PART I

SYSTEMATIC ACCOUNT OF SHIPWORMS ALONG THE SOUTH-WEST COAST OF INDIA
## CONTENTS

### PART I  Systematic account of shipworms along the South-west coast of India

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>List of species described</td>
<td>9</td>
</tr>
<tr>
<td>Descriptions of species and notes on distribution</td>
<td>11</td>
</tr>
<tr>
<td>General remarks</td>
<td>108</td>
</tr>
</tbody>
</table>

### PLATES
INTRODUCTION

A perusal of literature on teredinids has shown that the taxonomy of this group has been rather confusing; the description of one species could include several allied forms. The variation in taxonomic characters exhibited by individuals are so wide that exact determination of a species may be extremely difficult. No other group seems to have a more unsatisfactory classification than the teredinidae as pointed out by several earlier workers (Clapp 1923; Iredale 1932, '36; Moll & Roch 1937; Roch 1940; Edmondson 1942). The reason for this state of affairs has been (1) many of the species included under this group have been created on the basis of fragmented material regardless of wide range of variation exhibited by these bivalves, (2) the locality of the type species has not been accurately determined, (3) many new species have been described on the basis of zoo-geographic provinces, without taking into consideration their means of dispersal, (4) authors had described several new species without referring to earlier publications which were scattered and often unavailable. This has unfortunately resulted in the creation of many invalid species.

While the taxonomy of the Teredinidae was in this state of confusion, Turner (1966) undertook the compilation of a comprehensive work to "make available a catalogue of
all the names used in the family Teredinidae to illustrate as many of the type specimens as possible, giving descriptive notes concerning them and indicate synonyms whenever this could be done.

The shipworms have sufficient characters upon which a classification can be based, and if a large series of well preserved specimens had been available to early workers in this field, much of the confusion probably would have been avoided. This was not the case, however, and many species were described on the basis of shells only or upon a few dried specimens or on a single specimen and sometimes on a fragment of a pallet. In addition, the specimens were often taken from ships that had sailed on distant waters so that the origin of the specimens were unknown, or the locality in error. The fact that teredinids are readily distributed by floating woods or ships was not fully realised until recently and consequently many new species were described on the basis of zoo-geographic provinces (Turner, 1966).

Turner (1966) had the rare opportunity, not available to many earlier taxonomists of this group, of examining many type specimens, an essential pre-requisite for an attempt of this kind. Undoubtedly this work represents a milestone in the literature on the subject and will be an indispensable work of reference for all future workers.
There has been no publication in India dealing purely with the taxonomy of the shipworms until 1954, when Nair described 10 species belonging to the genera Teredo and Bankia from Madras coast. This was followed by the description of seven more species by Nair (1955) from Madras and Kerala. This was followed by publications of many workers from different parts of the east and west coasts of India. The number of described species from India showed a steady increase through detailed studies on these animals from different localities along the coast of India.

Owing to the existence of a wide range of variations especially in the shells and pallets of the Teredinidae and on account of the unsatisfactory nature of the taxonomy of this group before the publication of the illustrated catalogue of the Teredinidae (Turner, 1966), many of the species described were just synonyms. However, the total numbers of valid species occurring along the Indian coast is about 38 (Nair, 1988)

Seven species were collected, identified and described from West Bengal (Wright, 1864; Roonwal, 1954, 1954a, 1966; Roch, 1961; Rajagopal, 1961, 1964); 12 species from Mahanadi, Orissa (Subba Rao, 1968); 16 species from Andhra Pradesh coast (Nagabhushanam, 1955, 1960; Ganapati & Rao, 1959;
Rao, 1986); 24 species from Tamil Nadu coast (Nair, 1954, 1955, 1955a, 1955b, 1956, 1962, 1965; Nair and Dharmaraj, 1979, 1980, 1980a; Nair & Gurumani, 1956, 1957, 1957a, 1957b; Daniel, 1956; Radhakrishnan et al., 1983; Srinivasan & Chandramohan, 1973); 14 species from the Andaman and Nicobar Islands (Das & Dev Roy, 1980; Ganapati & Rao, 1960; Karande 1978; Tewari et al., 1980); 17 species from Kerala (Saraswathy, 1964, 1967; Dharmaraj & Nair, 1981, 1981a, 1981b; Nair et al., 1987); 20 from Lakshadweep Archipelago (Nair & Dharmaraj, 1983); 14 from Karnataka coast (Santhakumaran, 1973, 1976, 1985, 1986); 11 from Maharashtra coast (Karande 1968; Palekar & Bal, 1955; Palekar et al., 1964; Santhakumaran, 1971) and 12 from Gujarat coast (Santhakumaran 1973, 1976, 1984). This account is only tentative since our information of these borers along the coasts of the Indian mainland was reported primarily from widely separated and easily accessible areas such as harbours and areas near biological research centres.

Our information on the shipworms of the east coast of India is fairly satisfactory, whereas our knowledge about the shipworms of the South-west coast is meagre, more particularly that along the coast of Kerala and Lakshadweep Archipelago. The work about shipworms along the Kerala coast is confined only to some selected backwaters in the southern part of Kerala namely, Cochin backwaters, Kayamkulam Lake, Neendakara,
Kadinamkulam, Akathumury and Anjengo (Erlanson, 1936; Saraswathy, 1967; Nair & Saraswathy, 1971; Dharmaraj & Nair, 1981a; Nair & Dharmaraj, 1983) and virtually nothing has done so far from the northern part of Kerala.

In the light of above and in view of the paucity of information regarding the exact number of shipworms that occur along these areas in particular, a precise knowledge of the species in the backwaters is an essential pre-requisite for further investigations. For this an extensive collection of the shipworms was taken from the major backwater systems and estuaries of Kerala, such as the Veli Lake, Kadinamkulam, Akathumury, Paravur, Edava-Nadayara, Ashtamudy, Kayamkulam, Vembanad, Kodungalloor-Azhekode, Chettuva, Kadalundi, Beypore, Kallayi, Korapuzha, Badagara (Kottapuzha river estuary), Valapatanam, Nileswaram and the major islands of the Lakshadweep Archipelago, along the South-west coast of India. The result of this form the subject of the present section.

Turner (1966) has proposed a system of classification taking into consideration some features of the anatomy of the soft parts and also the structure and manner of growth of the pallets besides the conventional criteria for classification.

The family Teredinidae includes the well known shipworms which are highly specialized bivalves. Unlike typical lamellibranchs, the shipworms have a naked, long, slender
and cylindrical body with a greatly modified but remarkably small shell-valves adapted for boring into wood. The family Teredinidae and their nearest relative the piddocks belonging to the family Pholadidae together constitute the sub-order Pholadinae of the eulamellibranchiate order Myoida. The sub-order Pholadinae is characterised by a nearly closed mantle, somewhat discoidal foot, reduced hinge and internal ligament; considerably small anterior adductor muscles, relatively large and powerful posterior adductor muscle and greatly modified and specialized shell-valves armed with denticulated ridges over the anterior outer face and having a conspicuous pedal gape for the protrusion of the foot, conspicuous dorsal and ventral condyles are present to facilitate rocking movements of the valves in the Teredinidae but the Pholadidae lack ventral condyles for the insertion of the pedal muscles, styloid apophyses are present beneath the umbos. While the shell-valves of the bivalves can protectively cover the soft part when retracted, those of the shipworm are greatly reduced and have thus lost their protective function, but serve as effective cutting tools used for the specific purpose of excavation of the burrow. The worm-like body of the shipworm extend far beyond the posterior margin of the shell, the wood into which it burrows, affording protection for its bare body. Additional protection is ensured by a calcareous tubing around the animal secreted
by the mantle of this mollusc. While the shell of piddocks are provided with accessory plates, the shipworms have unique structures known as pallets located at the base of the siphons to close the burrow when the siphons are withdrawn.

It is usually possible to judge by the size of the holes whether the borers within a piece of infested wood belong the Teredinidae or the Pholadidae. Those of the teredinids are usually very small and the calcareous lining of the tube is often visible; the aperture of a mature pholad burrow is usually 2 to 3 times that size and does not have a calcareous lining. But to distinguish between newly settled pholads and teredinids is rather difficult.

Generally, wood boring pholads make burrows only slightly longer than the length of the shell. Teredinids usually continue to bore as long as there is enough substratum to work on and make tubular tunnels, the animal extending the entire length.

The generic classification of the Teredinidae is based on the morphology of the soft parts in conjunction with the type of pallets. Identification of species is almost entirely based on the nature of the pallets. Though the siphons have proved useful at times, there is no sufficient data on most species for them to be used in identification. The type of
A calcareous tube may also prove useful but unfortunately it is, too, insufficiently known in many species to form a reliable basis for identification. The characters of the shell can be useful in a few species but only in conjunction with the pallets. Generally the variation exhibited in a series of shells from a single locality is so great and the shells of species belonging to different genera are so similar that it is not possible to use them for taxonomic purposes (Turner, 1971).

Recognizing as many as 14 genera, Turner, discarded the usage of subgenera owing to the occurrence of transitional species between them. Turner (1966) divided the family into three subfamilies, namely Kuphinae Tryon including the mud-boring genus Kuphus Guettard, Teredininae Rafinesque, which includes nine genera of shipworms, namely Bactronophorus Tapparone-Canefrei, Neoteredo Bartsch, Dicyathifer Iredale, Teredothyra Bartsch, Teredora Bartsch, Uperotus Guettard, Psiloteredo Bartsch, Teredo Linnaeus and Lyrodus Gould and the new sub-family Bankiinae which includes four genera Nototeredo Bartsch, Spathoteredo Moll, Nausitora Wright and Bankia Gray. According to this new system, the total number of valid species of shipworms in the world has been reduced to 66. Some species synonymised in the catalogue were later found to be valid species (Ibrahim, 1981; Rayner, 1974; Hoagland & Turner,
1981). With this new classification as the basis, the species that were collected from the South-west coast of India have been determined.

The collection of species from the South-west coast of India including the Lakshadweep Archipelago when examined on the basis of this classification, was found to be represented by the following species.

**List of species described**

Genus group I

**SUB-FAMILY TEREDININAE Rafinesque**

Genus **DICYATHIFER** Iredale

1. *Dicyathifer manni* Wright

Genus **TEREDOTHYRA** Bartsch

2. *Teredothyra excavata* (Jeffreys)
3. *Teredothyra smithi* (Bartsch)

Genus Group II

Genus **TEREDORA** Bartsch

4. *Teredora palauensis* (Edmondson)
5. *Teredora princesae* (Sivickis)

Genus **UPEROTUS** Guettard

6. *Uperotus clavus* (Gmelin)
7. *Uperotus rehderi* (Nair)
Genus **PSILOTEREDO** Bartsch

8. *Psiloteredo senegalensis* (Blainville)

Genus Group III

Genus **TEREDO** Linnaeus

9. *Teredo aegypos* Moll
10. *Teredo bartschi* Clapp
11. *Teredo clappi* Bartsch
12. *Teredo fulleri* Clapp
13. *Teredo furcifera* von Martens
14. *Teredo mindanensis* Bartsch
15. *Teredo portoricensis?* Clapp
16. *Teredo somersi* Clapp
17. *Teredo triangularis* Edmondson

Genus **LYRODUS** Gould

18. *Lyrodus massa* (Lamy)
19. *Lyrodus pedicellatus* (Quatrefages)
20. *Lyrodus triste* (Iredale)

SUB-FAMILY **BANKIINAE** Turner

Genus **SPATHOTEREDO** Moll

21. *Spathoteredo obtusa* (Sivickis)

Genus **NAUSITORA** Wright

22. *Nausitora dunlopei* Wright
23. *Nausitora hedleyi* Schepman
24. *Nausitora fusticula* (Jeffreys)
25. *Nausitora globosa?*
26. *Nausitora oahuensis* (Edmondson)
Genus **BANKIA** Gray

27. _Bankia companellata_ Moll & Roch
28. _Bankia carinata_ (Gray)

**PHYLUM MOLLUSCA**

Class **Bivalvia**

Order **Myoida**

Family **Teredinidae**

Sub-family **TEREDININAE** Rafinesque


Includes genera in which the pallets are non-segmental in structure. In this family there is a trend toward increased protection of young culminating in the genus *Lyrodus* which retain the young within the mantle cavity to the late veliger stage. Shell typical of the family

A muscular collar absent, pallets varied, non-segmental, caecum present for the storage of grated particles of wood, intestine not traversing the heart.

Of the nine genera under this sub-family, seven are represented along the South-west coast namely *Dicyathifer*

Genus Group I

Stomach globular, gonads posterior to the caecum, anal canal closed (Turner, 1966, 1971).

Genus *Dicyathifer* Iredale

1932 *Dicyathifer* Iredale, Destruction of timber structure by marine organisms in the port of Sydney. Sydney Harbour Trust, Sydney, pp. 24-40


Salient features

Pallets solid, simple, almost entirely calcareous, somewhat triangular in outline and having a long, heavy stalk. Inner face of blade flat while outer face is convex and the distal end produced into a shallow cup which may partially or almost completely divided by a median longitudinal ridge. Shell
comparatively large bearing strong denticular ridges on the anterior outer face. Siphons separate and moderately long, labial palps small. Anterior portion of ctenidium well developed. The broad, flat ctenidia bear well developed food grooves on the ventral outer edge; stomach globular, caecum small and flask-shaped; intestine loops over the style-sac and after passing down the right side of the stomach crosses beneath it to the left side, extends posteriorly along the left side and after meandering passes beneath the pericardium to pass under and then around dorsally and then over the posterior adductor muscle. The intestine extends a short distance beyond the muscle before opening into the anal canal. Muscular folds at the end of the anal canal control the opening into the epibranchial cavity so that the faeces can be retained within the canal. The heart is approximately one half of the length of the animal extending from the posterior adductor muscle to the anterior end of the gills. Ventricle is short, broad, the auricles are long and tubular. Kidney is large extending from the posterior adductor backwards for nearly half the length of the heart. Includes species like *Dicyathifer manni* (Wright) occurring in the marine and brackish water areas of the Indo-Pacific (Turner, 1966).
Dicyathifer manni (Wright)
Plate IB, Figs. 1-4, Photographs 1&2


1928  Teredo bartsihi Sivickis, Philippines J. Sci., 37 : 292, Pl. 3, fig. 13

1936  Dicyathifer caroli Iredale, Queensland Forest Service Bull., 12 : 38, Pl. 1, Figs. 16-25

1956  Teredo sivicksi Miller, Proc. 8th Pacific Science Congress, 3A : 1575


Salient features

Pallets large and heavy, almost entirely calcareous and somewhat triangular in shape. The blade is about as wide as long, moderately cupped, with a medial ridge partially or completely dividing it. Blade flat on the inner face, and moderately convex on the outer face. The distal margin on the outer face of the blade is broadly U-shaped, that on the inner face straight or slightly curved. Shell somewhat triangular in outline with broad dorsal margin. Anterior lobe varies in size and shape and often eroded. Anterior median portion
large, middle median and posterior median portions are narrow but well defined. Auricle greatly reduced and set high on the posterior median part and does not form a shelf when viewed from within. Apophysis long, broad and flattened.

Siphons separate, gills broad and flat, branchial groove well developed, labial palps not free, stomach globular, caecum small, intestine looping over style-sac, anal canal closed, heart anterior, auricles deeply pigmented. Despite the fact that this is a large species, its caecum is small, the kidneys are well developed, anal canal long and this can be closed by a muscular fold.

Material examined

Several specimens were collected from water front structures from Kallayi, Beypore, Korapuzha, Badagara, Valappattanam estuaries and Nileswararam backwaters during the pre-monsoon period of 1988. Specimens measuring more than half a metre were among the collection from many sites in these estuaries. In Valapattanam estuary heavy attack of these animals has been noticed in live plants like Sonneratia caseolaris, Avicennia marina (Plate XVII, Fig. 3 & 4). In these live plants, these bivalves were found very commonly settling at the junction of the roots and shoot and growing downwards into the roots.
Occurrence


Distribution

East coast of Africa (Kenya, Tanganyka, Mozambique), Comoro Islands, Madagascar, Reunion (Roch, 1955), Indo-Malay Archipelago (Roch, 1955), Australia (Iredale, 1936), New Zealand and Papua-New Guinea (Roch, 1961; Rayner, 1974), Philippine Islands, Pacific Ocean Islands (Roch, 1961).

