

THE MOLLUSC FAMILY TEREDINIDAE OF NORTHERN SULAWESI, INDONESIA

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ABSTRACT

A total of 18 species of Teredinidae were obtained from drift wood and wooden panels exposed along the coast of northern Minahasa Peninsula and Sangihe Islands. The pallets of these species are described and illustrated. The species belong to eight genera: *Bactronophorus*, *Uperotus*, *Teredora*, *Teredo*, *Lyrodus*, *Spathoteredo*, *Nausitora*, and *Bankia*.

INTRODUCTION

In spite of a high species diversity within the family Teredinidae, the taxonomy has been little studied in Indonesia. Emphasis has been on boring activities and impact on wood installations in the sea (Yulianda 1996; Suhirman & Eaton 1984). Teredinids are commonly called shipworms (tambelo in local Indonesian language, Manado). They are readily recognised as a collective group, but accurate identification usually requires that pallets are available and preferably also the shells. However, pallets provide the most useful characters, so emphasis has been on this structure in the present study. We have defined and illustrated general features of soft body, shell and pallets with a view that they should serve as a reference in future studies.

MATERIALS AND METHODS

The present paper is based on the thesis of Gustaf Mamangkey submitted to the University of Sam Ratulangi in partial fulfilment of the requirements for the degree of B.Sc. The specimen were collected at seven localities in northern Minahasa peninsula and Sangihe islands (Fig. 1). Substrates of the teredinids were wooden panels placed in various sites and depths, drift wood exposed along the beaches, and dead wood collected in the intertidal zone.

The 20 x 20 x 2cm *Canangu* (fam. Annonaceae) wood panels were placed in Likupang, Kalasey, Tongkeina and Poopoh in various depths (surface to 5 m). Because of the wave impact of the

northwest moonsoon during rainy season, only panels from the first two locations could last for two months.

The pieces of wood containing shipworms were brought to the laboratory and stored in a freezer to stimulate animals to extend their pallets. Woods were peeled in 1 cm slices, or cut into small pieces, then rinsed, and the animals collected. Pallets and shells still sticking inside the wood were removed and stored in 70 % ethanol. The specimen were identified, using the catalogue by Turner (1966), and drawn free hand from a dissecting compound microscope. Pallets

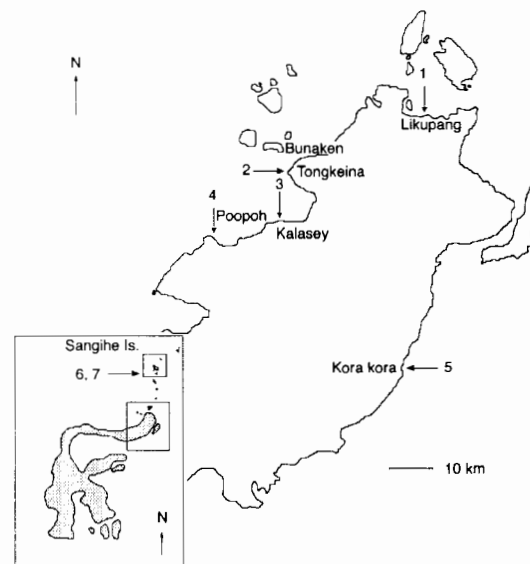


Figure 1. Northern Sulawesi, with the sampling localities indicated.

