VC	R	VC	O	A	C	A	O	A	R	A	MC	A	MC
<i>L. pedicellatus</i> (Quatrefages)	O	R	O	O	R	O	O	O	O	O	R	O	O	O	O	O	R	R
<i>Bankia carinata</i> (Gray)	O	O	O	O	O	R	MC	O	R	O	C	VC	O	O	C	R	O	R
<i>B. companellata</i> Moll & Roch	R	R	R	R	O	R	O	O	O	O	MC	MC	O	O	O	O	O	O
<i>Pholas chiloensis</i> Molina	O	O	O	O	O	O	O	O	O	MC	O	O	O	O	O	O	O	O
<i>Martesia fragilis</i> Verrill & Bush	O	R	O	R	O	O	O	O	O	R	O	R	O	O	O	O	O	O
<i>M. striata</i> (Linnaeus)	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Lakshadweep archipelago during the present survey. The genera known certainly from India, but not represented in the present collection are *Bactronophorus*, *Dicyathifer*, *Nausitora*, *Spathoteredo* and *Nototeredo*. Among these the first 3 are typical of low saline water and their absence is due to the absence of such a habitat. *Spathoteredo* has only once been recorded in Indian waters²⁵ and reasons for the apparent absence of *Nototeredo* in the archipelago are not clear. With the present report the total number of teredinids recorded in Indian waters becomes 34. Species such as *Teredora palauensis*, *Teredo aegypos* and *T. somersi* are reported from India for the first time. Besides, the report extends the distribution range of a few species such as *Teredo fulleri*, *T. triangularis*, *Uperotus rehderi* and *U. clavus* from the east coast of India to the west coast.

Incidence of pholadaceans in fixed wooden structures—The species found to bore into fixed wood alone are considered as endemic fauna and they include 12 species, all of the family Teredinidae. Table 2 gives the distribution and relative abundance of endemic and drift wood species in the vicinity of different atolls. Species diversity of the genus *Teredo* is high while that of *Bankia* is very poor in the archipelago when compared with the number of species under these 2 genera. The dominant species and therefore the most destructive forms are *Teredo fulleri*, *T. clappi* and *Lyrodus massa*. Species such as *Teredo furcifer*, *T. aegypos*, *T. somersi*, *T. triangularis*, *Teredora palauensis*, *Lyrodus pedicellatus*, *Uperotus rehderi*, *Bankia campanellata* and *B. carinata* infesting wooden objects sporadically in combination with one or more of the dominant forms are also important. In all the atolls where old wooden structures were examined, submerged portions were eaten away in varying degrees depending on the duration of submergence.

Incidence of drift wood pholadaceans—Species of borers collected from drift wood, fruits and nuts along the shores of the atolls are given in Table 2. Among them, *Teredothyra excavata*, *T. smithi*, *Teredora princesae*, *Uperotus clavus*, *Martesia fragilis* and *Pholas chiloensis* are probably not endemic to the archipelago. None of these species was recovered from fixed wooden structures and so may be considered as ocean travellers whose exact locality of origin could hardly be stated. Most of these species were identified on the basis of pallets and or shell valves only. Extremely hard shells of coconuts were also occasionally bored through by *Teredora princesae* and *Teredothyra smithi*.

Borer infestation on fishing and sailing vessels—Wooden boats sailing in the Lakshadweep sea were found attacked by *Teredo clappi*, *T. fulleri*, *Lyrodus*

massa, *Uperotus rehderi* and *Bankia carinata*. Among them *Teredo clappi*, *T. fulleri* and *Bankia carinata* were found in almost all samples of shipworm infested wood collected from vessels. A partially damaged wooden cargo boat contained entire specimens of *Lyrodus pedicellatus*, *Teredo furcifer*, *T. clappi* and a large number of *Martesia striata*. The apparent absence of *Martesia striata* in fixed wood tends to suggest that endemic population of this species has not been established so far in the archipelago probably due to some unfavourable environmental condition or biological competition with the densely occurring shipworms and limnoriids. Along with the molluscan borers, the planks of the boat contained living specimens of the crustacean borers namely *Sphaeroma terebrans*, *S. annandalei* and *S. walkeri*. The first two of the crustacean borers also could not be noticed in fixed wood. Therefore, initial settlement of them and *Martesia striata* in the boat probably occurred from the coast of the mainland.

Biofouling—Fouling on man made objects in the Lakshadweep sea is not severe when compared with the same along the shores of the Indian mainland²⁴. In species representation and relative abundance fouling community of the archipelago is insignificant. On jetties and other coastal installations they are represented by sparse settlements of rock oysters and serpulids. Floating logs contained patchy encrustations of bryozoans and, pedunculate barnacles. Fouling is relatively more conspicuous at Kavaratti than at other atolls. An important feature of fouling in the archipelago is the extreme rarity of major fouling elements such as the barnacles, bryozoans, mussels, hydroids and ascidians. This poor incidence of foulers may account for the abundance of marine wood boring organisms.

Associated fauna of shipworms—Several species of invertebrate macrofauna belonging to a number of phyla were recovered from the calcareous tubes of shipworms. They include flatworms, sipunculids, polychaetes, isopods, amphipods, alpheid shrimps and pinnotherid crabs. Nature of the relationship of these associates with shipworms is not exactly known and many polychaetes and flatworms are probably predators. A few may be scavengers and others casual visitors taking shelter inside the tubes.

Crustacean wood borers—The isopod wood borer *Limnoria* is abundant in Kavaratti and a few other atolls and specific identifications of the specimens collected are yet to be made. Limnoriids attack from the outside and destroy the superficial layers of wooden structures and in course of time produce a multitude of minute holes as galleries and convert wood into a weak and fragile mass. The destruction is accentuated by the coexisting amphipod *Chelura* sp.

which enlarges the burrows of limnoriids. Calcareous tubes of shipworms were exposed in many wooden structures due to the superficial deterioration of wood by limnoriids and chelurids. Dense populations of these crustacean borers do not seem to seriously inhibit the settlement of shipworms.

Preventive measures—Biodeterioration of wood as a result of infestation by boring molluscs can be reduced by carrying out repairs, replacements and fresh installations avoiding the peak settlement periods of the dominant borers. The periods and density of the settlement of various species are known to vary from place to place^{1,24} and this aspect has not been investigated for any species in the Lakshadweep sea. Apart from a detailed survey, the period of settlement of the dominant and thereby the highly destructive species such as *Teredo clappi*, *T. fulleri* and *Lyrodus massa* need to be investigated. All unnecessary timber harbouring stocks of parental populations which supply waves of viable shipworm larvae must be removed. Timber for waterfront structures must be treated properly with antiboring compositions prior to installation, to extend their service life. Boring and fouling animals have ample opportunities for introduction to new localities by navigation. With a proper surveillance over the existing members of the community, details of fresh introduction can be assessed.

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