Ecological notes

This species is reported to be common infesting mangrove trees in both marine and brackish waters of tropical and
sub-tropical South-east Asia. It is also found in fixed structures in both brackish and marine habitats.

_D. manni_ is a large shipworm of the Indo-Pacific region. According to Rayner (1974), this is a very common species growing to a large size in mangrove swamps of Papua-New Guinea. It has been reported as infesting live and dead mangrove trees in the Sundarbans of West Bengal (Roonwal, 1966). According to Palekar and Bal (1957) this is the most common species both in the Karwar Port and the sewri timber pond of Bombay. Santhakumaran (1976, 1989) stated that this is one of the most destructive shipworms on the North-west coast of India and many specimens collected from living mangrove trees at Cuffe Parade and Jamnagar. Specimens measuring from 8.3 to 23.4 cm were collected from South Andamans by Das and Dev Roy (1980). In Papua-New Guinea this species occurs in the Marshall Lagoon estuary in salinities between 10 and 35\% and in laboratory tests its growth was found to be faster in 20 and 30\%. Settlement occurred periodically along the mouth of the river in response to seasonal changes in salinity (Rayner, 1979).

**Remarks**

The structure of the pallets of the species under study closely tallies with the original description. The median
longitudinal ridge dividing the outer shallow cup was evident in all the pallets examined. Specimens collected from the various estuaries mentioned range from 2.3-62.2 cm in length. Heavy attack of this species was noticed in living trees in the Valapattanam estuary. Part of an old wooden ship found at the Beypore harbour (Plate XVII, Figs. 5&6) was heavily infested by *D. manni* along with *Teredo furcifera, L. pedicellatus, N. hedleyi, M. striata, Martesia* sp., *S. terebrans, S. annandalei* and *S. walkcri*. This is the first report of heavy attack of this species from Kerala coast. Previous report of it from Kerala was based on two specimens from Cochin backwaters by Saraswathy (1967) and Dharmaraj & Nair (1981a) reported it from Ashtamudy Lake based on a few pallets only. Specimens collected from these living trees were found deeply penetrating into the root system also. During the present study which covered all the major backwater systems of Kerala and Lakshadweep Archipelago, not a single specimen was found in the backwaters of southern Kerala. But in backwaters of the northern Kerala from Baypore upto Nileswaram there was continuous occurrence of this species and in all these systems attack was heavy.

**Genus TEREDOTHYRA** Bartsch

Salient features

Pallets consisting of a broad or elongate basal cup and a secondary inner cup which is divided medially. The stalk is partly sheathed by the basal cup and extends into the substance of the blade up to about the base of the inner cup.

Siphons long and separated, ctenidia extend from the base of the siphons to the posterior end of the gonads. The food grooves extend over the visceral mass to the anterior gill filaments and the labial palps which are rudimentary; stomach globular, caecum comparatively small and bent, intestine short with an anterior loop around the crystalline style-sac and after passing below the stomach loops around the caecum and curves over the posterior adductor muscle to open into the anal canal through a large muscular anus. Heart anterior,
with a short triangular ventricle, auricles long and tapering (Turner, 1966).

This genus is widely distributed in tropical and subtropical areas and includes species which are usually small such as T. dominicensis (Bartsch), T. excavata (Jeffreys), T. matacontana (Bartsch) and T. smithi (Bartsch).

Teredothyra excavata (Jeffreys)
Plate IC, figs.1-4, Photographs 3&4

Salient features

Pallet blade is longer than wide, distal margin on inner face nearly stright, margins of two cups on the outer face deeply U-shaped. Basal cup usually clearly visible, much shorter on outer face.
Shell sub-globular with the anterior slope provided with a deep sinus, posterior slope narrow.

**Material examined**

Five pairs of pallets and shells among the pallets and shells collected from a piece of timber found on the beach in Thinnakara island of the Lakshadweep Archipelago during May 1987.

**Occurrence**

Collected from a floating piece of wood cast ashore at Royapuram, Madras coast (Nair, 1955); Mandapam (Nair & Dharmaraj, 1980); Lakshadweep (Nair & Dharmaraj, 1983), Mangalore (Dharmaraj & Nair, 1981).

**Distribution**

Probably world-wide particularly in tropical and subtropical areas. Records are available from Guersey, England, Victoria in the Cameroons, Africa (Moll, 1941), at Subic Bay, Luzon, Philippine Islands (Edmondson, 1959); Papua New - Guinea (Rayner, 1974), Australia (Ibrahim, 1981) and from shipwrek at Koror, Palace Islands (Caroline Islands) (Edmondson, 1959).

**Ecological notes**

This species occurs in fair numbers in the mangrove forests adjoining the mouth of the Talapady River opening
into the Arabian Sea about 15 km south of old Mangalore Port and Nethravathy, Gurupur estuaries. Salinity varies from almost freshwater during monsoon to near marine condition during the pre-monsoon period. Shells and pallets have been collected from drift wood cast ashore in the Lakshadweep Archipelago.

**Teredo thyra smithi** (Bartsch)

Plate IIA, Figs. 1-4, Photograph 5

1927 *Teredo (Teredothyra) smithi* Bartsch, Bull. U.S. Natl. Mus., 100(2), Pt. 5: 540; Pl. 53, figs. 6-7; Pl. 56, fig. 4; Pl. 59, figs. 10-12

1927 *Teredo (Teredothyra) radcliffei* Bartsch, Bull. U.S. Natl. Mus., 100(2), Pt. 5: 542; Pl. 35, figs. 11-14; Pl. 56, fig. 5; Pl. 59, figs. 7-9

1927 *Teredo (Teredothyra) tanonensis* Bartsch, Bull. U.S. Natl. Mus., 100(2), Pt. 5: 543; Pl. 54, fig. 7; Pl. 56, fig. 1; Pl. 59, figs. 1-3


1945 *Kuphus (Idioteredo) kiinensis* Taki and Habe, Venus, 14: 115

1956 *Teredo (Zopoteredo) bengalensis* Nair, Rec. Indian Mus., 52: 411, figs. 10a-c


Salient features

Pallets long and spatulate with a cylindrical stalk (of variable length) which continues into the flat blade-like shaft of a feather. This extension of the stalk is noticeably prominent in the inner view of the pallet. Blade broad and elongate with a horn coloured periostracum at the distal end which is slightly cupped. The calcareous margins when viewed from the inner side may extend as two pointed horns at the distal end with the periostracum in between. A well defined median longitudinal fold may be present on the distal outer face of the blade. The sides of the pallet blade are not straight but slope towards the posterior end.

Shell sub-globular, white, anterior slope sculptured by closely set denticulated ridges, disc prominent, posterior slope well defined and conspicuous in young specimens but may be badly eroded in old specimens, umbal reflection and callus prominent, apophyses broad, long and slightly oblique springing from the underside of the umbo.

Siphons, relatively long and separated (Turner, 1966).

Material examined

Three pairs of pallets and a pair of shells from a drift wood washed ashore at Bungaram island in the Lakhadweep Archipelago collected during May 1987.
Occurrence

It has also been reported from other parts of the Indian coast, Madras, Pamban (Nair, 1955, 1962), Mangalore (Dharmaraj & Nair, 1981), Tondi, Ramanad (Nair & Gurumani, 1957, 1957a), Lakshadweep (Nair & Dharmaraj, 1983), Okha (Santhakumaran, 1976, 1976a).

Distribution

Indo-Pacific in Tropical and sub-tropical areas. Records are available from Tanganyika (Tanzania) (Moll & Roch, 1937); Kii, Japan (Taki and Habe, 1945); Matacot point, Western Luzon (Bartsch, 1927); Off Linao Point, Gulf of Davao, Mindanao (Bartsch, 1927); Off Pecador Islands, Tenon straight, Philippine Islands (Bartsch, 1927), Papua, New-Guinea (Rayner, 1974).

Ecological notes

Live specimens have been collected from the mangrove swamps of Talapady, Mangalore, India. At Madras, Nambudalai, Pamban, and Lakshadweep, only shells and pallets could be collected from drift material whose origin is not known. That this species occurs in fairly deep waters is evident from its incidence at 28 fathoms Off Linao Point, Gulf of Davao, Mindaneo; and at 300 fathoms Off Pecador Island in Tenon straight, Philippine Islands and Turner (1966) has reported it from
a depth of 5050 m (not living specimens).

**Remarks**

The present materials closely correspond with the original description of the species (Bartsch, 1927). The periostracal portion at the distal end of the blade is not complete in the pallets collected and showed various degree of erosion. The stalk is cylindrical, slender and curved and is clearly visible in the region of the blade also.

**Genus Group II**

Stomach globular anal canal open, gonads dorsal to caecum (Turner, 1966, 1971).

**Genus TEREDORA Bartsch**


1966 Teredora Bartsch, Turner, A survey and illustrated catalogue of Teredinidae (Mollusca Bivalvia), Museum of Comparative Zoology, Harvard University, Cambridge, Mass, p. 28, 75

Salient features

Pallets solid, entirely calcareous, blade oval to broadly oval in outline, with a short sometimes stout stalk. Blade thick at the base, the outer convex face resembling a nail in its nail bed marked by concentric lines of growth. In the young, the blades of the pallets are double-cupped. These double cups often remain as tubes at the base of the depressions in older specimens. In young, the pallet blade is wider than long. A median rib may occur extending from the base to the tip of the blade. Radiating wrinkles may also be present on the outer face of the pallet blade. Shell valves with small, high posterior slope and with the ventral margin of the shelf forming a nearly right angle to the dorso-ventral axis of the valves. The posterior slope is placed high on the dorsal margin that nearly half of it projects as a shelf inwardly and the outer half outwardly.

Siphons are united for most of their length, incumbent siphon with numerous large papillae; the ctenidia are blade-like, continuous extending from siphons to mouth; labial palps free; stomach elongate globular; caecum long and doubled upon itself to the right, intestine anteriorly loops around the style-sac and posteriorly loops around the caecum and curves over the posterior adductor to open into the anal canal; heart
relatively small with a short, broad ventricle and short, tapering auricles; kidney placed dorsal to heart.

The genus *Teredora* has a wide distribution in tropical and warm temperate waters and contain species such as *T. malleolus* (Turton), *T. palauensis* (Edmondson) and *T. princesae* Sivickis.

*Teredora palauensis* (Edmondson)
Plate II B, Figs. 1-4, Photographs 6&7

1959 *Teredo* (*Teredothyra*) *palauensis* Edmondson, Occ. Pap. P. Bishop Museum, 22 110 : 203, figs. 1a-d

**Salient features**

Pallets white and small, entirely solid and calcareous. No trace of periostracum even in young specimens; oval to broadly oval in outline with short stalk. Blade, convex on the outer and nearly flat on the inner face. Distally the blade is double-cupped, the two cups resembling burrowing excavated from the distal end leaving a thin calcareous wall between them. Gills extend from the siphons to the mouth of the specimen. Auricles of valves highly developed and large.
Material examined

Two small specimens having a length of 1.2 cm and 1.3 cm and a few pallets and shells from a piece of fixed wood at Kadamath Island and large number of pallets and shells were collected from drift wood obtained from the near shore waters of Agathi, Bungaram, Thinnakara, Kalpitty and Kadamath Atolls in the Lakshadweep Archipelago during May 1987.

Occurrence

Ladshadweep Archipelago, abundant in drift wood and occasionally in fixed wood also (Nair & Dharamaraj, 1983).

Distribution

Koror, Palan Islands (Caroline Islands, from hull of a wrecked ship) (Edmondson, 1959).

Ecological notes

The species was originally described on the basis of valves and pallets alone and Turner (1966) has stated that it may be a synonym of Teredothyra excavata (Jeffreys). Considered as a pelagic species invading drift wood, occurs occasionally in submerged fixed wooden materials also. However, careful examination of the specimens from wooden structures
along the shore waters of Lakshadweep Archipelago revealed that *T. palauensis* is a valid species (Close examination of this material by Turner, revealed that this species belong to the genus *Teredora* and not *Teredothyra*).

**Remarks**

The structure of the pallets closely resembles that of the original description given by Edmondson (1959). A unique feature of this shipworm is its small size. The pallets and shells collected were white and small in size. Large number of pallets and shells were collected from drift wooden material from different atolls of the Lakshadweep Archipelago. Shell is typical of the genus. The posterior slope is pronounced and obliquely placed high on the posterior dorsal margin.

Other species of shipworms namely *Teredora princesae* (Sivickis), *Lyrodus pedicellatus* (Quatrefages) and *Bankia carinata* Gray were also present in the wood from which pallets of *T. palauensis* were collected.

*Teredora princesae* (Sivickis)
Plate II C, Figs. 1-4, Photographs 8&9

1928 *Teredora princesae* Sivickis, *Philippine Jour. Sci.*, 37 : 291, Pl. 2, fig. 11


1938 Teredo (Teredora) gregorii Dall, Bartsch and Rehder, Bull. B.P. Bishop Mus., 153: 212, Pl. 55, figs. 1-5

1941 Teredo alfredensis van Hoepen? Tydskrif vir Westenokap en kuns, 2: 176, Pl. 10, figs. 3-6

1955 Teredo (Teredora) minori Nair, Rec. Indian Mus., 53: 274, text fig. 7a-d


Salient features

Pallets solid, broadly oval somewhat leaf-shaped. Blade thick at the base and thin at the distal end. The outer face has a conspicuous nail-like depression marked by concentric lines. Thickened area at the base and sides smooth. Stalk, short and thick and extends into the blade as a longitudinal rib.

Shell with characters of the genus. The posterior slope is large and obliquely placed high on the posterior dorsal margin.
Siphons united except at the tip, gills blade-like extending from base of siphons to the mouth. That part of the ctenidia over the visceral mass reduced in area when compared to those behind it with well developed branchial groove, labial palps free at the end, caecum elongate and doubled upon itself to the right. Intestine loops over style-sac in front and over the caecum behind, anal canal open, heart anterior with no pigmentation for auricles.

Material examined

Two specimens and a large number of pallets and shells from drift wood and fixed wood from different atolls of the Lakshadweep Archipelago were collected during May 1987.

Occurrence

Records are available from many parts along the coast of India. Vishakapatnam (Satyanarayana Rao et al., 1989), Mahanadi Estuary (Subba Rao, 1968), Madras (Nair, 1954, 1955, 1956; Daniel, 1958); Porto Novo (Nair & Dharmaraj, 1980a), Pamban (Nair, 1962, 1965; Nair & Dharmaraj, 1980); Cochin (Nair, 1964; Saraswathy, 1964); Lakshadweep (Nair & Dharmaraj, 1983); Mangalore (Dharmaraj & Nair, 1981); Bombay high (Raveendran & Wagh, 1986).
Distribution

*T. princesae* is well distributed in the Indo-Pacific from temperate to tropical regions. It has been reported from Korimba Islands, Mozambique, Portuguese, E. Africa (Moll, 1928); Port Alfred, Union of South Africa (van Hoepen, 1941); Malay Archipelago (Roch & Moll, 1929); Pureto Princesa, Palawon, Philippines (Sivickis, 1928); Manila, Philippines, Jawa (Roch & Moll, 1929); Panony Philippines (Roch, 1931); Keankaha, Hilo, Hawaii (Dall, Bartsch & Rehder, 1938); Hawaii (Edmondson, 1942); Papua, New-Guinea (Rayner, 1974); North Australia (Rayner, 1974); Packakarithi Beach, New Zealand (Mckoy, 1980).