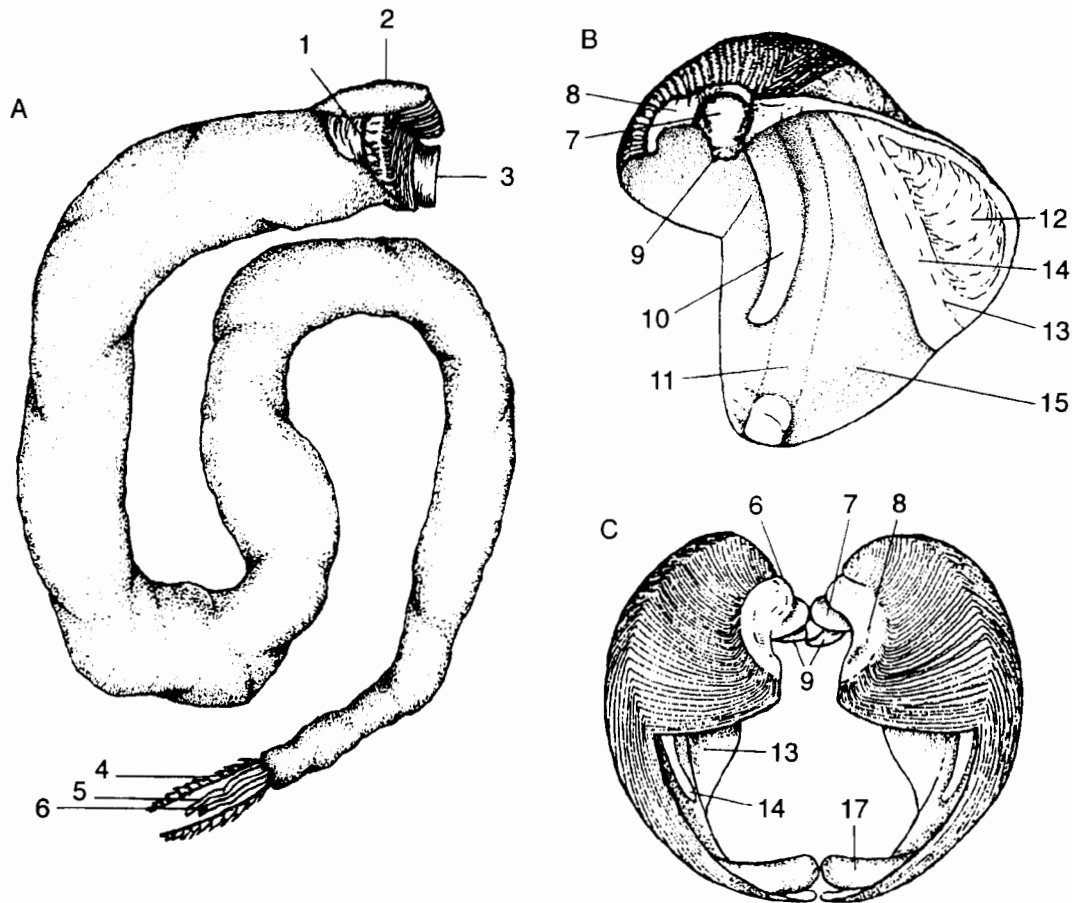


Figure 2. A. Diagrammatic sketch of an entire animal (*Bankia*). B. Internal view of right valve. C. Anterior view of opposed valves. Key to numbers: (1). Shell, (2). Cepalic hood, (3). Foot, 4. Pallet, (5). Inhalant siphon, (6). Exhalant siphon, (7). Dorsal condyle, (8). Umbonal reflection, (9). Chondrophore, (10). Apophysis, (11). Umbonal ventral ridge, (12). Muscle scar, (13). Posterior slope, (14). Shelf, (15). Disc, (16). Umbo, (17). Dorsal condyle.

and shells were used as taxonomic characters for teredinids. Measurements and terminology used in this study are shown in Figs. 2 and 3.

SYSTEMATIC ACCOUNT

Bactronophorus Tapparone, 1877

DIAGNOSIS: Pallets asymmetric, basal portion of blade more or less triangular in outline with a shallow cup which issues a pustulose, calcareous, dagger-like extension. Siphons relatively short and united for most

of their length. Wood borers, found in mangroves and brackish water areas of the Indo-Pacific (Turner 1966).

Bactronophorus thoracites (Gould, 1856)

MATERIAL EXAMINED: Only one specimen was collected from a mangrove area, Likupang. Dry specimen consisting of a pair of pallets and the shells. **DESCRIPTION:** Pallets asymmetric, basal blade with triangular, cup-like shape, distal margin like a half circle, pustulous outer surface of the dagger. Stalk hook-shaped (sinu-

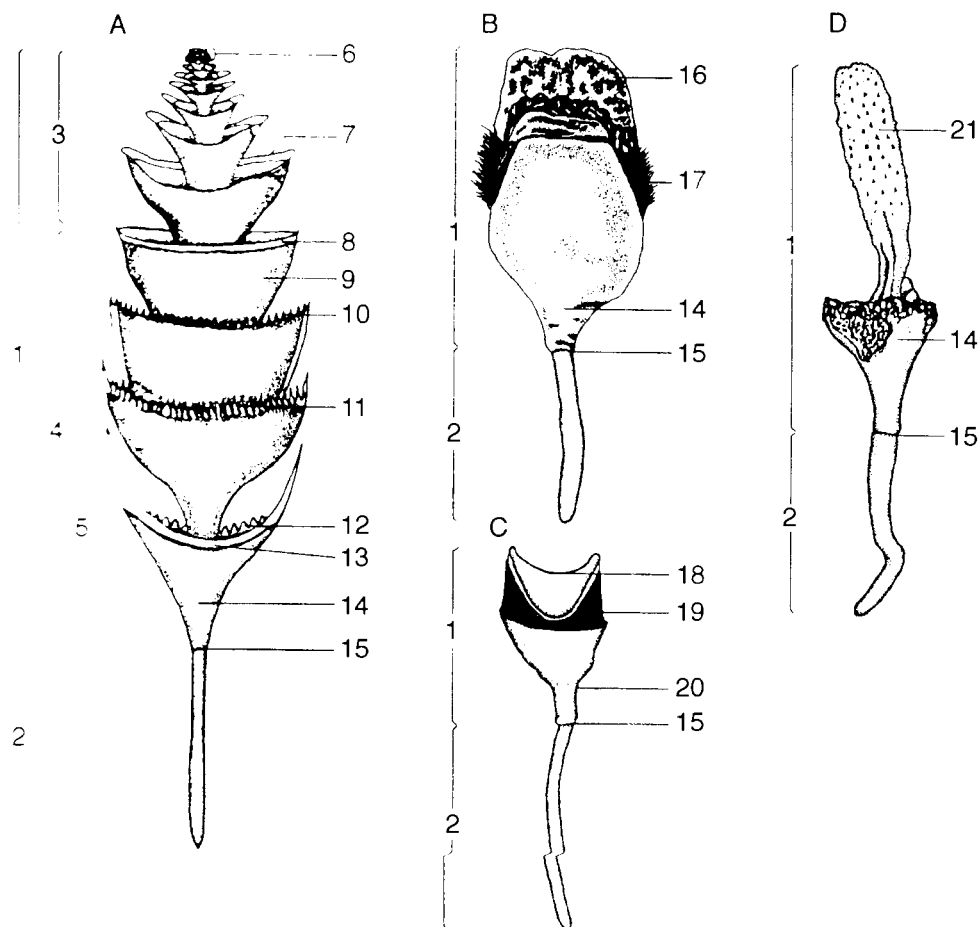


Figure 3. Hypothetical, composite pallet of A. *Bankia* (all genera carry pallets composed of a blade and a stalk), B. *Spathoteredo obtusa*, C. *Teredo furcifera* and D. *Bactronophorus thoracites*. Key to numbers: (1). Blade, (2). Stalk, (3). Cones closely spaced, (4). Cones distantly spaced, (5). Individual cone, (6). Embryonic cap, (7). Inner margin, (8). Smooth margin, (9). Calcareous portion, (10). Fine serration, (11). Chaffy serration, (12). Coarse serration, (13). Periostracal portion of blade, (14). Basal portion of blade, (15). Attachment stalk of blade, (16). Crust, (17). Periostracum (awn-like), (18). distal lip portion of blade, (19). Periostracal cover of blade, (20). Sleeve-like basal portion of blade, (21). Dagger.

ous). Shell broken, apophysis from beneath the middle of shell (Fig. 4).

