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NOTES ON GEOGRAPHIC DISTRIBUTION

Interesting shipworm (Mollusca: Bivalvia: Teredinidae) records from India

Rao M. V. *, Pachu A. V. and Balaji M.

Wood Biodegradation Centre (Marine), Institute of Wood Science and Technology via Yoga Village, Beach Road, A. U. Post, Visakhapatnam-530 003, A.P., India.
* Corresponding author. E-mail: *mvrao@icfre.org*

ABSTRACT: In a survey on the occurrence of marine wood boring organisms at Chippada-Rambilli, Visakhapatnam-Bhimunipatnam and Soralgondi-Nachugunta coastal stretches along Bay of Bengal on the east coast of India, a good assemblage of wood borers, especially teredinids were collected. Among these samples, five species of teredinids, namely, *Uperotus panamensis* (Bartsch), *U. lieberkindi* (Roch), *Teredora malleolus* (Turton), *Teredo poculifer* Iredale and *Nototeredo norvagica* (Spengler) are new records to India; three species, namely, *Teredo mindanensis* Bartsch, *T. portoricensis* Clapp and *T. somersi* Clapp new to the mainland and one species, namely, *Teredothyra matocotana* (Bartsch) new to the east coast. Systematic details of these nine teredinid taxa are presented in this communication.

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Information on the occurrence and distribution of marine wood borers in Indian waters relative to the country's vast coastal stretch is far from satisfactory (Rao et al. 2008). Hence, efforts have been renewed to generate data from under explored areas, particularly along the east coast. During a few such attempts at Chippada-Rambilli, Visakhapatnam-Bhimunipatnam and Soralgondi-Nachugunta coastal stretches along Bay of Bengal (Figure 1), a good assemblage of wood borers were recorded (Rao et al. 2008). These collections were based on pallets retrieved from destroyed built-up wooden canoes, 'Masula' (stitched plank-built), boats, mangrove stumps and drift wood as the animals had dried out much before sampling. In the absence of other choices, resorting to approach of this kind to decipher scientific facts, especially about teredinids is common (Cragg et al. 2009; Borges et al. 2011). Specimens of all these species were preserved in Wood Biodegradation Centre (Marine) [WBCMM] of Institute of Wood Science and Technology at Visakhapatnam. During these collections, 3 sphaeromatids (*Sphaeroma terebrans* Bate, *S. annandalei* Stebbing, *S. a.* var. *travencorensis* Pillai), 4 pholadids (*Lignopholas fluminalis* (Blanford), *Martesia striata* (Linnaeus), *M. fragilis* Verrill & Bush, *M. nairi* Turner & Santhakumaran) and 45 teredinids (*Bactronophorous thoracites* (Gould), *Teredothyra matocotana* (Bartsch), *T. excavata* (Jeffreys), *T. smithi* (Bartsch), *Lyrodus massa* (Lamy), *L. affinis* (Deshayes), *L. pedicellatus* (Quatrefages), *L. bipartitus* (Jeffreys), *L. singaporeana* Roch, *Uperotus clavus* (Gmelin), *U. rehderi* (Nair), *U. panamensis* (Bartsch), *U. lieberkindi* (Roch), *Teredora malleolus* (Turton), *T. palauensis* (Edmondson), *T. princesae* (Sivickis), *Psiloteredo senegalensis* (Blainville), *Dicyathifer manni* (Wright), *Teredo poculifer* Iredale, *T. parksi* Bartsch, *T. furcifera* von Martens, *T. bartschi* Clapp, *T. navalis* Linnaeus, *T. triangularis* Edmondson, *T. mindanensis* Bartsch, *T. fulleri* Clapp, *T. portoricensis* Clapp, *T. clappi* Bartsch, *T. somersi* Clapp, *T. indomalaiica* Roch, *Nototeredo norvagica* (Spengler), *N. edax* (Hedley), *Nausitora fusticula* (Jeffreys), *N. dunlopei* Wright, *Bankia carinata* (Gray), *B. brevis* (Deshayes), *B. campanellata* Moll & Roch, *B. bipalmulata* (Lamarck), *B. gracilis* Moll, *B. philippinensis* Bartsch, *B. destructa* Clench, *B. fimbriatula* Moll & Roch, *B. australis* (Calman), *B. bipennata* (Turton), *B. nordi* Moll) were obtained. Among these, five species new to the country, three species new to the mainland and one species new to the east coast are being reported in this communication (apart some new records of *Bankia* spp. that need wet specimens for further examination and confirmation) and their systematic details presented following classification of Turner (1966; 1971) to diagnose the specimens. Status of each species was arrived at based on the marine ecoregions recognized by Spalding et al. (2007).