Ecological notes

This is a temperate to tropical Indo-Pacific species found in drift wood and boat hulls. According to Edmondson (1962) this is typically an open ocean species and attacks drift logs. Some of the recovered shells in Hawaii were 19 mm in height and the largest burrows exceeded 60 cm in length making the species the largest in Hawaiian Waters. This is a species habitually adapted to floating wood. Some observations indicate that it can grow to about 75 cm in 140 days in Douglas fir test panels in Koneohe Bay, Oahu. A maximum penetration of 70 mm was recorded in Koa wood at Waimanalo, Oahu during a a 180 days period, the shells attaining a height
of 8 mm in that time. Shells of 14 mm high were recovered from a floating raft of California red wood anchored on Waikiki reef for two years.

Teredora and Uperotus have been reported from Pilings, floats and other fixed timbers on the coasts of India (Nair & Saraswathy, 1971; Raveendran and Wagh, 1986; Rao et al., 1989) and in drift wood on the east coast of Australia and on the north coast of Papua, New Guinea (Turner & Marshall, 1973; Rayner, 1974). There are obviously enough wooden stepping stones across the Pacific Ocean to allow the continuous distribution of these species.

Genus UPEROTUS (Guettard)

1770 Uperotus Guettard, Memoires sur differentes parties des sciences et arts, 3: 126-128


1840 Guetera Gray Synopsis of the contents of the British Museum, ed. 42, p. 154


1936 Glumebra Iredale, Queensland Forest Service Bull., No. 12: 42

1966 Uperotus Guettard, Turner, A survey and illustrated catalogue of Teredinidae (Mollusca Bivalvia), Museum of Comparative Zoology, Harvard University, Cambridge, Mass, p. 28, 75

**Salient features**

Solid calcareous pallets which vary from oval to rectangular in outline with a short, heavy stalk. The proximal portion of the blade smooth while the distal portion marked by well defined radiating ribs. Shell variable depending on the substratum into which it bores, specimens boring into nuts have narrow shells and those boring into hard wood have more typical shells, while those living in softer woods have intermediate type of shells. Both the anterior and posterior slopes, especially the latter are comparatively small and placed high on the shell. The protective calcareous tubing that lines the burrow is concamerated at the opening. Gills extend continuously from the base of the siphons to the mouth. Siphons united to the tip, labial palps free, stomach globular, caecum long and bent on itself to the right, intestine makes an anterior loop around the style-sac and a posterior loop over the caecum. This interesting genus is circumtropical in distribution and includes such species as *Uperotus clavus* (Gmelin), *U. panamensis* (Bartsch), *U. rehderi* (Nair), *U. lieberkindi* (Roch).
Salient features

Pallet somewhat spoon-shaped, blade long, narrow and sub-triangular, almost straight sided with the distal margin bluntly rounded. Proximal portion of the blade solid, thick and smooth, the distal part marked by radiating longitudinal ribs like the leaf of a palm. Shell valves narrow and high, anterior and posterior slopes greatly reduced, the denticulated
ridges of the anterior slope few and widely spaced, the posterior slope small, placed in the posterior dorsal aspect, ventral knob quite prominent.

Siphons united except at the tip, gills blade-like extending from the siphons to the mouth as in Teredora, branchial groove well developed, labial palps free, stomach globular, caecum long and doubled on itself, intestine looping over the style-sac anteriorly and the caecum posteriorly, before curving over the posterior adductor to open into the anal canal, heart anterior with no pigmentation for auricles.

The burrows of this species are lined by a thick-walled calcareous tubing. These tubes are closely crowded and very often twisted together in floating nuts.

Material examined

A single specimen and five pairs of pallets and two pairs of shells were extracted from some nuts collected from the inshore waters of Kavarathi Island in the Lakshadweep Archipelago during May 1987. Specimens of Lyrodus pedicellatus were also present in the nuts from which U. clavus was collected.

Occurrence

Visakhapatnam (Purushotham & Rao, 1971); Madras beach from floating nuts of the mangrove, Carapa molucensis
(Gravely, 1941; Nair, 1954); drift wood (Crichton, 1941; Daniel, 1958); Tondi, Ramnad district of Tamil Nadu from a drift log cast ashore (Nair & Gurumani, 1957); Pamban, Mandapam (Nair & Dharmaraj, 1980); Lakshadweep (Nair & Dharmaraj, 1983).

**Distribution**

Distributed in the Indo-Pacific in tropical areas. It has been reported from Indian Ocean Islands, Green Islands, Off Cairns, North Queensland, Australia (Iredale, 1936); Shionomisakei, Wakayama Pref. Honshu, Japan (Habe, 1952).

**Ecological notes**

This species is usually seen in floating nuts and drift wood. It has also been reported (not living) from the nuts of Pandanus dredged out from a depth of 7488 metres in the Bunda Sea (Turner, 1966). *U. rehderi* is probably an ecological variation of *U. clavus* found only in floating wood rather than nuts in the tropical to sub-tropical Indo-Pacific. The large and extensive gills suggest that this species can more effectively utilize phytoplankton as food in the over crowded substratum. This is probably an ecological adaptation for oceanic species to survive where wood is scarce.
Uperotus clavus is a remarkable ocean traveller (Edmondson, 1962). It lives a curious gregarious life in ocean borne seeds of mangroves, Cocos palms and Pandanus. Iredale (1936) reported this species living gregariously in calcareous tubes in the husk of a coconut, floating in sea water off South Queensland. Seeds of Xylocarpus molucensis growing near the ocean in Samoa, Fiji and other Pacific Islands and getting drifted in ocean currents get infested at mid ocean by this species and cast ashore on the beaches of Canton Island. Edmondson (1962) stated that "when the solid substance of the seed is destroyed by the invading borers their cutting function ceases. In the meanwhile calcareous deposits have been forming strong protective tubes about individual animals, tubes which fuse into compact clusters. Cavities of large seed stranded on Canton Island were almost completely filled with calcareous tubes of T. clava (= U. clavus). However, the living organisms once encased in these calcareous tubes had perished, leaving only their shells and pallets. When the cutting activity of the living Teredo is complete, the anterior end of the tubes is closed permanently and the animal soon perishes".

A correlation between the character of the shell and the environment in which the bivalve lives is discernible. The absence of well-defined teeth on the anterior lobe of the
shell indicates that the substance through which it is boring is relatively soft, offering little resistance. The development of a strong tube suggests that much of its energy is expressed in chemical, rather than physical activity. "The valves are curiously narrow and strongly incurved. The nature of the valves support the view of a slowing down or a complete cessation of the cutting activity of the animal. The posterior slope of the shell reduced to a rudimentary lobe, indicating a minimum of muscular activity. The physical aspects of the shell as a whole, with power and weight so near the fulcrum, points to a limited range of rocking movements of the valves, thereby greatly reducing the cutting potential of the shell" (Edmondson, 1962).

Remarks

Pallets and shells of the present collection closely correspond with the original description of the species. All shells collected were typical of the species having narrow shell valves, anterior and posterior slopes greatly reduced, few and widely spaced denticulated ridges on the anterior slope. Turner (1966) states that "the difference in shell characters of various species of *Uperotus* probably results from the material in which they are living. All the species found in nuts have a narrow shell, while others with very similar pallets living in the same living area, but boring into wood have a more
typically shaped shell "Uperotus found in the vicinity of Madras and Mandapam camp, indicate that clavus (nut borer) and rehderi (wood borer) are probably the same species for it was possible to get transition forms, the valves of specimens boring into soft wood being much closer in appearance to the nut borers than those taken from hard wood". Turner, however, concludes that this cannot be stated definitely until it has been shown experimentally that the young of clavus when boring into wood mature to look like rehderi.

**Uperotus rehderi** Nair

Plate III A, Figs. 1-4, Photographs 10 & 12

1954 *Teredo (Teredora) rehderi* Nair, Rec. Indian Mus., 52: 408, fig. 9a-d


1966 *Uperotus rehderi* Nair, Turner, A survey and illustrated catalogue of Teredinidae (Mollusca Bivalvia), Museum of Comparative Zoology, Harvard University, Cambridge, Mass, p. 28, 76


**Salient features**

Pallets spoon-shaped with a broadly oval blade and short stalk. Outer face of the blade ribbed with radiating
longitudinal rows of ridges and troughs. These ribs protrude slightly at the distal end of the blade which is entirely calcareous with no trace of periostracum. Valves small and nearly resemble those of the genus *Teredora*.

**Material examined**

Three pairs of pallets and shells from a small piece of wooden plank removed from a country craft operating in the waters around Kadamath Island along with few pallets from Agathi and Thinnakara Islands of the Lakshadweep Archipelago during May 1987. Pallets and shells of other shipworms namely *L. pedicellatus*, *T. furcifera* and *B. carinata* were also present in the wooden plank from which pallets of *U. rehderi* were collected.

**Occurrence**

This has also been collected from other parts of India like Andamans (*Das & Dev Roy, 1980, 1988*), Madras (*Nair, 1954, 1956*), Ramanad (*Nair & Gurumani, 1957b*); Mandapam from both fixed and drift wood (*Nair & Dharmaraj, 1980*).

**Distribution**

Distributed in the Indo-Pacific in tropical areas. Reported from Papua New Guinea (*Rayner, 1974*).
Ecological notes

This species invades fishing crafts off the coast of Madras. It is a pelagic species commonly found in drift wood and rarely in fixed wooden objects.

Remarks

The pallets and shells of the present collection very much resemble those of the original description of the species by Nair (1954). Nair (1954) described this species from drift wood collected from Madras beach after comparative studies of material from the Indo-West Pacific. Edmondson also confirmed the identification. Turner (1966) feels that this is probably a young wood-boring form of *Uperotus clavus* in which the shell is more typically developed. Nevertheless, Turner states that "this cannot be stated definitely, until it has been shown experimentally that the young of *clavus* when boring into wood mature to look like rehderi.

Genus **Psiloteredo** Bartsch

1922    **Psiloteredo** Bartsch, Bull. U.S. Natl. Mus., **122** : 36

1941    **Dactyloteredo** Moll, Sitzungsber. Ges. Naturforsch Fr. Berlin, **193**

1966    **Psiloteredo** Bartsch, Turner, A survey and illustrated catalogue of Teredinidae (Mollusca Bivalvia), Museum of Comparative Zoology, Harvard University, Cambridge, Mass, p. 28, 76

Salient features

Pallets solid, almost entirely calcareous, broad to elongate oval in outline, and with a short stalk, blade thick at the base, becoming thin at the distal margin, slightly concave on the inner face and convex on the outer. Outer face with a moderate to deep thumbnail-like depression or a slight depression with two finger-like projections extending from it in the young stage, the pallets becoming paddle-like in the adult. Valves with prominent condyles and moderate to large, ear-shaped posterior slopes which are usually flaring. Tubes of all species probably concamerated at the posterior end. Siphons united except at the tip. Gills reduced to the food groove only over the visceral mass (Turner, 1966).

This genus includes species such as P. healdi (Bartsch), P. megotara (Hanley) and P. senegalensis (Blainville).

Psiloteredo senegalensis (Blainville)
Plate III B, Figs. 1-4, Photograph 13

Psiloteredo senegalensis (Blainville), Turner, A survey and illustrated catalogue of Teredinidae (Mollusca: Bivalvia), Museum of Comparative Zoology, Harvard University, Cambridge, Mass. p. 121


Salient features

Pallets heavy and almost entirely of calcareous material with a thin film of periostracum adhering to the outer face, blade elongate-oval in outline with a short stalk. Posterior slope (auricles) of the valves large and usually flaring.

Material examined

Seven pairs of pallets and shells removed from a piece of wood cast ashore on Agathi Atoll of the Lakshadweep Archipelago during May 1987.

Occurrence

Reported only from the Lakshadweep Archipelago

Distribution

Niger, Senegal (Blainville, 1828), Marigot de Diabakar, Senegal (Moll, 1941).

Ecological notes

This is reported as a variable species with striking differences occurring with age. Monod (1952) discussed and
illustrated the variation occurring in the pallets of *senegalensis* and showed the *petitii* Recluz is the young form. Rancurel has since shown that specimens growing in areas of low salinity and in uncrowded conditions retain the *petitii* form throughout life. Thus it appears that *petitii* is a young and ecological form of *senegalensis* Blainville (Turner, 1966).

**Remarks**

The present material shows slight variation from the general characteristics of the pallets of this species. There is no periostracum adhering to the outer face. The depression on the outer face is not pronounced. The posterior slope of the shell valve is small in the present collection.

**Genus Group III**

Stomach elongate, young held in brood pouch to straight hinge or pediveligar stage (Turner, 1966, 1971).

**Genus TEREDO Linnaeus**

1758  
Teredo Linnaeus, *Systema Naturae*, 10 : 651

1923  

1923  
Salient features

Pallets variable, blade in one piece with a small cup-like depression at the distal end which may be divided medially. A thin periostracum closely adhering to the calcareous portion is present but is never in the form of a cap as in Lyrodus. A solid stalk of varying length extends into the basal part of the blade for a short distance. The shell is typically teredine and indistinguishable from those of Lyrodus and Bankia.

Siphons long and separate. Ctenidia blade-like and extend from the base of the siphons to about the middle of the visceral mass, labial palps evident, stomach elongate, caecum cylindrical and large with a highly coiled typhlosole inside. Intestine does not loop around the style-sac in front but curves over the caecum and passes over the posterior adductor to open into the anal canal. Heart is dorsal to
the caecum with an elongate, posteriorly lobed muscular ventricle and unpigmented, tubular, posteriorly tapering auricles.

Fertilization is internal in the genus *Teredo* which brood their young in the epibranchial cavity. The larvae are retained in the brood pouch for varying lengths of time in the different species. Development of eggs takes place in the branchial chamber and young are retained until the veliger stage (Turner, 1966).

The genus *Teredo* as constituted above by Turner (1966) is the largest and most variable genus in the Teredinidae and may eventually be split into two or more genera. This genus occurs throughout the world in marine habitats and rarely in brackish waters.


*Teredo aegypos* Moll
Plate III C, Figs. 1-4, Photographs 14 & 15

Salient features

Pallet spatulate, blade slightly longer than stalk, distal margin of inner face slightly concave on outer face deeply concave, distal end of pallet covered with a dark-brown periostracum, rest of the pallet greyish ivory in hue, with base of blade and stalk almost translucent.

Material examined

Seven pairs of pallets and two small specimens were collected from a pile in the Kavarathi Atoll and Kadamath Atoll respectively during a survey of the Lakshadweep Archipelago in May 1987.

Occurrence

Reported only from the Lakshadweep Archipelago (Nair & Dharmaraj, 1983).

Distribution

Beira, South-east Africa, Mozambique (Moll, 1941).
Remarks

This species has been rarely noticed in fixed wood along the shores of Kavarathi and Kadamath Atolls, and the features of the pallets closely resembled the original description by Moll (1941). This species has already been reported from the Lakshadweep Archipelago during an earlier survey of Nair & Dharmaraj (1983).

_Teredo bartschi_ Clapp
Plate III D, Figs. 1-4, Photograph 16


1932 _Teredo_ _balatro_ Iredale, Sydney Harbour Trust, p. 31, Pl. 2, figs. 4-7

1932 _Teredo_ _shawi_ Iredale, Sydney Harbour Trust, P. 30, Pl. 1, Figs. 5-8

1935 _Teredo_ _aegyptica_ Roch, Sitzungsber. Akad. Wiss. Wien., 144 : 267, Pl. 1, fig. 5


1942 _Teredo_ (_Teredo_) _hiloensis_ Edmondson, Occ. Pap. B.P. Bishop Mus., 17(10) : 113, Fig. 4d-h

Salient features

Pallets typically teredo-like, outer face of blade convex and inner face flat, stalk about as long or slightly longer than blade. Distal margin broadly U-shaped, the outer more deeply excavated than the inner. Lower half of blade calcareous without the ridge at midpoint, distal half covered over by a closely adhering golden-brown periostracum produced into two horns laterally.

Shell sub-globular, ridges on the anterior lobe widely spaced and spread fan-wise from anterior to posterior end. Posterior slope prominent.