Teredora Bartsch, 1921

DIAGNOSIS: Pallets solid, symmetric, almost entirely calcareous, oval to broadly oval in outline and with a short stalk. Blade thick at the base, thin at the distal margin, convex on the outer and concave on the inner face. Outer face with a small to large, deep thumbnail-like depression which is marked

with broadly curved, concentric growth lines. The thickened area at the base and on the side of depression is smooth. Blades of the pallets in the young are double-cupped, the two cups often remaining as tubes at the base of the depression in older specimens. Stalk extending only to the base of the depression (usually best seen in young specimens or cleared adult specimens when viewed with transmitted light). Valves with the posterior slope small, high and with the

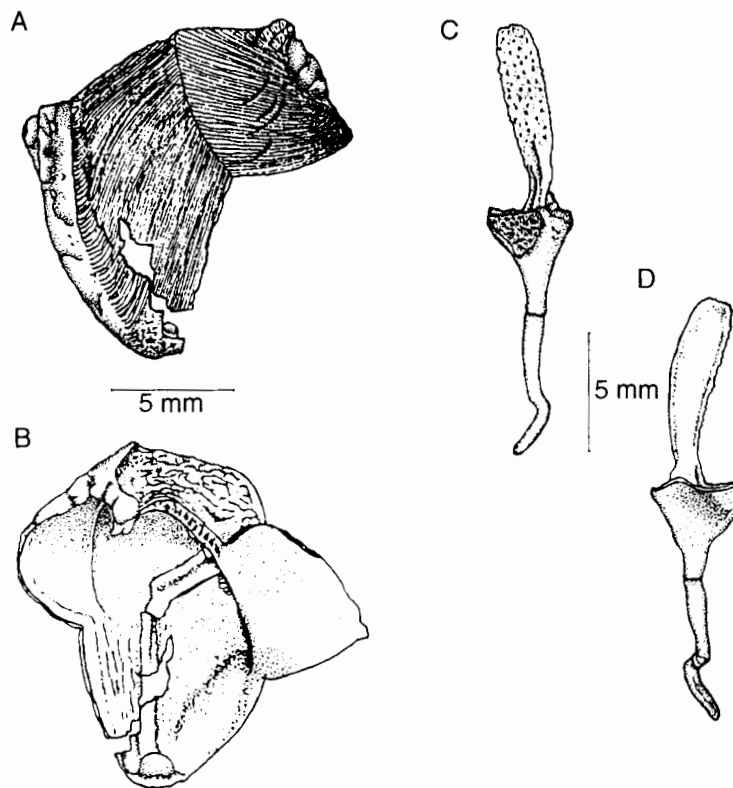


Figure 4. *Bactronophorus thoracites* (Gould, 1856). (A). Outer view of shell. (B). Inner view of shell. (C). Outer face of pallet. (D). Inner face of pallet.

ventral margin of the shelf forming a nearly right angle to the dorsoventral axis of the valves. Tube probably concamerated at the posterior end. Siphons united, gills extending without reduction from the siphons to the mouth (Turner 1966).

Teredora princessae Sivickis, 1928

MATERIAL EXAMINED: 3 dry pallets, exposed wood, Sangihe Talaud.

DESCRIPTION: Pallet calcareous, solid, broadly oval, with a short stalk. Blade thick at the base and thin at the distal margin, convex on the outer and concave on the inner face. V-shaped outer face of blade beginning from almost the middle and widening to the distal portion (looks like a broken sack), broadly curved, concentric growth lines in depression (Fig. 5).

Uperotus Guettard, 1770

DIAGNOSIS: Pallets oval to rectangular in outline with a heavy stalk. The basal portion of the blade nearly smooth, thickened and the distal portion with pronounced radiating ribs. Shells with the anterior and posterior slopes greatly reduced or typical in shape with the posterior slope high. Tube of all species probably concamerated at the opening. Gills extending without reduction from the siphons to the mouth (Turner 1966).

Uperotus clavus (Gmelin, 1791)

MATERIAL EXAMINED: 3 pallets were collected from exposed wood, Sangihe Talaud, dry condition.

DESCRIPTION: Pallet white, oblong distally truncated. Distal half of blade with pronounced radiating ribs to mid-point of blade.

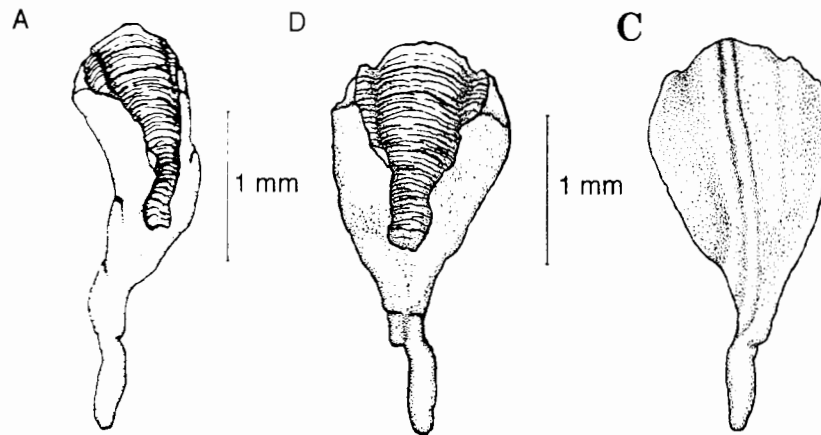


Figure 5. *Teredora princessae* Sivickis, 1928. (A). Side view of pallet. (B). Outer face of pallet. (C). Inner face of pallet.