NEW RECORDS TO INDIA

1. *Uperotus panamensis* (Bartsch, 1922) (Figure 2)

Original name: *Teredo* (*Teredora*) *panamensis* Bartsch 1922: 34, figs. 27: 3-4, 35: 2

Distinctive Characters: Pallet thin, leaf like; blade entirely calcareous, broadly oval, convex on dorsal side, concave on ventral side, more or less rounded both at distal and proximal ends, proximal end tapering, longer than wide, thumbnail depression at dorsal distal half without lobe; stalk shorter than blade, stout and rounded proximally.

Material examined: WBCMM-35, 1 pallet from 'Masula', Kapula uppada, 17°50′37″ N, 83°24′39″ E, M V Rao and M Balaji, 2004; WBCMM-133, 3 pallets from drift wood, Chippada-Rambilli stretch, 17°28′00″ N, 82°59′00″ E – 17°28′00″ N, 82°58′41″ E, M V Rao, 2005.

Measurements: Total length-3.40mm, Blade length-

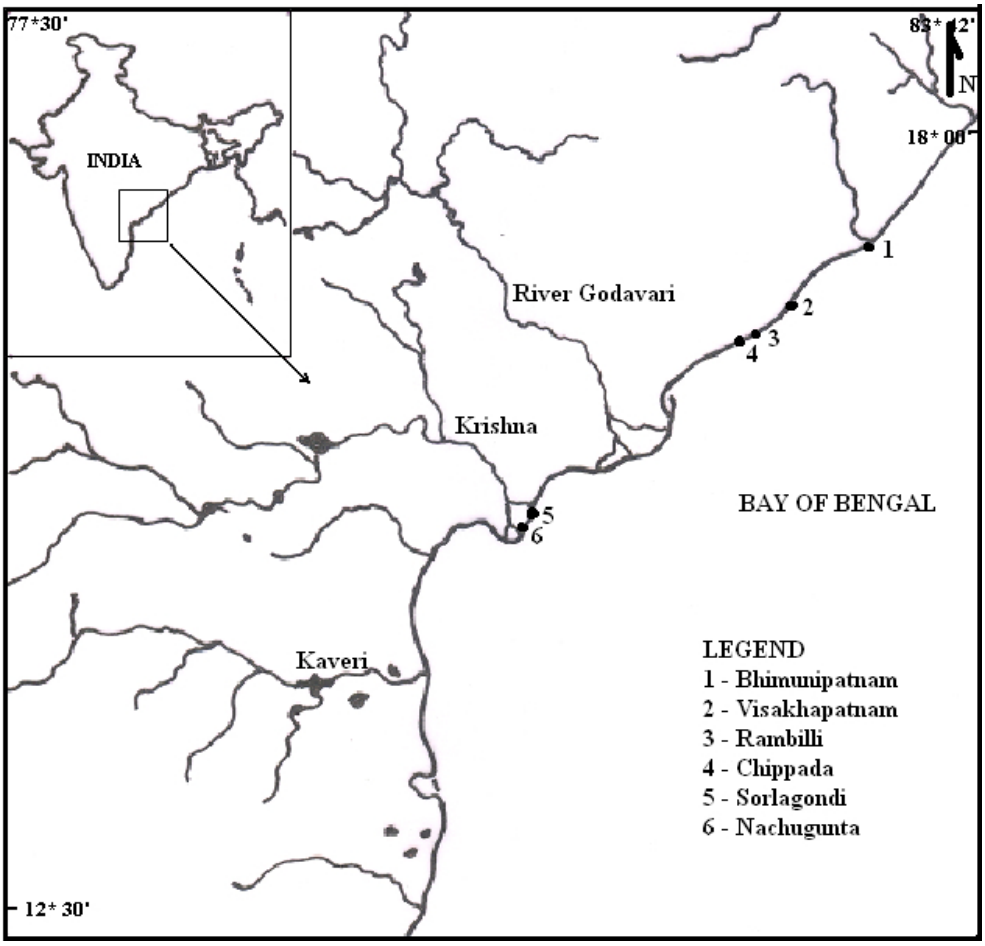


Figure 1. Localities surveyed for marine wood borer fauna.