Material examined

One specimen and two pairs of pallets were collected from fixed timber structures in the harbour at Kavarathathi and Bungaram Islands of the Lakshadweep Archipelago during May 1987.
Occurrence

Vishakhapatnam harbour (Nagabhushanam, 1955); Pamban (Nair & Dharmaraj, 1980)

Distribution

World-wide, tropical to subtropical. It has been reported from Basra, Iraq (Moll, 1937); Port Said, Ismailia, Suez Canal, Egypt (Roch, 1935); East-coast of Africa, Mediterranean Madagascar, Red Sea, Persian Gulf (see Turner, 1966); Pyrmont, Port Jackson, Sydney Harbour, N.S. Wales, Australia (Iredale, 1932); Hilo (Hawaii), Hawaii Island (Edmondson, 1942); St. Georges, Bermunda (Clapp, 1924); Port Tampa, Florida (Clapp, 1923).

Remarks

This is the first report of this species from the Lakshadweep Archipelago and has been collected from fixed wooden structures in the harbour areas in Kavarathi and Bungaram Atolls. This species is rare in the two atolls. Though it has been reported from many areas from tropical and subtropical sea (Turner, 1966, 1971) its occurrence was scanty in the Indian waters (Nagabhushanam, 1955; Nair & Dharmaraj, 1980).
Teredo clappi Bartsch
Plate IV A, Figs. 1-4, Photographs 17 & 18


1924 Teredo trulliformis Miller, Univ. California Publ. Zool., 26 : 150; Pl. 11, figs. 31-34


1935 Teredo adanensis Roch, Sitzungsber Akad. Wiss. Wien., 144 : 265; Pl. 1, fig. 3

1935 Teredo renschi Roch, Sitzungsber Akad. Wiss. Wien., 144 : 267, text fig. 5


1955 Teredo (Zopoteredo) tenlliformis Nagabhushanam, Rec. Indian Mus., 53


Salient features

Pallet with a short, broad, solid blade having a convex outer face and flat inner face and a well defined long stalk which instead of tapering toward the end becomes gradually expanded like the handle of a trowel. Distal part of the
blade covered by a brownish periostracum with a crescent-shaped excavation at the end. Pallets of young may have a small median cleft on the outer face. Shell with a reduced posterior slope.

Siphons separate, gills blade-like branchial groove well developed, labial palps not free, stomach elongate, caecum moderate, intestine not looping over style-sac, anal canal open, heart median, auricles not pigmented, larviparous.

**Material examined**

Large number of specimens collected during May 1987 from the different atolls of Lakshadweep Archipelago and from Nileswaram backwater of northern Kerala. The specimens collected range from 0.5-5.3 cm in length and most of them contained larvae. The wood samples were mainly coconut timber.

**Occurrence**

It is a destructive species to water front structures in many parts of India. Reports are available from Off Puri, Orissa (Ganapati & Rao, 1961); Visakhapatnam (Nagabhushanam, 1955); Godavary estuary (Ganapati & Rao, 1959; Purushotham & Rao, 1971); Madras (Daniel, 1958); Ramnad (Nair, 1965); Pamban (Srinivasan & Chandramohan, 1973); Cochin (Nair, 1964; Saraswathy, 1964); Lakshadweep (Nair & Dharmaraj,
1983); Panaji, Goa, Bombay, Diu, Okha and Jafrabad (Santhakumaran, 1966, 1976).

**Distribution**

Distributed world-wide from tropical to sub-tropical regions. Reported from Port Aden, Aden Protectorate (Roch, 1935); India (Nagabhushanam, 1955); Singapore (Roch & Moll, 1929); Hermit Island, Bismark Archipelago (Rich & Moll, 1929); Honolulu, Oahu, Hawaii Islands (Miller, 1924); Curacao (Dutch West Indies) (Moll, 1941); Key West Florida (Bartsch, 1923); South eastern Australia (Turner & Marshall, 1973).

**Ecological notes**

This species occurs in the Indo-Pacific area. At ciffe Parade, Bombay it is reported as attacking live mangrove trees (Santhakumaran, 1966). *T. clappi* occurs abundantly and is one of the most destructive species in the Lakshadweep area.

**Remarks**

Specimens of the present collection closely resemble the original description of the species (Bartsch, 1923). During the present study it could be noted that it is one of the dominant borer in the Lakshadweep Islands causing severe destruction
to fixed timber structures and wooden boats. It was present along the shores of all the atolls surveyed.

Two other species of shipworms namely T. **fulleri** and **Lyrodus massa** and in some cases **Lyrodus pedicellatus**, were also present in the wood samples from which T. **clappi** was collected.

*Teredo fulleri* Clapp
Plate IV B, Figs. 1-4, Photographs 19 & 20

1924 *Teredo (Zopoteredo) fulleri* Clapp, Trans. Acad. Sci. St. Louis, **25**(1) : 12; Pl. 3, figs. 16-32

1935 *Teredo bicorniculata* Roch, Sitzungsber Acad. Wiss.Wien, **144** : 265; Pl. I, fig. 2

1935 *Teredo indomalaiica* Roch, Sitzungsber Akad. Wiss. Wien., **144** : 2624, text fig. 2

1966 *Teredo fulleri* Clapp, Turner, A survey and illustrated catalogue of Teredinidae (Mollusca Bivalvia), Museum of Comparative Zoology, Harvard University, Cambridge, Mass, p. 102


**Salient features**

Shell sub-globular, anterior slope small, posterior slope small or median in size placed posteriorly, slightly
to the dorsal side of the disc without forming a shelf on the inner side.

Pallets small, spatulate, opaque and chalk white, with a narrow margin of yellowish or brownish periostracum, the distal end which is slightly cupped. A median longitudinal cleft splits the distal half of the outer face of the pallet blade. Blade narrow, longer than wide, more or less parallel sided and sheathing the stalk. Pallet-stalk distinct, cylindrical, attenuating towards the tip, about as long as the blade.

Siphons separate, gills blade-like, branchial groove well developed, labial palps not free, stomach elongate, caecum moderate, intestine not looping over style-sac, anal canal open, heart anterior.

Material examined

Several specimens were collected from all the atolls of the Lakshadweep Archipelago surveyed during May 1987. All the specimens were small and ranged from 0.4-4.3 cm.

Occurrence

It has also been reported earlier from other parts of India namely, Krusadi Islands and Hare Islands (Nair & Dharmaraj, 1980); Pamban (Nair, 1965); Mandapam (Nair &
Dharmaraj, 1980); Lakshadweep (Nair & Dharmaraj, 1983); Okha (Santhakumaran, 1985).

**Distribution**

Distributed world-wide from tropical to sub-tropical areas. Reported from San Diego Suarez, Vintano to Sainte-Marie near Madagaskar (Roch, 1935); Singapore (Roch, 1935a), Christiansted, St. Coix, Virgin Islands (Clapp, 1924).

**Ecological notes**

This is a common species in the atolls of the Lakshadweep Archipelago, and is highly destructive both to fixed underwater structures as well as to wooden crafts in the area. Reported earlier from the Palk Bay and Gulf of Mannar along the east coast (Nair, 1965; Nair & Dharmaraj, 1980) where it causes serious damage to timber structures used in aquaculture farms. Recently Santhakumaran (1985) reported it from the mainland, west coast at Okha where it is stated to be very rare.

**Remarks**

Specimens collected during the present study closely resemble the description of the original species by Clapp (1924) and Turner (1966). The specimens were small and highly destructive to water front structures and wooden crafts in
all the atolls surveyed of the Lakshadweep Archipelago. The branchial space of a majority of the specimens contained larvae in different growth stages.

Teredo furcifera von Martens

Plate IV C, Figs. 1-4, Photographs 21 & 22

1894 Teredo furcifera von Martens (in) Semon Zoologische Forschungsseisen in Australian und dem Malayischen Archipel, 5: Mollusken, p.95, Pl. 4, fig. 9


1924 Teredo furcillatus Miller, Univ. Calif. Publ. Zool., 26: 149, Pl. 10, figs. 16-20

1935 Teredo australasiatica Roch, Sitzungsber Akad. Wiss. Wien., 144: 208. text fig. 6

1935 Teredo furcata Moll, Sitzungsber. Akad. Wiss. Wien., 144: 267; Pl. 1, fig. 4

1935 Teredo krappci Moll, Sitzungsber Akad. Wiss. Wien., 144: 268; Pl. 1, fig. 6

1946 Teredo (Teredo) bensoni Edmondson, Occ. Pap. B.P. Bishop Mus., 18(15): 214, fig. 1a-d

1955 Teredo (Teredo) parksi madrasensis Nair, Rec. Indian Mus., 53: 265, fig. 2a-e

1955 Teredo (Teredo) parksi Nagabhushananam, Rec. Indian Mus., 53


**Salient features**

Pallet highly variable, largely calcareous. Blade with a transverse ridge at widest point, outer face of blade slightly convex and the distal end deeply indented in the form of 'U' or 'V', inner face flat, with the distal end having a shallower excavation. A thin, light, yellowish-brown or brownish, black periostracum is present which closely adheres to the distal aspect of the blade.

Shell typical of the genus, anterior slope small marked by closely packed denticulated ridges.

Siphons separate, gills, blade-like, branchial groove well developed, labial palps not free, stomach elongate, caecum cylindrical, intestine not looping over style-sac, anal canal open, heart median with a light brown pigmentation for auricles, larviparous.

**Material examined**

Several specimens were collected from the major estuaries and backwater systems of Kerala and also from the atolls surveyed in the Lakshadweep Archipelago during 1987 and 1988.
Occurrence

This is a very common species all along the coasts of India, Andaman Islands (Karande, 1978; Das & Dev Roy, 1988; Santhakumaran & Srinivasan, 1988). Visakhapatnam (Nagabhushanam, 1955, 1960; Satyanarayana Rao et al., 1987); Godavari estuary (Ganapati & Rao, 1959); Pulicat Lake (Nair, 1963; Srinivasan, 1969); Madras (Nair, 1955, 1958; Daniel, 1958); Porto-Novo (Radhakrishnan et al., 1983; Radhakrishnan & Natarajan, 1987); Mutunpet (Srinivasan & Chandramohan, 1973); Tondi (Nair & Gurumani, 1957); Pamban (Nair & Dharmaraj, 1980); Tuticorin (Nair & Dharmaraj, 1979); Cochin (Saraswathy, Nair, 1965); Lakshadweep (Nair & Dharmaraj, 1983); Mangalore (Dharmaraj & Nair, 1981); Bombay, Daman, Okha (Palekar et al., 1964; Santhakumaran, 1976).

Distribution

*T. furcifera* has a world-wide distribution i.e., from tropical to sub-tropical areas. It has been reported from East coast of Africa, Medagaskar, Reunion (Roch, 1935); Colombo, Ceylon (Moll, 1936); Singapore (Roch, 1935a); Amboina, Molucca Island (see Turner, 1966); Tutnila, Samoa (Miller, 1924); Pearl harbour Oahu, Hawaii (Bartsch, 1921); San Francisco Brazil (Moll, 1936); Venezuela (Nair, 1975); Australia (Turner & Marshall, 1973; Ibrahim, 1981).
Ecological notes

This is a very important and dominant wood-boring mollusc along the coasts of India. It occurs in most of the harbours in India attacking wooden water front structures, it also occurs in the wooden stakes and other water front structures in the backwaters of Kerala. This species readily settles on test panels exposed at Cochin Harbour during the hot highly saline pre-monsoon period. One of the serious impediments for the culture of oysters around Tuticorin is the massive infestation by this species (Nair & Dharmaraj, 1979). It also occurs in the piles of the turtle pens in places such as Tondi and Adiramapatnam on the East coast of India (Nair & Gurumani, 1957).

According to Karande and Pendsey (1969) T. furcifera breeds throughout the year in Bombay Harbour. It attains sexual maturity when it is barely 20 days old and may liberate larvae after 56 to 60 days in the laboratory tanks if fed on nannoplankton. The laboratory life of this species has been found to be not less than 18 months. At Cochin Harbour its settlement is confined to the hot, highly saline pre-monsoon period (February-June) with sparse settlement during the early part of monsoon and later part of the post-monsoon periods (Nair & Saraswathy, 1971). At Visakhapatnam it settles
on test panels all through the year with a peak during the summer months between March and June (Nagabhushanam, 1959). In the Gulf of Cariaco, Venezuela, Nair (1975) noticed its incidence almost continuously throughout the year on test panels with a peak in October-November. *T. furcifera* occurs at the mouth of the Gonema River in the Macfarlane Harbour?, Papua New Guinea where settlement, as reported by Rayner (1979) is periodical in response to changes in salinity, occurring in salinities over 20°/oo with further growth rates in 30°/oo.

Remarks

A study of the pallets collected from different backwater and from different species of timber gave evidence of considerable variations in their features. The variations pertain chiefly to the relative lengths of the pallet stalk and blade and also to the length-breadth ratio of the pallet blade. The periostracal structure showed evidence of erosion in many cases. The differences in the nature of pallets may be due to geographical ecotypical differences, and over crowding also may have some influence.

*Teredo mindanensis* Bartsch
Plate IV D, Figs. 1-4

Salient features

Blade of pallet conical, hollow to stalk, with a thin, yellow periostracum at the distal end. Stalk short, irregular and knobby at the proximal end.

Material examined

Two pallets collected along with pallets of *Lyrodus pedicellatus* and *Teredo furcifera* from a piece of wooden plank separated from a country craft destroyed by the activity of boring organisms from Amini Atoll in the Lakshadweep Archipelago during May 1987.

Occurrence

Lakshadweep Archipelago
Distribution

Off Linao Point, Gulf of Darao, Mindanao, Philippine Islands at 28 fathoms (Bartsch, 1923); Sumatra, Indonesia (Roch, 1955).

**Teredo portoricensis**? Clapp

Plate V A, Figs. 1-4, Photograph 23

1927 *Teredo (Teredo) portoricensis* Clapp, *Trans. Acad. Sci. St.Louis, Missouri*, 25(1) : 2; Pl. 1, figs. 1-7


Salient features

Pallets slender. The golden-yellow periostracum is thin, closely adhering to the calcareous portion, covering the distal half of the blade and extends as a border, through which the calcareous portion is visible. Blade sheathing the stalk for a short distance. Stalk long, slender and solid.

Material examined

Two pairs of pallets removed from a piece of wood of an old jetty pile in the Amini Atoll in the Lakshadweep Archipelago during May 1987.
Occurrence

Lakshadweep

Distribution

Western Atlantic, tropical to sub-tropical, San Juan, Porto Rico (Clapp, 1924)

Remarks

The present material closely correspond with the original description of the species (Clapp, 1924). This is the first record of this species from Indian waters.

Teredo somersi Clapp
Plate V C, Figs. 1-4, Photograph 24

1924 Teredo (Zopoteredo) somersi Clapp, Proc. Arts and Sci. (Cambridge), 59(12) 284; 7-12; Pl. 3, figs. 15, 16


1966 Teredo somersi Clapp, Turner, A survey and illustrated catalogue of Teredinidae (Mollusca; Bivalvia), Museum of Comparative Zoology, Harvard University, Cambridge, Mass, p. 122

Salient features

Pallet-blade length equal to that of the stalk and stout. Distal half of blade covered by a dark-brown periostracum, the cavity of the blade filled with debris. Stalk straight and thick.

Material examined

Three pallets collected from a piece of wood cast ashore on Kalpíṭṭi Island in the Lakshadweep Arcipelago during May 1987.

Occurrence

Lakshadweep

Distribution

Western Atlantic, tropical to sub-tropical. Ireland, Bermuda (Clapp, 1924); East London, Dutch, East Africa, Union of South Africa (Moll, 1937).