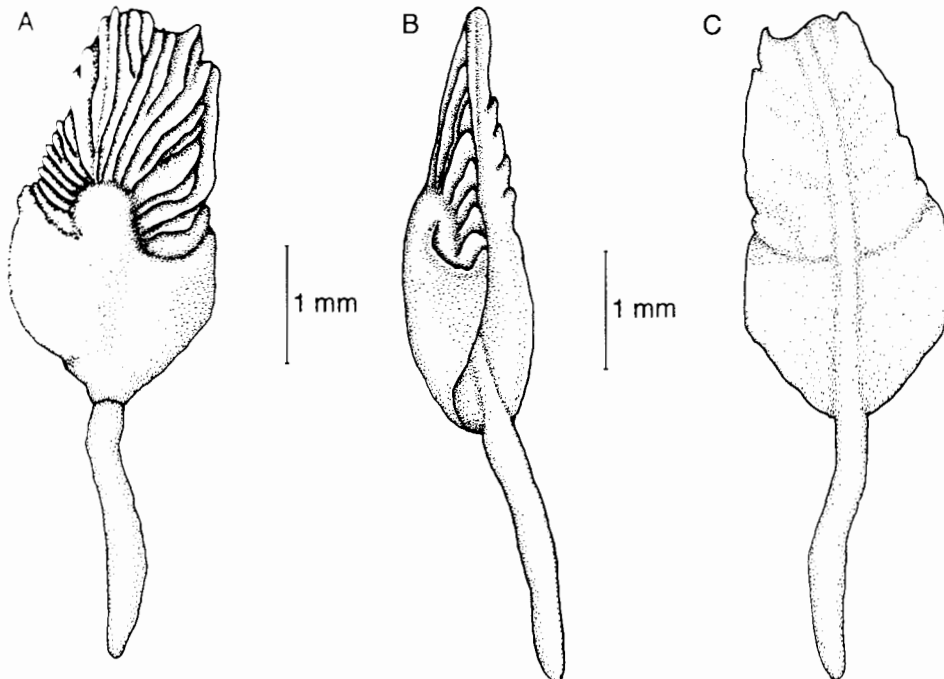


Figure 6. *Uperotus clavus* (Gmelin, 1791). (A). Outer face of pallet. (B). Side view of pallet. (C). Inner face of pallet.

The outer face of blade convex, inner face concave. Without periostracum (Fig. 6).

Teredo Linneaus, 1758

DIAGNOSIS: Pallets small, broadly oval to elongate, usually slightly to deeply cupped, cup divided or not, distal margin of the in-

ner face straight, rounded, V- or U-shaped. Periostracum covering the distal half of the blade but not extending beyond the calcareous portion. Pallets variable in shape, but with the blade always in one piece, usually with a small cup. Periostracum usually thin and closely adhering to the calcareous por-

tion, but if extending beyond the calcareous portion as a border, it is never a cap as in *Lyrodus*. Blade usually sheathing the stalk for a short distance, the stalk varying in length but solid. The shells cannot be distinguished from those of *Lyrodus* and *Bankia*. The siphons are long and separate. The young are retained within the female until the veliger stage.

The genus *Teredo* is found throughout the world usually in marine condition, though a few species are found in brackish water. This is the largest and most variable genus in the family (Turner 1966).

Teredo furcifera von Martens, 1894

MATERIAL EXAMINED: A total of 34 pairs of pallets from panels at Likupang (5 pairs in surface, 29 in 1.5 m depth), and 26 pallets from exposed wood at Tongkeina and Sangihe Talaud. Only part of the pallets were preserved.

DESCRIPTION: Pallet chalky-white and solid. The distal half of the blade covered by thin periostracum. The distal lip blade is concave, but the outer face of blade more concave than the inner one. Periostracum is golden-brown to brown. Basal portion of blade like a sleeve sheathing a stalk. The inner surface of blade is flat but convex on the outer one (Fig. 7).

Teredo fulleri Clapp, 1924

MATERIAL EXAMINED: 19 pairs of pallets from panels, Likupang; 4 in surface panel, 15 in 1.5 m depth, and 18 pallets from exposed wood at Likupang and Sangihe Talaud, including 7 pallets from the pier.

DESCRIPTION: Milk-white blade with short gap dividing the distal portion of outer surface of blade. Golden brown periostracum like a thin band surrounding distal lip portion of blade. The base of blade slightly wider, abruptly narrowing where it is connected with stalk. Stalk is translucent-white (Fig. 8).

Teredo portoricensis Clapp, 1924

MATERIAL EXAMINED: A total of 37 pairs of pallets from panels at Likupang and Kalasey (23 pairs in 1.5 m depth at Likupang, 14 pairs in 5 m depth at

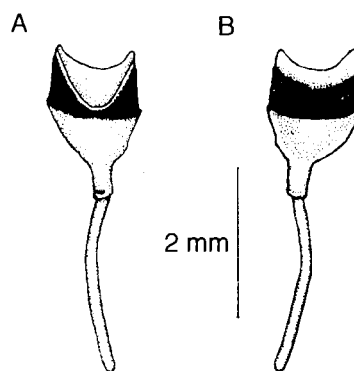


Figure 7. *Teredo furcifera* von Martens, 1894. (A). Outer face of pallet. (B). Inner face of pallet.

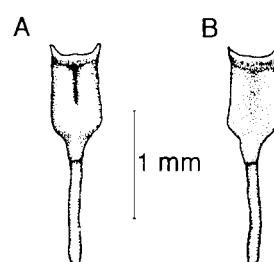


Figure 8. *Teredo fulleri* Clapp, 1924. (A). Outer face of pallet. (B). Inner face of pallet.

Kalasey), and 2 pairs of pallets from the pier.

DESCRIPTION: Thin periostracum covers the distal, outer half of the blade. Periostracum relatively thick, band-like surrounding the distal lip portion of blade on the inner side. Blade "V" shaped distally, clear-white, the inner surface more flat than the outer. Stalk is translucent-white (Fig. 9).

Teredo bartschi Clapp, 1923

MATERIAL EXAMINED: Only one pair of pallets was taken from 5 m depth panel, Likupang.

DESCRIPTION: Blade wide. Periostracum covering mid-portion and pass over the distal portion of blade, golden-brown, thin and transparent. The distal half of the inner surface of the pallet has a broad V-shaped cleft (Fig. 10).

Teredo clappi Bartsch, 1923

MATERIAL EXAMINED: 14 pairs of pallets from

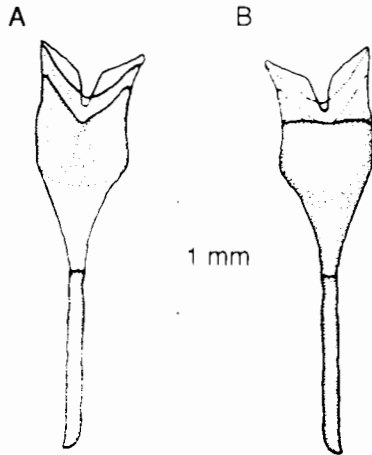


Figure 9. *Teredo portoricensis* Clapp, 1924. (A). Inner face of pallet. (B). Outer face of pallet.

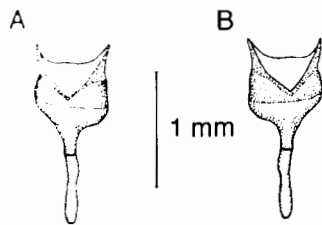


Figure 10. *Teredo bartschi* Clapp, 1923. (A). Outer face of pallet. (B). Inner face of pallet

panel in 5 m depth at Kalasey, and 8 pallets from exposed wood, Tongkeina and Sangihe Talaud.

DESCRIPTION: Wide cup-shaped, slightly asymmetric blade with dark-brown band on inner surface. Thin periostracum covering distal lip portion of blade, brown in colour. Blade clear-white. Stalk translucent white (Fig. 11).

Teredo johnsoni Clapp, 1924

MATERIAL EXAMINED: 5 pairs of pallets from 5 m depth panel, Kalasey.

DESCRIPTION: Distal portion of blade has a short cleft dividing it into two cups. Brown lines surround the distal portions. The inner surface more flat than the outer. Blade white. Stalk white, translucent (Fig. 12).

Teredo mindanensis Bartsch, 1923

MATERIAL EXAMINED: 10 specimens, exposed

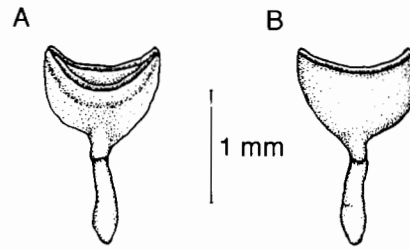


Figure 11. *Teredo clappi* Bartsch, 1923. (A). Inner face of pallet. (B). Outer face of pallet.

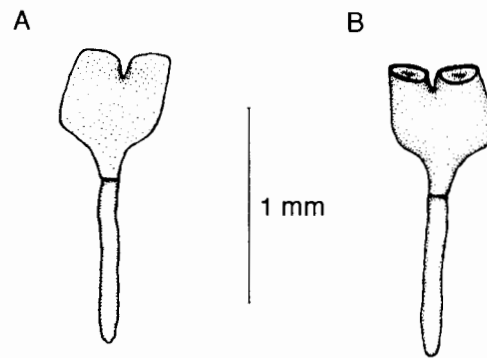


Figure 12. *Teredo johnsoni* Clapp, 1924. (A). Inner face of pallet. (B). Outer face of pallet.

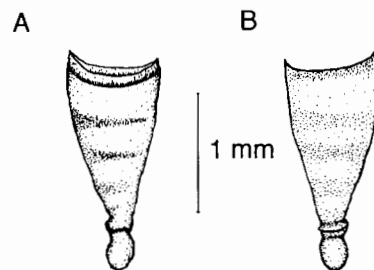


Figure 13. *Teredo mindanensis* Bartsch, 1923. (A). Outer face of pallet. (B). Inner face of pallet.

wood, Likupang.

DESCRIPTION: Blade elongated triangular. Thin, band-shaped periostracum on the distal lip on the outer surface. Stalk very short, approaching spherical outline; ring-like attachment to blade. The outer surface convex; the inner surface flat (Fig. 13).

Lyrodus Gould, 1870

DIAGNOSIS: Pallets with a calcareous base.

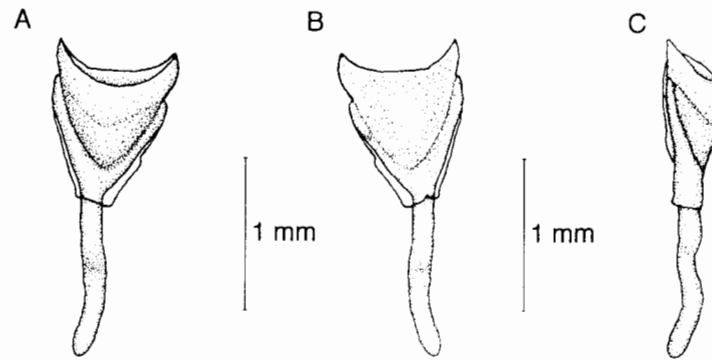


Figure 14. *Lyrodus massa* (Lamy, 1923). (A). Outer face of pallet. (B). Inner face of pallet. (C). Side view of pallet.