Remarks

Nair & Dharmaraj (1983) also collected two specimens of this species from the shore of Tilakkam Atoll in the Lakshadweep Archipelago. The type locality of the species is the Island of Bermuda in the Atlantic. Probably, this is a circumtropical to circumtemperate marine species (Rayner, 1974).
**Teredo triangularis** Edmondson
Plate V B, Figs. 1-4, Photographs 25 & 26

1942  *Teredo (Zopoteredo) triangularis* Edmondson, Occ. Pap. B.P. Bishop Mus., 17(10) : 126, fig. 8a-b

1945  *Kuphus (Coeloteredo) teredoides* Taki & Habe, Venus, 14 : 116


**Salient features**

Pallet blade thick and heavy like an elongated triangle, flattened on the inner face and strongly convex on the outer face, broadening distally where the concave border is capped by a brownish periostracum. Distal border of calcareous portion of blade irregularly truncate. Stalk stout, tapering, shorter than the blade.

Shell higher than broad, anterior slope small, posterior slope short, internally overlapping the disc.

**Material examined**

17 pairs of pallets separated from fixed timber structures collected from the Kavarathi, the Bungarum and Kalpitty Islands

Occurrence

Vishakapatnam (Nagabhushanam, 1960); Mandapam (Nair & Dharmaraj, 1980); Lakshadweep (Nair & Dharmaraj, 1983).

Distribution

Distributed in the Indo-Pacific from tropical to sub-tropical regions. Reported from Suzaki-tyo, Taka oka-gun, Kochi-ken, Japan (Take & Habe, 1945); Kahului, Maui, Hawaiian Islands (Edmondson, 1942).

Remarks

The structure of the pallets closely resembles that of the original description given by Edmondson (1942). This species has been noticed rarely in the Vishakapatnam harbour, Mandapam and from the Lakshadweep Archipelago.

Genus LYRODUS Gould


Salient features

Pallet blade with a basal calcareous portion which is narrowly to broadly rounded and marked by concentric lines of growth. Brown or black easily removable periostracal portion caps the calcareous portion. Distal margin of the periostracal part may be straight, curved, or may be produced into lateral horns. The periostracal part may be solid, hollow, or may be produced into a knob-like structure.

Shell typically teredine, siphons short and separate, young are carried in the mantle cavity until late veliger stage. General anatomy similar to that of *Teredo* (Turner, 1966).

This genus is distributed widely in tropical and warm temperate seas and includes species such as *Lyrodus pedicellatus* (Quatrefages), *L. affinis* (Deshayes), *L. bipartita* (Jeffreys), *L. massa* (Lamy), *L. medilobata* (Edmondson) and *L. takanoshimensis* (Roch).

In this genus fertilization is internal and as in the genus *Teredo* the young ones are retained in the epibranchial chamber for varying periods of time.
Lyrodus pedicellatus (Quatrefages)
Plate VI A, Figs. 1-4, Photographs 27 & 28

1849 Teredo pedicellatus (Quatrefages), Ann. Sci. Nat. Zool., (3) 11: 26, Pl. 1, fig. 2

1865 Teredo pedicellata truncata Jeffreys, British Conchology, 3: 174

1870 Teredo chlorotica Gould, Invertebrata of Massachusetts, p. 33, fig. 360

1916 Teredo diegensis Bartsch, Nautilus, 30: 48

1922 Teredo diegensis Bartsch, Bull. U.S. Natl. Mus., 122: 29; Pl. 22, fig. 3; Pl. 34, fig. 3

1922 Teredo (Teredops) floridana Bartsch, Bull. U.S. Natl. Mus., 122: 28; Pl. 22, fig. 1; Pl. 34, fig. 1

1924 Teredo samoensis Miller, Univ. California Publ. Zool., 26: 149; Pl. 10, figs. 1-25

1927 Teredo (Teredo) siamensis Bartsch, Jour. Siam Soc. Nat. Hist. Suppl., 7(1): 59; Pl. 6, figs. 2-5, 9,11


1931 Teredo calmani Roch, Proc. Malac. Soc. London, 19: 208; Pl. 23, fig. 15

1931 Teredo (Lyrodus) hibicola Kuronuma, Venus, 2(6): 295; Pl. 8, Fig. 4; Pl. 9, figs. 20-22


1931 Teredo (Teredops) tateyamensis Kuronuma, Venus, 2(6): 295; Pl. 8, fig. 5; Pl. 9, figs. 23-25

1932 Teredo portingens Iredale, Sydney Harbour Trust, p. 31; Pl. 2, figs. 8-11
Salient features

Pallets highly variable, calcareous portion being club-like with a long, slender stalk and blade consisting of an oval, knob-like portion marked by concentric growth lines capped by an elongated dark brownish or black periostracum which can be separated from the base. The periostracal cap more or less straight sided, the distal margin concave, in some U-shaped in others, and extending as lateral horns. Distal
margin in older specimens eroded exposing the knob-like calcareous portion.

Shell similar to that of Teredo or Bankia.

Siphons separate, gills blade-like, branchial groove well developed, labial palps not free, stomach elongate, caecum moderate, intestine not looping over style-sac, anal canal open, heart anterior, auricles not pigmented, larvivorous.

Material examined

Collected in fair numbers from all the backwater systems surveyed in Kerala for marine borer attack and from the Lakshadweep Archipelago during 1987, 1988.

Occurrence

Andaman Nicobar Islands (Taki & Habe, 1945; Das & Dev Roy, 1980, 1981, 1988; Santhakumaran & Srinivasan, 1988; Das, 1989); Mahanadi estuary (Subha Rao, 1968); Vishakapatnam (Nagabhushanam, 1955, 1960; Satyanarayana Rao et al., 1987); Pulicat Lake and Madras (Nair, 1954, 1956, 1964; Srinivasan, 1969); Porto-Novo (Nair & Dharmaraj, 1980a; Radhakrishnan & Natarajan, 1987); Muthupet (Srinivasan & Chandramohan, 1973); Tondi and Adirampatnam (Nair & Gurumani, 1957); Ramnad, Pamban, Tuticorin (Nair, 1962, 1965; Nair & Dharmaraj, 1979); Trivandrum, Anjengo, Kayamkulam, Cochin (Erlanson,

**Distribution**

World-wide from temperate to tropical areas. Reports are available from Togo, West Africa (Roch & Moll, 1929); British Isles (see Turner, 1966); Guipuscoa, Spain (Quatrefages, 1849); Naples, Italy, Mediterranean Sea (Roch & Moll, 1929); Port Aden (Roch, 1935); Port Said, Ismailia, Egypt (Moll, 1936); Siamons Twon, South Africa (Roch, 1931); Colombo, Sri Lanka (Moll, 1936); Singapore (Roch, 1935); Singora, Siam (Bartsch, 1927); Port Lincoln, S. Australia (Roch, 1931); Pyrmont, Port Jackson, N.S. Wales, Australia (Iredale, 1936); Australian harbour (Ibrahim, 1981); New Zealand (Mckoy, 1980); Japan (Moll, 1928); Tateyama Bay, Chiba Prefecture, Japan (Kuronuma, 1931); Taiwan, Formosa (Taki & Habe, 1945); Off Liano Point, Mindanao, Philippine Islands in 28 fathoms (Bartsch, 1927); Midway Islands (Edmondson, 1946); Tutuila Samoa (Miller, 1924); Off South coast of Oahu, Hawaiian Islands from 211-253
fathoms (Dall, Bartsch & Rehder, 1938); Honolulu Harbour, Oahu, Hawaii (Dall et al., 1938); Tampa, Florida (Bartsch, 1922); Massachusetts from ships that have cruised in the Pacific Gould (1870); San Deigo, California (Bartsch, 1916); South San Francisco, Carolina (Bartsch, 1922); Gulf of Cariaco, Venezuela (Nair, 1975); Brazil (Roch, 1935).

Ecological notes

This is one of the highly destructive species occurring both along the east and west coasts of India. It attacks live mangrove in the Godavary estuary and causes severe damage to oyster culture poles at Tuticorin. L. pedicellatus is an incubatory species. This species settles in Bombay harbour in great numbers from January to late October. After October only a few specimens are seen on panels until January. Santhakumaran (1976b, 1977) found that seasonal abundance and vertical distribution are both influenced by the prevailing hydrographic conditions and also by the presence or absence of fouling organisms. Santhakumaran & Alikunhi (1971) reported that at Trombay attack started in March, gradually increased in intensity upto July and reached a peak in August. After September only a few specimens were settling till March. In the Gulf of Cariaco this is the most destructive shipworms with continuous settlement and a peak in October-November.
(Nair, 1975). In the Gonema River, Papua New Guinea it is found in areas with salinities over 20°/o (Rayner, 1979). Edmondson (1962) observed its larva to survive for 10 days in a salinity of about 15°/o.

According to Rancurel (1951) the larvae are photopositive upto metamorphosis and Greenfield (1952) has suggested the effect of a negative geotactic response.

Remarks

Considerable variations could be noticed in the nature of the pallets of _L. pedicellatus_ collected from different backwater systems of Kerala. It is mainly in the relative lengths of the pallet stalk and blade and the length-breadth ratio of the pallet blade. These variations are a reflection of age, ecologic conditions and wear, or are the result of drying and exfoliation of the periostracal cap (Turner, 1966).

**Lyrodus massa** (Lamy)
Plate V D, Figs. 1-4, Photographs 29 & 30

<table>
<thead>
<tr>
<th>Year</th>
<th>Species</th>
<th>Author</th>
<th>Journal</th>
<th>Volume</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1935</td>
<td>Teredo infundibulata</td>
<td>Roch, Sitzungsber Akad. Wiss.</td>
<td>Wien., 144: 265, fig. 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1935</td>
<td>Teredo singaporeana</td>
<td>Roch, Sitzungsber Akad. Wiss.</td>
<td>Wien., 144: 266, fig. 4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**Salient features**

Pallet blade variable in shape, almost entirely calcareous. Periostracal covering thin, following the outline of the calcareous portion, not extending beyond or only slightly so in young specimens. Periostracal cap inserted in calcareous base varying from light golden-brown to dark red-brown.

Siphons separate, gills blade-like, branchial groove well developed, labial palps attached, stomach elongate, caecum moderate, intestine not looping over style-sac, anal canal open, heart median, auricles not pigmented, larviparous.

**Material examined**

Several specimens were collected from all the atolls surveyed in the Lakshadweep Archipelago and also from the major backwaters of Kerala namely Ashtamudy, Vembanad, Kodungallur, Chettuva and Korapuzha estuary. The specimens collected range from 1.5-7.2 cm in length.
Occurrence

*L. massa* has been reported from Vishakapatnam (*Nagabhushanam*, 1955); Pamban (*Nair, 1955*); Lakshadweep (*Nair & Dharmaraj, 1983*) and Goa (*Santhakumaran, 1983*a).

Distribution

Aden Massaonah, Mer Rouge (Arabia) (*Lamy, 1923*); Singapore (*Roch, 1935*).

Ecological notes

This species has been collected in fair numbers from all the atolls surveyed in the Lakshadweep Archipelago and is one of the most destructive species of the region. Though this species is present in the backwaters of Kerala, it is not destructive and in all the areas from where this species has been collected the salinity was similar to or near to sea water.

*Lyrodus triste* (*Iredale*)

Photograph 31

1936 *Teredo (Pingoteredo) triste* *Iredale, Queensland Forest Service Bull., No. 12, p. 35; Pl. 1, figs. 10-15*

Salient features

Pallets consists of a basal calcareous portion which is capped with a prominent brown to nearly black periostracal
cap which can be removed from the base. The distal end of the calcareous base is conical and extends for some distance into the periostracal cap. Distal margin of periostracal cap straight, broadly curved or may have lateral horns. It may even be solid or with a shallow cavity.

**Material examined**

Three specimens and four pairs of pallets were collected from a piece of coconut timber from the Neendakara area of the Ashtamudy Lake during May 1988. The specimens measured 3.2-4.7 cm.

**Occurrence**

Ashtamudy, Kadinamkulam (Dharmaraj & Nair, 1981a); Mangalore (Dharmaraj & Nair, 1981).

**Distribution**

Sandgate, Brisbane, Australia (Iredale, 1936); Papua New Guinea (Rayner, 1974).

**Ecological notes**

This is an estuarine species occurring in localities ranging from nearby freshwater zones at the upper reaches of estuaries and backwaters to nearly marine conditions. Some of the specimens hitherto considered as *L. pedicellatus*
(Turner, 1966) probably belong to this species. This has been reported as infesting wooden waterfront structures in the Australian waters (Ibrahim, 1981) also. He further stated that this has been considered as a valid species by Turner (Ibrahim, 1981).

**SUBFAMILY BANKIIINAE Turner**


Includes genera having segmented pallets, mostly external fertilization, and planktonic larval stage (Turner, 1966).

**Genus SPATHOTEREDO Moll**


Salient features

Pallets paddle-shaped, with a somewhat triangular blade composed of compactly packed indistinct segments, with a pustulose calcareous incrustation at the distal end and a dark band of periostracum at about the mid portion. The blade especially in young specimens is covered by a brownish periostracum which extends laterally as awns. The pallet stalk extends through the blade.

Shell, typically teredine, resembles that of Teredo. Siphons short, and united for nearly half their length, ctenidia narrow to broadly U-shaped, food groove well developed, anterior part of the ctenidium with about 20 filaments, stomach and caecum resemble those of Nausitora, heart dorsal to caecum, ventricle long and deeply lobed posteriorly, auricles long and tapering (Turner, 1966).

This genus includes species restricted mainly to tropical and sub-tropical waters of the Indo-Pacific and Western Atlantic such as S. obtusa (Sivickis), S. spatha (Jeffreys).

Spathoteredo obtusa (Sivickis)
Plate VI B, Figs. 1-4, Photographs 32 & 33

1928 Teredo obtusa Sivickis, Philippine Jour. Sci., 37: 290; Pl. 2, fig. 9
1928 Teredo variegata Sivickis, Philippine Jour. Sci., 37: 291; Pl. 2, fig. 10
Salient features

Pallet spatulate, blade rectangular consisting of an almost triangular basal portion and fused segments covered over by a calcareous incrustation at the distal end. A dark-brown periostracum encircles the middle region of the blade dividing it into a distal and a proximal portion. Basal portion of the blade is whitish and the distal portion darker than the basal portion, and is lighter than the periostracal band and both can be clearly distinguished. The periostracal band is narrower in the inner view than in the outer view. The pallet stalk extends through the blade. The inhalent and exhalent siphons are short, almost of equal length and united
except at their tip, with dark-brown ends. Collar well developed. Shell valves resemble that of the genus *Nausitora*. The calcareous lining thick, towards the posterior end of the burrow.

**Material examined**

One specimen having a total length of 8.7 cm was collected from a fixed piece of coconut timber collected from a shallow water area near the bar mouth of the Ashtamudy estuary during the present study.

**Occurrence**

This has been reported early from the Ashtamudy backwaters by Dharmaraj & Nair (1981b) and also from Andaman area (Santhakumaran & Srinivasan, 1988).

**Distribution**

Indo-Pacific, tropical Madagascar (Roch, 1935), Amboina, Moluca Islands, Indonesia (Taki & Habe, 1945); Batavia (Moll & Roch, 1931); Christmas Islands, Off Jawa (Moll, 1936); Palawan, Cebu, Philippine Islands (Sivickis, 1928); Amboina, Ralum, Bismarck Archipelago (Moll, 1928).

**Remarks**

The nature of specimen of the present collection, closely resembles that of the original species. It has been reported
earlier from the brackish water area of the Ashtamudy Lake by Dharmaraj & Nair (1981b). It has also been reported as a dominant borer from the Andaman area by Santhakumaran & Srinivasan (1988). According to Das (1989), *Spathoteredo obtusa* does not occur in the Andamans.

Genus *NAUSITORA* Wright


Salient features

Elongate pallets with blade composed of closely packed and fused but quite distinct segments built around a central stalk. A brownish periostracum covers the blade and may be produced as awns especially on the proximal part of young specimens. Shell valves large with conspicuous anterior lobe, siphons short, united for nearly half their length.

This genus occurs chiefly in brackish waters and mangrove swamps of tropical and sub-tropical waters and is common in the Indo-Pacific, Eastern Pacific and Western Atlantic and
includes species such as *Nausitora hedleyi* Schepman, *N. dunlopeii* Wright, *N. dryas* Dall *N. fusicula* (Jeffreys), and *N. globosa* (Sivickis).