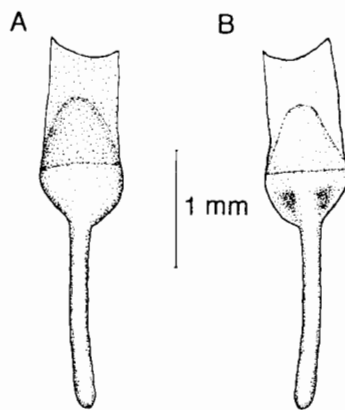


Figure 15. *Lyrodus pedicellatus* (Quatrefages, 1894) (A). Outer face of pallet. (B). Inner face of pallet.

Distal half of blade composed of a brown to nearly black periostracal cap which overlaps the calcareous basal portion, or with a periostracal cup inserted in a basal, mainly calcareous one (*Lyrodus massa* only). The young are brooded (Turner 1966).

Lyrodus massa (Lamy, 1923)

MATERIAL EXAMINED: A total of 5 pairs of pallets from panels in Likupang and Kalasey (3 pairs in 1.5 m depth, Likupang and Kalasey; 2 pairs in 5 m depth, Kalasey), 69 pallets from exposed wood Tongkeina, Poopoh, Kora-kora, and 39 pallets from the pier in Likupang.

DESCRIPTION: Blade broadly triangular. Periostracum V-shaped, distally thick, but

thin, golden-yellow on the basal cup. The stalk is bent.

Lyrodus pedicellatus (Quatrefages, 1849)

MATERIAL EXAMINED: A total of 55 pairs of pallets from panels (6 pairs in 1.5 m depth, 17 pairs in 5 m depth, Likupang; 13 pairs in 1.5 m depth, 19 pairs in 5 m depth, Kalasey); 31 pallets from exposed wood in Kora-kora, and the pier in Likupang.

DESCRIPTION: Blade oblong, widest at the base. Periostracum thicker on outer side than inner side, extends from base to distal part of blade, golden-brown to brown in colour. Pallet white to grayish-white. The outer surface of blade convex, the inner somewhat concave. Stalk as long as the blade (Fig. 15).

Spathoteredo Moll, 1928

DIAGNOSIS: Pallets more or less rectangular in outline, with a pustulose, calcareous incrustation at the distal end, and a dark band of periostracum at the mid-portion. Stalk extending through the blade (best seen in cleared specimens viewed with transmitted light). Segments of the blade very closely packed, the brown periostracum covering them extending laterally as awns, particularly in young specimens. Valves similar to those in *Teredo*. The siphons (in preserved specimens) short, united for about half their length (Turner 1966).

Spathoteredo obtusa (Sivickis, 1928)

MATERIAL EXAMINED: 9 pairs of pallets from

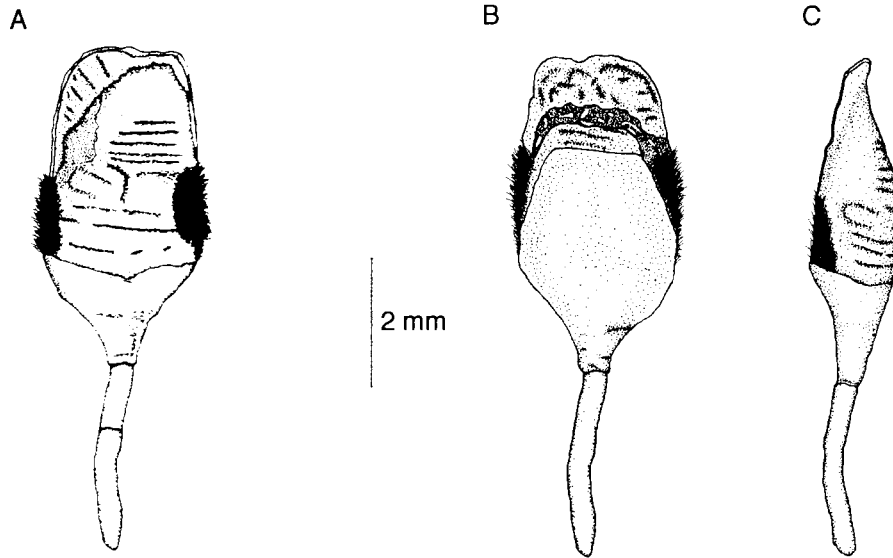


Figure 16. *Spathoteredo obtusa* (Sivickis, 1928). (A). Outer face of pallet. (B). Inner face of pallet. (C). Side view of pallet.

surface panel, Likupang. 170 pallets from Likupang, Kalasey, Poopoh, Tongkeina and Sangihe Talaud, including 47 pallets from the pier.

DESCRIPTION: Blade oblong, white-greyish, distal half with dark wrinkles; incrustation on the inner surface. Periostracum thin on the distal half of the outer side of blade, thickened, awn-like on the side of the blade, golden-brown in colour. Stalk much shorter than blade, white to greyish-white (Fig. 16, wet preparation).

Nausitora Wright, 1864

DIAGNOSIS: Pallets elongate, composed of closely packed and fused, cone-like elements built upon a central stalk. Periostracal covering often extending as awns on the basal portion of the blade, particularly in young specimens. Distal portion of the blade of many and perhaps all species with a papillose, calcareous covering which may be worn off in old specimens. Valves large. Siphons short, united for at least half their length (Turner 1966).

Nausitora dunlopei Wright, 1864

MATERIAL EXAMINED: 3 dry pallets from ex-

posed wood in Poopoh; 2 pallets, Kalasey and 2 pallets, Likupang.

DESCRIPTION: Blade elongate, diamond-shaped, distally truncated, symmetric, calcareous segments fused, colour white. Distal half with periostracum extending as awns along lateral outer surface of blade. Slender stalk, shorter than blade (Fig. 17).

Bankia Gray, 1842

DIAGNOSIS: Pallets greatly elongate, blade composed of numerous cone-like segments on a central stalk, cones separate and easily removed from the stalk, particularly in dried specimens. Cones with 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 laterally as awns. Siphons fairly long and separated. Young retained within the parent (Turner 1966).

Bankia australis Calman, 1920

MATERIAL EXAMINED: 17 pallets from exposed wood at Likupang and Tongkeina. A total of 6 pairs of pallets from panels (1 pair, surface panel,

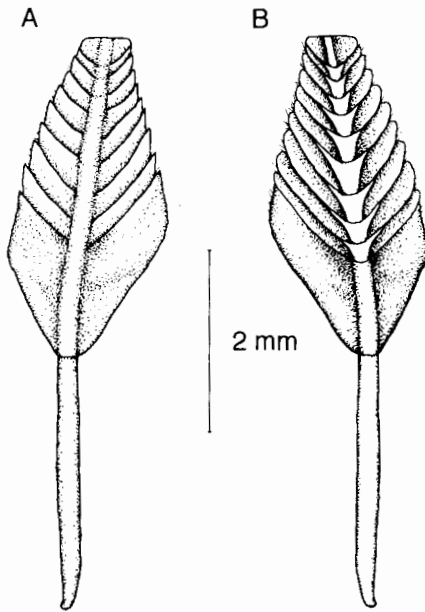


Figure 17. *Nausitora dunlopei* Wright, 1864. (A). Inner face of pallet. (B). Outer face of pallet.

Likupang, 5 pairs in 1.5 m depth, Kalasey).

DESCRIPTION: Blade oblong, individual segments stacked, cone-like, chalky white. Periostracum around the distal segment, awn-like, transparent. Stalk longer than blade, white (Fig. 18).

Bankia carinata (Gray, 1827)

MATERIAL EXAMINED: 7 pallets from exposed wooden at Kalasey.

DESCRIPTION: Blade long, cone-like, individual segments (cones) closely stacked. Periostracum transparent around distal end of each segment, band-like and smooth. Blade white. Stalk shorter than blade, transparent, outer surface convex, inner surface flat (Fig. 19).

Bankia destructa Clench & Turner, 1946

MATERIAL EXAMINED: 10 pairs of pallets were collected from 5 m depth panel. Likupang.

DESCRIPTION: Blade long, vermiform, individual segments cone-shaped, overlapping. Periostracum widened over distal portion of each segment, transparent, coarsely serrated on the outer surface, somewhat finer serrated on the inner. Blade white. Stalk much shorter than blade, white, translucent (Fig. 20).

Bankia bipalmulata (Lamarck, 1801)

MATERIAL EXAMINED: A total of 115 pairs of pallets from panels at Likupang and Kalasey (3 pairs

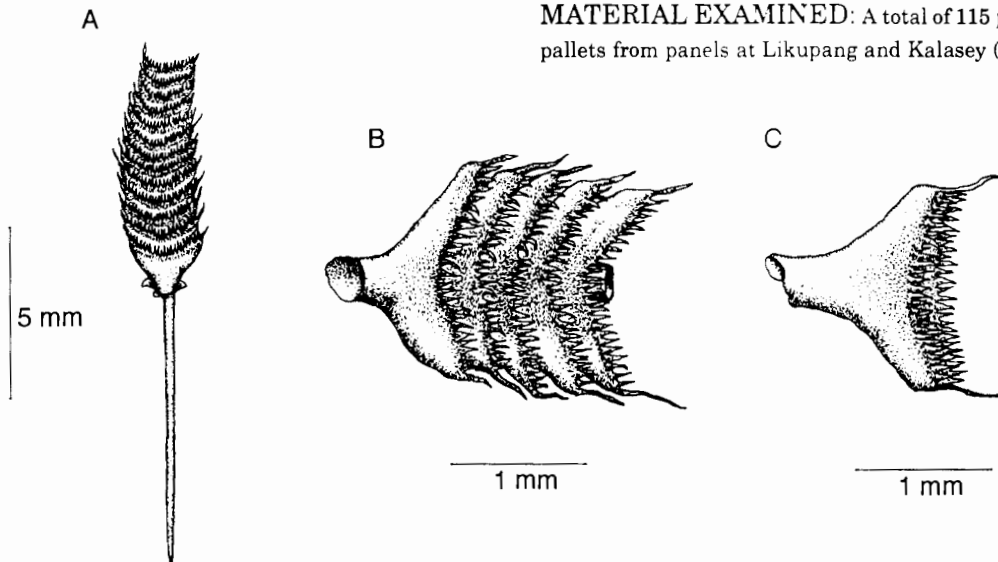


Figure 18. *Bankia australis* Calman, 1920. (A). Outer face of pallet. (B). Inner face of enlarged cones. (C). Enlargement of a single cone.

in 1.5 m depth, 21 pairs in 5 m depth. Likupang; 91 pairs in 5 m depth, Kalasey.

DESCRIPTION: Blade oblong, stacks of separated, non-overlapping cones. Periostracum coarsely serrated on margin of inner face of individual cones, laterally drawn into horn-like projections, the outer face smooth, band-like, colour golden-brown to brown. Distal cone concave but more concave on the outer face than the inner. Slen-

der stalk, slightly longer than blade. Pallet greyish white to white (Fig. 21).

DISCUSSION

Teredo furcifera and *Teredo portoricensis* were the common species penetrating panels floating on the sea surface. *Bankia bipalmulata* dominated on the bottom. *Spathoteredo obtusa* and *Lyrodus massa* were common in the exposed wood. *Uperotus clavus* and *Teredora princessae* were found as dry pallets only which may indicate that they were not coastal water species.