**Nausitora dunlopeii** Wright
Plate VI C, Figs. 1-4, Photographs 34 & 35

1864 *Nausitora dunlopeii* Wright, Trans. Linn. Soc. London, **24**: 453; Pl. 46, figs. 1-12

*Catobates fluviatilis* Hedley, Proc. Linn. Soc. New South Wales, **23**: 94, figs. 1-6

1927 *Bankia (Nausitora) smithi* Bartsch, Jour. Siam. Soc. Nat. Hist., Suppl., 7(1): 61; Pl. 6, figs. 1, 6-8,10,12

1928 *Bankia globosa* Sivickis, Philippine Jour. Soc., **37**: 288; Pl. 1, fig. 5

1928 *Bankia quadrangularis* Sivickis, Philippine Jour. Sci., **37**: 287; Pl. 1, fig. 3

1928 *Bankia triangularis* Sivickis, Philippine Jour. Sci., **37**: 286; Pl. 1, fig. 1

1932 *Nausitora messeli* Iredale, Sydney Harbour Trust, **37**, Pl. 4, figs. 9-12

1935 *Nausitora madagassica* Roch, Sitzungsber Akad. Wiss. Wien., **144**: 271; Pl. 2, fig. 2

1935 *Nausitora pennaanseris* Roch, Sitzungsber Akad. Wiss. Wien., **144**: 274; Pl. 2, fig. 4

1935 *Nausitora schneideri* Moll, Sitzungsber Akad. Wiss. Wien., **144**: 271; Pl. 2, fig. 1

1936 *Nausitora queenslandica* Iredale, Queensland Forest Service Bull., No. 12, p. 37; Pl. 2, figs. 8-14

1954 *Bankia (Nausitora) madrasensis* Nair, Rec. Indian Mus., **52**: 399, fig. 5a-d


Salient features

Pallets asymmetrical, blade with a broad smooth basal part covered with light brown periostracum. Rest of blade composed of closely packed V-shaped segments which are fused but distinct. Distally the blade narrows considerably. Periostracal margins and lateral awns clearly evident at the basal portion of the blade. The stalk often visible on outer face of the blade. Pustules or small wart-like protuberances occur at the tip of the pallets.

Shell large, sub-globular, anterior lobe large, anterior median extensive, posterior median comparatively small and narrow, auricles greatly reduced or absent in outer views of shell.

Siphons partially separate, gills blade-like, branchial groove weak, labial palps attached, stomach elongate, caecum large, intestine not looping over style-sac, anal canal open,
heart posterior, auricles deeply pigmented, fertilization external.

**Material examined**

Seven specimens and five pairs of pallets were collected from five backwaters of Kerala namely Kadinamkulam, Edavanadaya, Kayamkulam, Chettuva and Nileswaram during 1987 and 1988. The specimens collected range from 5.2-31.3 cm in length.

**Occurrence**

Many reports are available about the occurrence of *N. dunlopei* along the coast of India. Hooghly river (Calcutta) (Wright, 1864), Sundarbans (Rajagopal, 1964, 1964a); Mahanadi estuary (Subha Rao, 1968); Vishakapatnam (Nagabhushanam, 1955, 1960); Andaman Nicobar Islands (Das & Dev Roy, 1988; Das, 1989; Rajagopal & Daniel 1972; Santhakumaran & Srinivasan, 1988; Tewari et al., 1980); Madras (Nair, 1954, 1956); Pamban (Srinivasan & Chandramohan, 1973); Cochin (Mohan, 1981); Goa (Santhakumaran, 1985).

**Distribution**

*N. dunlopei* is well distributed in the Indo-Pacific from tropical to warm temperate brackish water. It has been reported from Port Choisel, Maroantesetra, Vintano, Madagascar (Roch, 1935a); Chao Phya River at Bang Soru, Siam (Bartsch,
1927); Rewa and Navua Rivers, Vitilevu, Fiji Islands (see Turner, 1966); Palawan, Dalahican, Cavite, Luzon, Cebu, Philippine Islands (Sivickis, 1928); Karlei, Nenpommorn, Bismarck Archipelago (Moll, 1936); Port Jackson and Cattaicreek, Hawkesbury River, New South Wales, Australia (Iredale, 1932); Chelmer, Upper Brisbane River, Queensland, Australia (Iredale, 1936); Brisbane Port office wharf, Australia (Ibrahim, 1981).

Ecological notes

_N. dunlopei_ is a typical brackish water species of the tropical to warm temperate Indo-Pacific areas, well adapted to waters of low salinity. It is a common species in the mangroves and being tolerant of very low salinities, grows to a large size in the upper reaches of rivers where the salinity may be as low as 0.2°/oo (Rayner, 1974). In Papua New Guinea this species occurs in abundance in the Gonema River. In the Marshall Lagoon estuary it is noticed mostly in salinities 1-10°/oo in which it grew at a faster rate than in higher salinities and could tolerate a salinity of even 30°/oo. Watson _et al._ (1936) found that in the Brisbane River this species occurred in salinities between 1-10°/oo rarely between 10 and 15°/oo and never in salinities over 30°/oo. They report that the transfer of adults from 5 to 30°/oo was fatal in three weeks. Recently Santhakumaran (1985) collected this in large numbers from the Mandovi estuary near Panaji, Goa.
Remarks

The present materials show slight variations from the general characteristics of the pallets of this species. The calcareous incrustations on the outer distal face of the blade has been found to be evident and in a few cases papillose. Normally in this species such incrustations is small and may not be evident at all. In some specimens the demarcation of the cones on the inner face was indistinct giving the blade the appearance of a single piece.

During the present survey, covering all the major backwaters of Kerala, only a few specimens could be collected and these also were in isolated areas in widely separated backwaters namely Kadinamkulam, Edava-Nadayara, Kayamkulam, Chettuva and Nileswaram. In all areas from where this species has been collected the salinity was below 20°/oo. The discontinuous distribution of this species in the backwaters which are all interconnected may be due to higher salinities in areas between these backwaters, since it is a true brackish water species, they may not be able to withstand higher salinities (Watson et al., 1936). The dispersal might have occurred through the agency of wooden sail boats plying between these backwaters.
**Nausitora hedleyi** Schepman

Plate I A, Figs. 1-4, Photographs 36 & 37.

1919 *Nausitora hedleyi* Schepman, *Nova Guinea*, 13 *Zoologie*, p. 195; Pl. 7, fig. 3


**Salient features**

Pallets long, feather-like and inequilateral, stalk cylindrical, stout and much shorter than the blade. Outer surface flat, blade composed of compactly packed segments, those on the broad basal portion extending straight across the blade, those on the distal part V-shaped. The outer surface of the cone-like units are slightly folded and their rims present a wavy appearance. The basal portion of pallet blade is covered over by an yellowish-brown periostracum.

Shell large, sub-globular with large anterior slope. The anterior lobe and the anterior median lobe sculptured with strong dentate ridges. Posterior slope prominent in young specimens but may be eroded or be completely absent in old ones.
Siphons partially separate, gills blade-like branchial groove weak, labial palps attached, stomach elongate, caecum large, not looping over style-sac, anal canal open.

**Material examined**

Numerous specimens were collected from the Vembanad Lake and also from Kodungallur backwater, Beypore estuary, Badagara estuary and Valapattanam estuary during 1987 and 1988. This is one of the most common species in the Cochin backwaters infesting all kinds of underwater wooden structures. Specimens collected from these backwaters range from 3.2-78.6 cm in length, the largest from Vembanad Lake.

**Occurrence**

It has been reported as a common species infesting wooden structures in the brackish water areas along the coast of India. Reports are available from Mahanadi estuary (Subha Rao, 1968); Pulicat Lake (Nair, 1963); Mangrove area of Andaman (Das & Dev Roy, 1980, 1988; Das, 1989; Santhakumaran & Srinivasan 1988; Tewari et al., 1980); Madras (Nair, 1956); Porto-Novoo (Nair & Dharmaraj, 1980a); Kadinamkulam (Dharmaraj & Nair, 1981a); Cochin (Nair, 1955, 1964; Saraswathy, 1964); Mangalore (Dharmaraj & Nair, 1981); Karwar, Goa, Bombay and Kandle (Santhakumaran, 1971, 1976, 1981, 1983, 1985, 1987; Santhakumaran & Jain, 1981; Santhakumaran et al., 1988).
Ecological notes

This is one of the most destructive species of shipworms in the brackish water areas in the Vembanad Lake, *N. hedleyi* is a brackish water species well adapted to waters of low salinity. It spawns during the monsoon season when the salinity of the ambient medium is comparatively low at Cochin Harbour. Fresh settlement of the species in the area is noticed only during the period of low salinity, even though the species is found to exist throughout the year. Tests conducted to ascertain the effect of salinity changes on the activity showed that though it can tolerate a wide range, the most suitable salinity range for early development is from 11.24-14.54°/oo, with the range 8.73-16.80°/oo being tolerable. In grades above and below this range, segmentation was abnormal and the percentage of normally developing embryos fell considerably (Saraswathy & Nair, 1974).

Records of occurrence of *Nausitora* clearly shows that this species is sensitive to higher salinities and is, therefore, restricted to areas where estuarine condition prevails. Tests carried out to examine the salinity tolerance of the adults showed that they are capable of surviving the entire range of salinity that occurs in the Cochin Harbour i.e., 0.65-33.68°/oo and are capable of considerable amount of acclimatisation in its habitat. Rayner (1979) found the species quite common
in the Gonema River in Papua New Guinea in salinities less than 10°/\text{o}. and was not common at the mouth of the estuary when salinities were constantly over 20°/\text{o}. The heaviest settlement occurred towards the mouth of the river during dry and intermediate seasons in salinity fluctuations between 5 and 30°/\text{o}.

Remarks

Though the present material closely resembles the original description given by Schepman (1919) in many aspects, considerable variations may be noticed regarding the proportion of the stalk and the blade in many pallets examined. Further, two pallets even of the same pairs may frequently be different with regard to the proportion of the different regions. Towards the distal end the periostracal cover and the edges of the cones get rubbed off through friction leaving a median vertical rod-like structure which probably represents the stalk of the blade. The pallet blades of the young specimens are composed of well defined cone-in-cone elements.

During the present study covering all the major brackish water systems of Kerala along the South-west coast of India, \textit{Nausitora hedleyi} was found as the most destructive species of shipworms in the Cochin backwater and also in the Kodungalloor Azhekode backwater. This was common in other estuaries
from where, it has been collected namely Beypore, Badagara and Valapattanam. In all these areas, they are found to attack all kinds of timbers, irrespective of hardness. Reports of this species show a discontinuous distribution along the coasts of India occurring in certain brackish water lakes and backwaters and also in the mangrove swamps (Nair, 1988).

**Nausitora fusticula** (Jeffreys)

Photograph 38


1922 *Bankia* (Nausitora) *brazilensis* Bartsch, Bull. U.S. Natl. Mus., 122 : 15; Pl. 20, fig. 3; Pl. 31, fig. 1

1922 *Bankia* (Nausitora) *excolpa* Bartsch, Bull. U.S. Natl. Mus., 122 : 13; Pl. 8, fig. 2; Pl. 31, fig. 4

1966 *Nausitora fusticula* (Jeffreys), Turner, A survey and illustrated catalogue of Teredinidae (Mollusca Bivalvia), Museum of Comparative Zoology, Harvard University, Cambridge, Mass, p. 30, 80


**Salient features**

Blade 2-3 times as long as wide, sheathing long stalk asymmetrical, and composed of 10-15 segments. Papillose calcareous incrustation, largely on narrow side of blade at distal end. Young often without incrustation, blade with
thick periostracum. Incurrent siphon with 12 large tentacles, siphons partially separate, gills broad and flat, branchial groove well developed, labial palps attached, stomach elongate, caecum moderate, intestine not looping over style sac, anal canal open, heart posterior, auricle lightly pigmented.

**Material examined**

One specimen collected from the Kadinamkulam backwater during January 1987.

**Occurrence**

Mahanadi estuary (Subha Rao, 1968).

**Distribution**

Tropical Western Atlantic and possibly eastern Pacific, brackish water, Santos, Brazil, Gulf of California from Spanish Cedar.

Nausitora globosa (Sivickis)

Photograph 39

1928 Bankia globosa Sivickis, Philippine Jour. Sci., 37 288; Pl. 1, fig. 5

**Salient features**

Pallets elongately oval in outline, with short stalk. Segments of blade orderly arranged, very closely packed and
clearly distinguishable. Segments are of similar nature except for the size which is small at the distal end. Yellowish-brown periostracum covers the blade and is awned corresponding to the segments of the blade. Pallets symmetrical. Unlike in other species of the genus, no incrustation could be seen in the blade. Embryonic cap-like structure as in B. carinata can be distinguished at the distal tip of the blade. Pallets devoid of periostracum, resemble oval, comb-toothed on both the lateral sides.

Material examined

A pair of pallet was collected from a piece of coconut timber obtained from the Ashtamudy Lake.

Occurrence

Kadinamkulam backwater (Dharmaraj & Nair, 1981a).

Distribution

Sir J. Brook Point, Palawan, Philippine Islands (Sivickis, 1928).

Remarks

This is an estuarine species. Turner (1966) has synonymised this species with N. dunlopei. But on closer observations this was found as a distinct species. This has
also been recorded by Ibrahim (1981) from Australian waters.

**Nausitora oahuensis** (Edmondson)

Photographs 40 & 41

1942 Bankia (Nausitora) oahuensis Edmondson, Occ. Pap. B.P. Bishop Mus., 17(10) : 134, fig. 9g-k

**Salient features**

Pallets feather-shaped, weak and with stout stalks. Pallets are asymmetrical, stalk extends through the blade, best seen when viewed through bright transmitted light. Blade consists of very closely packed segments which are nearly fused and covered with pale brown non-adherent periostracum. Distal portion of the stalk at the point where it enters into the blade is also covered with periostracum. No sign of segmented nature could be seen in the periostracum. Outer face of the blade convex and inner face concave. Shell typical of the genus.

**Material examined**

Three pairs of pallets and shells collected from an isolated creek of the Ashtamudy Lake and another set of two pallets from the Kadinamkulam backwater during May, 1988.

**Occurrence**

Kadinamkulam backwaters (Dharmaraj & Nair, 1981a) in Cocos nucifera piles used as stakes along the waterfront.
Distribution

Kalihi Entrance, Oahu, Hawaiian Islands (Edmondson, 1942).

Ecological notes

An estuarine species. Not much is known on the ecology of this species. Original description was based on numerous valves and a few pallets recovered from submerged branches of a tree near the mouth of Kalihi stream, Oahu, Hawaii. Since the publication of the original description no reference has been made to this species except by the author himself (Edmondson, 1946).

Genus BANKIA Gray

1842 Bankia Gray, Synopsis of the contents of the British Museum, ed. 44. p.76


1946 Bankiopsis Clench & Turner, Johnsonia, 2: 16


The eight subgenera recognised under this genus namely Bankia Gray, Bankiella Bartsch, Clupibankia Moll, Deviobankia Iredale, Liliobankia Clench & Turner, Lyrodobankia Moll, Neobankia Bartsch and Plumulella Clench & Turner, on the basis of the structure of the pallets have been considered as invalid by Turner (1966) owing to the existence of transitional species between them.

**Salient features**

Pallets greatly elongate with blade composed of numerous distinct and well defined cone-in-cone segments on a central stalk. Each segment consists of a calcareous base covered with periostracum which extends as a border. The width and ornamentation of the periostracal border varies greatly. It may be smooth, coarsely to finely serrated or produced into lateral awns. Siphons long and separate. Fertilization and development of young external. Gills broadly U-shaped, to flattened, extend from base of siphons anteriorly to about a third of the visceral mass, stomach elongate; caecum large; heart anterior, dorsal to the caecum, ventricle long, posteriorly lobed, auricles tubular and without pigmentation (Turner, 1966).