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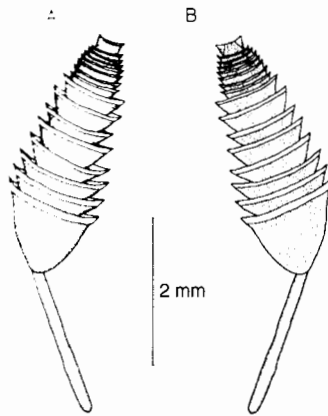


Figure 19. *Bankia carinata* (Gray, 1827). (A). Outer face of pallet. (B). Inner face of pallet.

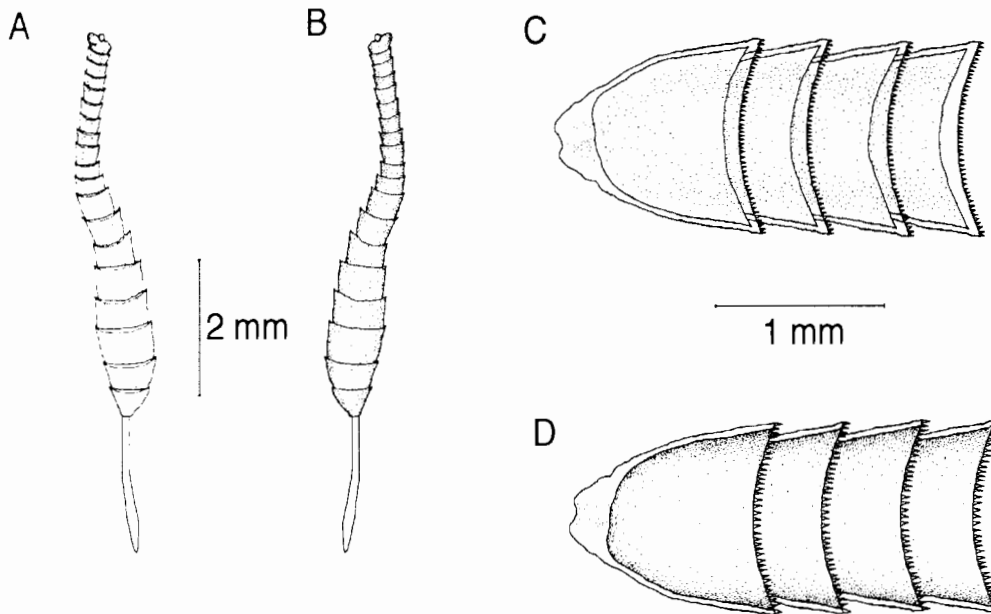


Figure 20. *Bankia destructa* Clench & Turner, 1946. (A). Inner face of pallet. (B). Outer face of pallet. (C). inner view of enlarged cones. (D). Outer view of enlarged cones.

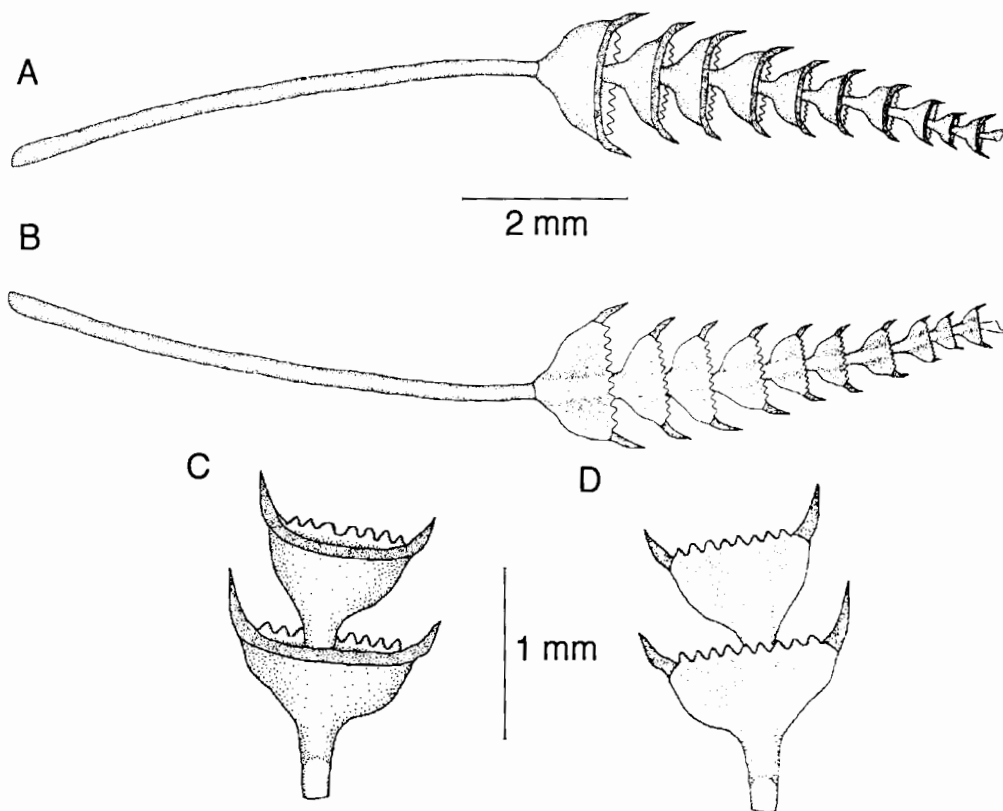


Figure 21. *Bankia bipalmulata* (Lamarck, 1801). (A). Out face of pallet. (B). Inner face of pallet. (C). Outer face of enlarged cones. (D). Inner face of enlarged cones.

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