Except for two species namely Bankia setacea and B. martensis occurring in cold waters, all others reported from temperate to tropical waters.
Two species of this genus occur along the South-west coast of India namely Bankia companellata and B. carinata.

Bankia companellata Moll & Roch
Plate VII A, Figs. 1-4, Photographs 42 & 43


1946 Bankia (Liliobankia) katherinae Clench & Turner, Johnsonia 2(19): 18; Pl. 11, figs. 1-6

1949 Bankia campanellata Clench & Turner, Johnsonia, 2 (19): 27

1954 Bankia (Bankia) bengalensis Nair, Rec. Indian Mus., 52: 388, fig. 1a-c


Salient features

Pallets consist of a series of widely spaced, cone-in-cone elements forming the blade, with a cylindrical stalk shorter than the blade. Cones forming the blade are bell-shaped with their distal margin reflected forming a broad rim. The distal 1/3 of each joint is covered by a golden brown periostracum. Periostracal margin of outer face less concave than that of
the inner face. Lateral portions broadened and upwardly curved forming wide blunt awns. The embryonic cones at the distal end are not crowded.

Shell sub-globular, anterior lobe large with closely set denticulated ridges. Auricle well developed, projecting posterior median part as a shelf. Umbonal knob strong. Apophysis blade-like and curved.

Siphons separate, gills blade-like, branchial groove well developed, labial palps attached, stomach elongate, caecum moderate, intestine not looping over style-sac, anal canal open, heart anterior, auricles not pigmented.

Material examined

One specimen and 14 pallets were collected from drift wood from the shore waters of Parali and Kadamath atolls of the Lakshadweep Archipelago during May 1987 and a total of seven pallets from two backwaters in the northern part of Kerala namely Nileswaram and Valapattanam along the South-west coast of India.

Occurrence

Bankia campanellata has been reported from different areas along the coast of India. Sundarbans (Roonwal, 1966;
Rajagopal, 1964a); Mahanadi estuary (Subha Rao, 1968); Godavary (Ganapati & Rao, 1959; Rao, 1986); Vishakapatnam (Nagabhushanam 1955, 1960; Satyanarayana Rao et al., 1987); Pulicat Lake (Srinivasan, 1969); Madras (Nair, 1954); Muthupet (Srinivasan & Chandramohan, 1973); Mandapam and neighbouring islands (Nair & Dharmaraj, 1980); Andamans (Karande, 1978; Santhakumaran & Srinivasan, 1988); Cochin (Saraswathy, 1964); Mangalore (Santhakumaran, 1976; Dharmaraj & Nair, 1981); Karwar, Goa, Ratnagiri, Bombay, Gholvad, Daman, Camban, Bhavenagar, Diu, Veraval, Okha and Kandla (Santhakumaran, 1976, 1981; Santhakumaran & Pillai, 1975); Pichavaram (Radhakrishnan & Natarajan, 1987a).

**Distribution**

World-wide, tropical, Indo-Malay Archipelago (Roch, 1955); Bahia, Brazil (Clench & Truner, 1946); Hobart and Launceston, Australia (Ibrahim, 1981).

**Ecological notes**

At Vishakapatnam Harbour B. _campanellata_ settles on freshly immersed test panels during August to February and has not been found in the summer months March to July (Nagabhushanam, 1962). This is in contrast with the seasonal distribution of the other two important molluscan borers in the local harbour
i.e. *Martesia striata* and *Teredo furcifera* which occur throughout the year, the maximum attack being in the summer months (Nagabhushanam, 1962). It occurs throughout the year in Madras with a slight increase in attack during the summer months. At Trombay (near Bombay) attack occurs during March, gradually increasing till September with a peak during August. From October onwards no further settlement is noticed, the peak spawning being from late July to late September. Rate of settlement increases with depth. In the Godavary estuary this species occurs in waters of fluctuating salinity. *B. campanellata* is a protandric species, the majority of individuals passing through a preliminary male phase before reaching the female phase. Full grown specimens have the appearance of either males or females with an indication of being ambisexual (Ganapathi & Nagabhushanam, 1959). *B. campanellata* is an oviparous species, fertilization is external, breeding season extends from August to February in Vishakapatnam (Nagabhushanam, 1962).

Remarks

The present material has close resemblance with the original description of the species given by Moll & Roch (1931). This species is fairly common along the coasts of a few atolls as well as in drift wood washed ashore. This species is rarely found in the backwaters of Kerala.
Bankia carinata (Gray)
Plate VII B, Figs. 1-4, Photographs 44 & 45

1827 Teredo carinata Gray, Phil. Mag. (N.S.), 2: 411
1829 Teredo bipalmata Delle Chiaje, Memorie Sulla Storia e Notomia degli Animali Senza Vertebre del Regno. di Napoli, 4: 28, 32, 115; Pl. 54, figs. 18, 22-24
1931 Bankia (Bankia) nukazawai Kuronuma, Venus, 2(6): 290; Pl. 8, fig. 8; Pl. 9, figs. 32-34
1946 Bankia (Bankiopsis) caribbea Clench & Turner, Johnsonia, 2: 16, p. 10
1954 Bankia (Bankiella) indica Nair, Rec. Indian Mus., 52: 393, fig. 3a-d
1956 Bankia (Bankiella) edmondsoni, Nair, Rec. Indian Mus., 52: 396, fig. 4a-c
Salient features

Pallet elongate, with long, cylindrical stalk, blade composed of a series of moderately to closely spaced cone-like units, each cone having the calcareous portion funnel-shaped with the inner margin higher than the outer margin, periostracal margin of these cones shallowly U-shaped, narrow and smooth both on the inner and outer faces. The cones are well spaced at the proximal part of the blade but become compactly packed and crowded towards its distal aspect. The pallet stalk slightly shorter than the blade, the outer face of the latter convex but the inner face flat.

Shell variable, globular, posterior slope well formed and placed high on the posterior margin of the disc in young specimens.

Siphons separate, gills blade-like, branchial groove well developed, labial palps attached, stomach elongate, caecum moderate, intestine not looping over style-sac, anal canal open, heart anterior, fertilization external.
Material examined

Several specimens and a large number of pallets were collected from fixed wood and drift wood from almost all the atolls of the Lakshadweep Archipelago during May 1987. Some specimens and several pallets have also been collected from underwater wooden structures, *(Cocos nucifera, Mangifera indica, Thespesia populina)* from Nilswaram backwaters, Kallayi Estuary and Cochin backwaters along the South-west coast of India, during 1987-'88.

Occurrence

This species has been reported from almost all localities along the Indian coasts where records on marine wood borers are available. Calcutta (Becker, 1958; Nair, 1964); Mahanadi estuary (Ganapati & Rao, 1959); Vishakapatnam (Nagabhushanam, 1960); Madras (Nair, 1954, 1956; Daniel, 1958); Porto-Novo (Nair & Dharmaraj, 1980; Radhakrishnan & Natarajan, 1987; Radhakrishnan et al., 1983); Tondi (Nair & Gurumari, 1957); Pamban (Nair, 1965); Mandapam and nearby islands (Nair & Dharmaraj, 1980); Cochin (Saraswathy, 1964); Mangalore (Dharmaraj & Nair, 1981); Goa (Santhakumaran, 1983); Bombay (Becker, 1958; Karande, 1968); Pichavaram (Radhakrishnan & Natarajan, 1987a); Godavary estuary (Rao, 1986); Bombay high (Raveendran & Wagh, 1988).
Distribution

Distributed world-wide in tropical to sub-tropical waters, Mediterranean (Blainville, 1828); Sicilli, Naples, Italy (see Turner, 1966); Jaffa, Israel (Roch, 1935); Africa West coast (Roch & Moll, 1929); Indian Ocean Islands, Indo-Malay Archipelago (Roch, 1955); Sumatra, Philippine Islands, Pacific Ocean Islands; Gulf of Mexico, Caribbean (Turner, 1966); Kingyoku, Takanoshima (Roch & Moll, 1929); Tateyama Bay, Chiba pref, Japan (Kuronuma, 1931); Gulf of Cariaco, Venezuela (Nair, 1975); South-eastern Australia (Truner & Marshall, 1973; Ibrahim, 1981).

Ecological notes

This species is common all along the coast of India, quite destructive and appears readily on test panels exposed in the sea. At Madras this species occurs in fair numbers in the wooden floats employed in pomfret fishing. Occasionally it has also been collected from wooden structures, discarded country canoes as well as from drift wood cast ashore. Bankia carinata is protandric, all females passing through a preliminary functional male phase before reaching the female phase. The female after a functional phase can revert to the functional male phase (Nair, 1956a). Breeding is continuous marked by seasonal intensity. Abundant occurrence of larvae in
the plankton and intensive settlement in July and August respec-
tively suggest that this period is conducive for larval development
and settlement in Madras. *B. carinata* is oviparous, fertilization
is external, typical pediveliger stage is reached on the 15th
day. Larvae are pelagic feeding on the plankton and when
17 days old are ready for settlement. It can retain the larval
organs and postpone metamorphosis if a suitable substratum
is not available and continue as a free-swimming larva for
some days (Nair, 1957a).

**Remarks**

The materials collected during the present study very
much resembles the original species described. It has been
collected in fair numbers from drift wood and rarely from
fixed wood in the Lakshadweep Archipelago. It was found
only in certain isolated backwaters of Kerala, namely Nileswaram,
Kallayi and Vembanad backwaters during the present study
and in these areas it is rarely found.
General Remarks

Table I furnishes a catalogue of all the names used in earlier work in India together with the names of authors and the year of publication. The specific name is given in the first column and the synonyms if any are indicated against each name in the 2nd column. The classification suggested by Turner (1966) has been followed. Thus the Indian shipworm fauna consists of at least 40 species assignable to 13 genera, one species each in Bactronophorus, Neoteredo, Dicyathifer, Psiloteredo, and Spathoteredo; two each in Teredora, Uperotus and Nototeredo; three in Teredothyra; five in Lyrodus and Nausitora; seven in Bankia and nine in Teredo. The occurrence of one of the above mentioned species is questionable namely Neoteredo reyniei. The species Teredora palauensis was considered as belonging to the genus Teredothyra but dissection and study of the material during a visit to Trivandrum by Dr. Ruth Turner proved that it belongs to the genus Teredora. Nausitora globosa (Sivickis) was considered a synonym of N. dunlopei by Turner. But the present observation indicates that it to be a distinct species, similarly, N. oahuensis and Uperotus rehderi (Nair) are also distinctive species.

In Table 2 is presented the pattern of distribution of the different species of shipworms along the coasts of India.
It will be seen that 30 species are active along the east coast including Andaman Nicobar Islands and 34 (including the present study) have so far been reported from the west coast including Lakshadweep Archipelago. 22 species are common in the east and west coasts. Of these, Dicyathifer manni, Teredo furcifera, Lyrodus pedicellatus, Bankia carinata and Bankia campanellata seem to have an almost continuous distribution along the coasts of India, being present in almost all areas from where records are available. Forms like Neoteredo reynei, Nototeredo knoxi, Bankia bipalmulata, B. bipennata and B. fimbriatula collected from the east coast have not yet been noted along the west coast. Similarly Teredothyra matacontana, Teredora palauensis, Psiloteredo senegalensis, Teredo aegypus, Teredo mindanensis, T. portoricensis, T. somersi, Lyrodus medilobata, Nausitora globosa and Nausitora oahuensis have been collected only from the west coast.

At least seven species of shipworms are known to occur in West Bengal. It is certain that this does not represent the actual number that exist in that area because the extensive mangrove forests that occur there should certainly be harbouring a much greater number than is known at present. From the mangrove forests of Sunderbans, B. thoracites has been reported as a serious pest infesting both living and dead trees (Roonwal, 1954, 1954a). D. manni, N. dunlopei, B. campanellata, B.
nordi and B. rochi are the other species reported as active in West Bengal.

12 species have so far been collected from the Mahanadi estuary in Orissa and these include all the species reported from W. Bengal except B. nordi.

The marine wood borers of Andhra Pradesh have been studied in considerable detail by Nagabhushanam (1958, 1960); Ganapati and Lakshmana Rao (1959). Of the 16 species of shipworms that occur in the region T. furcifera, L. pedicellatus and B. campanellata are the most destructive in the area especially in the Vishakapatnam Harbour.

No other region in India has been subjected to such detailed and extensive surveys as the Tamil Nadu coast. Since 1953 as many as 24 species have been collected, identified and described from this area covering the south eastern part of India. The most destructive species in this area are T. furcifera, L. pedicellatus, B. carinata and U. rehderi (see Daniel, 1958; Nair, 1954, 1955, 1956, 1962, 1965; Nair and Dharmaraj, 1979, 1980; Nair & Gurumani, 1957; Nair and Saraswathy 1971; Radhakrishnan et al., 1983; Srinivasan & Chandramohan, 1973).

The Andaman and Nicobar Islands commonly known as the Bay Islands occupy a unique position Zoogeographically.
Recent studies have brought to light the existence of 21 species of shipworms in these islands (Das & Dev Roy, 1980; Ganapati & Rao, 1960; Karande, 1978; Tewari et al., 1980).

From the South-west coast of India 26 species have been reported. These include the material from the present collection along the coast of Kerala and Lakshadweep Islands. *L. pedicellatus* and *T. furcifera* were the most destructive and commonly occurring species in all the major backwaters surveyed during the present study. *N. hedleyi* was found destructive in the Cochin backwaters and also in the Kodungallur backwater, Korapuzha estuary, Badagara estuary and Valapattanam estuary. *D. manni* which occurs only in the northern backwaters of Kerala namely Kallayi, Beypore, Korapuzha, Badagara, Valapattanam and Nileswaram was found to be highly destructive infesting living trees as well as wooden crafts operating in this areas. The present surveys along the extensive backwaters of Kerala also have brought to light the existence of a few interesting species such as *N. globosa*, *N. oahuensis*, and *L. triste*.

The Lakshadweep Archipelago situated off the South-west coast of India the major inhabited and uninhabited islands of which have been surveyed during the present study - harbour 20 species of shipworms. Species highly destructive are *T. fulleri*, *T. clappi* and *L. massa*. *Teredora palauensis*, Teredo
Aegypos and Teredo somersi are reported only from this area of the Indian waters (see also Nair & Dharmaraj, 1983).

The North-west coast of India representing the region north of Goa has also been subjected to detailed surveys by Santhakumaran (1973, 1976, 1985, 1986). These along with earlier records show that 20 species occur north of Goa (including the coast of Maharashtra and Gujarat) in the Indian waters.

The occurrence, abundance and activity of the borers show remarkable variations and fluctuations in the different areas along the coast of India, each having its own dominant set of species and an assemblage of less important forms. It is well known that reactions of closely allied species may be different and even individuals of the same species may vary according to the peculiar hydrographic conditions prevailing in an area. It is noteworthy that each species has its characteristic preferences, distinctive life history and seasons of settlement. Species density has fluctuated over long periods and within the same period their attacks have differed considerably in various locations along the same stretch of coast (Becker, 1958). So the problem varies with the species occurring in any locality and also with climatic and hydrographic conditions.
Table I

Indian shipworms with synonyms found in earlier Indian works

<table>
<thead>
<tr>
<th>Name of species</th>
<th>Synonyms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bactronophorus thoracites (Gould)</td>
<td>Teredo (Bactronophorus) thoracites (Gould) Roonwal, 1954, 1956; Palekar &amp; Bal, 1957; Nagabhushanam 1955</td>
</tr>
<tr>
<td>2. Neoteredo reynei (Bartsch)</td>
<td>Identity of this species is doubtful</td>
</tr>
<tr>
<td>3. Dicyathifer manni Wright</td>
<td>Teredo (Kuphus) manni (Wright), Palekar, Santhakumaran &amp; Bal, 1964; Palekar &amp; Bal, 1957a; Saraswathy, 1964; Nair, 1964; Daniel, 1958; Nair, 1963; Roonwal, 1966</td>
</tr>
<tr>
<td></td>
<td>Teredo manni (Wright), Nair, 1964, 1984</td>
</tr>
<tr>
<td></td>
<td>Teredo (Teredothyra) manni (Wright), Nagabhushanam, 1955</td>
</tr>
<tr>
<td>4. Teredothyra excavata (Jeffreys)</td>
<td>Teredo (Teredothyra) linearis, Nair, 1955</td>
</tr>
<tr>
<td>5. Teredothyra matacontana Bartsch</td>
<td>Teredo (Zopoteredo) bengalensis Nair, 1954; Nair &amp; Gurumani, 1957</td>
</tr>
<tr>
<td>6. Teredothyra smithi (Bartsch)</td>
<td>Teredo (Nototeredo) nambudalaiensis Nair &amp; Gurumani, 1957; Nair, 1962</td>
</tr>
<tr>
<td>7. Teredora palauensis Edmondson</td>
<td></td>
</tr>
</tbody>
</table>
8. Teredora princesae (Sivickis)  
Teredo (Teredora) minori Nair, 1955
Teredo (Dactyloteredo) diederichseni Roch, Daniel, 1955; Nair, 1962, 1955; Saraswathy, 1964
Teredo (Teredora) gregoryi Dall, Bartsch & Rehder, Nair, 1954, 1956
Teredo diederichseni Nair, 1964

9. Uperotus clavus (Gmelin)  
Teredo clava Gmelin, Gravely 1941; Crichton, 1941
Teredo (Uperotus) clava Gmelin, Nair, 1954, 1965; Daniel, 1958

10. Uperotus rehderi (Nair)  
Teredo (Teredora) rehderi Nair, 1954, 1956
Teredo (Teredora) vattanansis Nair & Gurumani, 1957

11. Psiloteredo senegalensis (Blainville)

12. Teredo aegypos Moll

13. Teredo bartschi Clapp  
Teredo (Teredo) bartschi Clapp, Nagabhushanam, 1955
Teredo (Teredo) navalis Linnaeus, Nagabhushanam, 1955

14. T. clappi Bartsch  
Teredo (Zopoteredo) trulliformis Miller, Nagabhushanam, 1955; Ganapati & Rao, 1959, 1961
15. **T. fulleri** Clapp

16. **Teredo furcifera** von Martens

17. **Teredo mindanensis** Bartsch

18. **Teredo portoricensis?** Clapp

19. **Teredo somersi** Clapp
20. **Teredo triangularis** Edmondson
   Teredo (Zopoteredo) triangularis Edmondson, Nagabhushanam, 1960

21. **Lyrodus affinis** (Deshayes)
   Teredo (Lyrodus) milleri Dall, Bartsch & Rehder, Nagabhushanam, 1960

22. **Lyrodus massa** (Lamy)
   Teredo (Coeloteredo) singaporeana Roch, Nagabhushanam, 1960; Nair, 1965

23. **Lyrodus medilobata** Edmondson
   Lyrodus medilobata (Edmondson), Santhakumaran, 1986

24. **Lyrodus pedicellatus** (Quatrefages)
   Teredo (Teredo) madrasensis Nair, 1954, 1962; Nair & Gurumani, 1957
   Teredo (Teredo) indica Nair, 1955, 1956; Nair & Gurumani, 1957
   Teredo (Teredo) diegensis Bartsch, Erlanson, 1936; Nagabhushanam, 1955
   Teredo (Teredops) samoensis Miller, Erlanson 1936; Nagabhushanam, 1955
   Teredo (Lyrodus) malaceana Roch, Nagabhushanam, 1960; Nair, 1962, 1965; Saraswathy, 1964; Palekar, Santhakumaran & Bal, 1964
   Teredo (Lyrodus) pedicellatus Quatrefages, Palekar, Santhakumaran & Bal, 1964
   Teredo (Teredops) diegensis Bartsch, Erlanson, 1936
   Teredo malaceana Nair, 1964

25. **Lyrodus triste** Iredale
<table>
<thead>
<tr>
<th></th>
<th>Scientific Name</th>
<th>Author(s) and Year(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.</td>
<td><em>Nototeredo edax</em> (Hedley)</td>
<td>Teredo (<em>Psiloteredo</em>) tondiensis Nair &amp; Gurumani, 1956, 1957a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teredo (<em>Teredora</em>) thomsonii Teyon, Nagabhushanam, 1955</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teredo (<em>Dactyloteredo</em>) juttingae Roch, Ganapati &amp; Rao, 1959; Nagabhushanam, 1960</td>
</tr>
<tr>
<td>27.</td>
<td><em>Nototeredo knoxi</em> (Bartsch)</td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td><em>Spathoteredo obtusa</em> (Sivickis)</td>
<td>Teredo obtusa (Sivickis)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teredo variegata (Sivickis)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teredo bataviana Moll &amp; Roch Taki &amp; Habe, 1945</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teredo semoni Moll</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teredo murrayi Moll</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bankia (<em>Nausitora</em>) excolpa Bartsch, Nagabhushnam, 1955</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bankia (<em>Nausitora</em>) lanceolata Rajagopal, 1964; Roonwal, 1966</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bankia (<em>Nausitora</em>) dunlopei Wright, Nagabhushanam, 1960</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nausitora lanceolata Rajagopal, Subha Rao, 1968</td>
</tr>
<tr>
<td>30.</td>
<td><em>Nausitora fusticula</em> (Jeffreys)</td>
<td></td>
</tr>
<tr>
<td>31.</td>
<td><em>Nausitora globosa</em> (Sivickis)</td>
<td></td>
</tr>
</tbody>
</table>
32. **Nausitora hedleyi** Schepman  
   *Bankia (Nausitora) gabrieli* Nair, 1955, 1956  
   *Bankia (Nausitora) hedleyi* (Schepman), Nair, 1963

33. **Nausitora oahuensis** (Edmondson)

34. **Bankia bipalmulata** (Lamarck)  
   *Teredo bipalmulata* Lamarck, 1801  
   *Bankia (Bankia) bipalmulata* (Lamarck), Nair, 1954, 1962, 1965  
   *Teredo palmulatus* Lamarck, 1818

35. **Bankia bipennata** Turton  
   *Bankia (Neobankia) lineata* Nair, 1955; Daniel, 1958, 1956  
   *Bankia (Neobankia) denticuloserrata* Daniel, 1956, 1958  
   *Bankia (Plumulella) lineata* (Nair), Nair, 1962, 1965; Nagabhushanam, 1960

36. **Bankia campanellata** Moll & Roch  
   *Bankia (Bankia) bengalensis* Nair, 1954  
   *Bankia (Bankia) setacea* (Tryon), Nagabhushanam, 1955

37. **Bankia carinata** (Gray)  
   *Bankia (Bankiella) indica* Nair, 1954, 1965  
   *Bankia (Bankiella) edmondsoni* Nair, 1954, 1964; Nair & Gurumani, 1957a; Ganapati & Rao, 1959  
   *Bankia (Bankiella) consularis* Moll, Daniel, 1958; Saraswathy, 1964; Karande, 1968
38. *Bankia fimbriatula* Moll & Roch

39. *Bankia nordi* Moll

40. *Bankia rochi* Moll
<table>
<thead>
<tr>
<th>Name of species</th>
<th>West Bengal</th>
<th>Orissa</th>
<th>Andhra Pradesh</th>
<th>Tamil Nadu</th>
<th>Andaman and Nicobar</th>
<th>Lakshadweep Archipelago</th>
<th>Kerala</th>
<th>Karnataka and Goa</th>
<th>Maharashtra</th>
<th>Gujarat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shipworms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bactromphorusthoracites (Gould)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neoteredo reynoi (Bartsch)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liernathiter manni (Wright)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredotheva excavata (Jeffreys)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredotheva macrotana (Bartsch)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredotheva angula (Bartsch)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredora daluensis (Edmondson)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredora princesae (Sivickis)</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operotus clavus (Gmelin)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operotus rehderi (Nair)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pholoteredoneum generalis (Blainville)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredo aequinoe Moll</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredo bartensi Clapp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredo clappi Bartsch</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredo ful ⊖ri Clapp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredo furcifera von Martens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredo mindanensis Bartsch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredo portoricensis? Clapp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredo somersi Clapp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teredo triangularis Edmondson</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lyrodus affinis (Deshays)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lyrodus massa (Lay)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lyrodus modiloba (Edmondson)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lyrodus tristi (Iredale)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lyrodus pedicellatus (Quatrefages)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notobergodema edax (Hedley)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notobergodema rehderi (Bartsch)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spathoteredon obtusus (Sivickis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausitora daniopel Wright</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausitora fusica (Jeffreys)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausitora gibosa (Sivickis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausitora hedleyi Schepman</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausitora oahuensis (Edmondson)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankia bipalmulata (Lamark)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankia bipennata Turton</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankia campanellata Moll &amp; Roch</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankia carinata (Gray)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankia fimbriatula Moll and Roch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankia nordi Moll</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankia rochi Moll</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Pholads                         |             |        |                |            |                     |                        |        |                  |             |         |
| Barnea birmarica (Philippi)     |             |        |                |            |                     |                        |        |                  |             |         |
| Barnea manilensis (Philippi)    |             |        |                |            |                     |                        |        |                  |             |         |
| Pholas chiloensis (Molina)      |             |        |                |            |                     |                        |        |                  |             |         |
| Lignopholas sp.                 |             |        |                |            |                     |                        |        |                  |             |         |
| Martesia fragilis Verrill and Bush | x          | x      | x              | x          | x                   | x                      | x      | x                |             |         |
| Martesia striata                | x           | x      | x              | x          | x                   | x                      | x      | x                |             |         |
| Martesia sp.                    |             |        |                |            |                     |                        |        |                  |             |         |
| Martesia sp. (Oxteata Sowerby)  |             |        |                |            |                     |                        |        |                  |             |         |
| Sibogphana sp.                  |             |        |                |            |                     |                        |        |                  |             |         |
PLATE I

A. *Nausitora hedleyi* Schepman
   - Fig. 1 Outer view of shell
   - Fig. 2 Inner view of shell
   - Fig. 3 Outer face of pallet
   - Fig. 4 Inner face of pallet

B. *Dicyathifer manni* (Wright)
   - Fig. 1 Outer view of shell
   - Fig. 2 Inner view of shell
   - Fig. 3 Outer face of pallet
   - Fig. 4 Inner face of pallet

C. *Teredothyra excavata* (Jeffreys)
   - Fig. 1 Outer view of shell
   - Fig. 2 Inner view of shell
   - Fig. 3 Outer face of pallet
   - Fig. 4 Inner face of pallet
A. Teredothyra smithi (Bartsch)
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

B. Teredora palauensis Edmondson
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

C. Teredora princesae (Sivickis)
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

D. Uperotus clavus (Gmelin)
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet
A. Uperotus rehderi Nair
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

B. Psiloteredo senegalensis (Blainville)
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

C. Teredo aegypos Moll
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

D. Teredo bartschi Clapp
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet
A. *Teredo clappi* Bartsch

Fig. 1 Outer view of shell
Fig. 2 Inner view of shell
Fig. 3 Outer face of pallet
Fig. 4 Inner face of pallet

B. *Teredo fulleri* Clapp

Fig. 1 Outer view of shell
Fig. 2 Inner view of shell
Fig. 3 Outer face of pallet
Fig. 4 Inner face of pallet

C. *Teredo furcifera* Von Martens

Fig. 1 Outer view of shell
Fig. 2 Inner view of shell
Fig. 3 Outer face of pallet
Fig. 4 Inner face of pallet

D. *Teredo mindanensis* Bartsch

Fig. 1 Outer view of shell
Fig. 2 Inner view of shell
Fig. 3 Outer face of pallet
Fig. 4 Inner face of pallet
PLATE V

A. Teredo portoricensis Clapp
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

B. Teredo triangularis Edmondson
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

C. Teredo somersi Clapp
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

D. Lyrodus massa (Lamy)
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet
PLATE VI

A. *Lyrodus pedicellatus* (Quatrefages)
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

B. *Spathoteredo obtusa* (Sivickis)
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet

C. *Nausitora dunlopei* Wright
   Fig. 1 Outer view of shell
   Fig. 2 Inner view of shell
   Fig. 3 Outer face of pallet
   Fig. 4 Inner face of pallet
A. *Bankia campanellata* Moll and Roch

Fig. 1 Outer view of shell
Fig. 2 Inner view of shell
Fig. 3 Outer face of pallet
Fig. 4 Inner face of pallet

B. *Bankia carinata* (Gray)

Fig. 1 Outer view of shell
Fig. 2 Inner view of shell
Fig. 3 Outer face of pallet
Fig. 4 Inner face of pallet
Photograph 1. Shells (inner and outer views) of *Dicyathifer manni*

Photograph 2. Pallets (outer and inner faces) of *Dicyathifer manni*

Photograph 3. Shells (outer and inner views) of *Teredothyra excavata*

Photograph 4. Pallets (outer and inner faces) of *Teredothyra excavata*
Photograph 5. Pallets (outer and inner faces) of Teredothyra smithi

Photograph 6. Pallets (Outer (above) and inner (below) faces) of Teredora palauensis

Photograph 7. Shells (inner and outer views) of Teredora palauensis
Photograph 8. Pallets (outer and inner faces) of Teredora princesae

Photograph 9. Shells (outer and inner views) of Teredora princesae
Photograph 10. Pallets (outer and inner faces) of *Uperotus clavus* (above) and *Uperotus rehderi* (below).

Photograph 11. Shells (outer and inner views) of *Uperotus clavus*

Photograph 12. Shells (outer and inner views) of *Uperotus rehderi*
Photograph 13. Pallets (outer (above) and inner (below) faces) of *Psiloteredo senegalensis*

Photograph 14. Pallets (outer and inner faces) of *Teredo aegypos*

Photograph 15. Shells (outer and inner views) of *Teredo aegypos*
Photograph 16. Pallets (outer and inner faces) of Teredo bartschi

Photograph 17. Pallets (outer and inner faces) of Teredo clappi

Photograph 18. Shells (inner and outer views) of Teredo clappi
Photograph 19. Pallets (outer and inner faces) of *Teredo fulleri*

Photograph 20. Shells (inner and outer views) of *Teredo fulleri*

Photograph 21. Pallets (outer and inner faces) of *Teredo furcifera*

Photograph 22. Shells (inner and outer view) of *Teredo furcifera*
Photograph 23. Pallets (outer and inner faces) of *Teredo portoricensis*

Photograph 24. Pallets (outer and inner faces) of *Teredo somersi*

Photograph 25. Pallets (outer and inner faces) of *Teredo triangularis*

Photograph 26. Shells (outer and inner views) of *Teredo triangularis*
Photograph 27. Pallets (outer and inner faces) of *Lyrodus pedicellatus*

Photograph 28. Shells (inner and outer views) of *Lyrodus pedicellatus*
Photograph 29. Pallets (outer and inner faces) of *Lyrodus massa*

Photograph 30. Shells (outer and inner views) of *Lyrodus massa*

Photograph 31. Pallets (outer and inner faces) of *Lyrodus triste*
Photograph 32. Pallets (outer and inner faces) of *Spathoteredo obtusa*

Photograph 33. Shells (inner and outer views) of *Spathoteredo obtusa*
Photograph 34. Pallets (outer and inner faces) of Nausitora dunlopei

Photograph 35. Shells (inner and outer views) of Nausitora dunlopei
Photograph 36. Pallets (outer and inner faces) of *Nausitora hedleyi*

Photograph 37. Shells (inner and outer views) of *Nausitora hedleyi*

Photograph 38. Pallets (outer and inner faces) of *Nausitora fusticula*
Photograph 39. Pallets (outer and inner faces) of Nausitora globosa

Photograph 40. Pallets (outer and inner faces) of Nausitora oahuensis

Photograph 41. Shells, (inner and outer views) of Nausitora oahuensis
Photograph 42. Pallets (outer and inner faces) of Bankia campanellata

Photograph 43. Shells (inner and outer views) of Bankia campanellata
Photograph 44. Pallets (outer and inner faces) of Bankia carinata

Photograph 45. Shells (inner and outer views of Bankia carinata