2.10mm, Blade width-1.50mm and Stalk length-1.30mm.

Distribution: Panama (Bartsch 1922). Atlantic, Tropical (Turner 1971).

Status: Since this species is known so far from "Tropical Atlantic" biogeographical realm alone, present status of the species with regard to India might be cryptic.

Remarks: Pallets of this species can be distinguished from *U. lieberkindi* by their shape, lack of round lobe at mid dorsal portion of blade and non-converging ribs on dorsal distal half of blade. Other wood borers found occurring along with this species were *M. striata*, *T. mindanensis*, *T. princesae* and *B. carinata*.

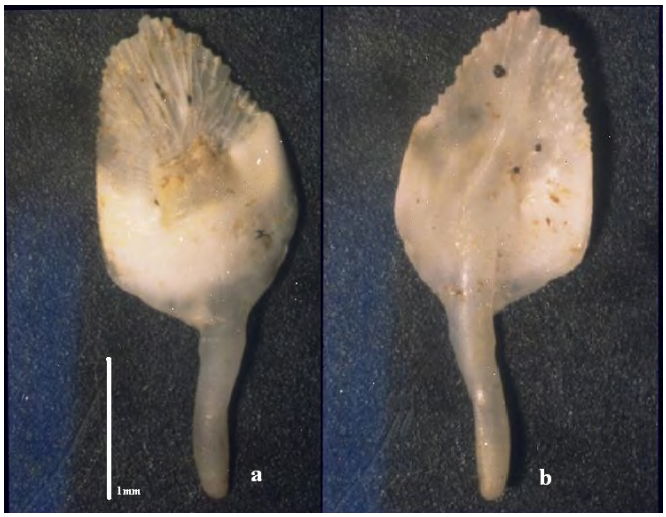


Figure 2. *Uperotus panamensis*, pallet, A. Dorsal view, B. Ventral view.

2. *Uperotus lieberkindi* (Roch, 1931) (Figure 3)

Original name: *Teredo lieberkindi* Roch 1931: 15, fig. 2-5

Distinctive characters: Pallet thin, leaf-like; blade entirely calcareous, broadly oval to rectangular, basal half thickened, convex on dorsal side, concave on ventral side, longer than wide, lateral margins slightly folded ventrally, distal margin flat or slightly depressed, proximal margin broadly round; stalk as long as or longer than blade, stout, club-like, tapering distally, rounded proximally and running half-way through blade.

Material examined: WBCMM-21, 1 pallet from drift wood, Rishikonda, 17°46′53″ N, 83°23′08″ E, M V Rao and M Balaji, 2004; WBCMM-54, 1 pallet, Bhimunipatnam, 17°53′02″ N, 83°27′07″ E, M V Rao and M Balaji, 2004; WBCMM-86, 1 pallet from mangrove stump, Sorlagondi, 15°49′30″ N, 80°58′53″ E, MVR and AVP; WBCMM-134, 13 pallets from drift wood, Chippada-Rambilli stretch, 17°28′00″ N, 82°59′00″ E-17°28′00″ N, 82°58′41″ E, M V Rao, 2005.

Measurements: Total length-1.4 to 2.0mm (1.70mm), Blade length-1.0mm, Blade width-0.9 to 1.1mm (1.00mm) and Stalk length-1.0mm.

Distribution: Africa (Roch 1931) and Atlantic, tropical (Turner 1971).

Status: Since this species is known so far from "Tropical Atlantic" realm alone, present status of the species with regard to India might be cryptic.

Remarks: Pallets of this species can be distinguished from *U. panamensis* by their shape, presence of a lobe at mid dorsal portion and converging ribs on dorsal distal half

of blade. Turner (1971) opined that probably this species is an ecological variant of *U. panamensis*. A close examination, however, of the pallets of the two species points out that they are distinct from one another. Other wood borers found occurring along with this species were *M. striata*, *M. fragilis*, *T. princesae*, *U. panamensis* and *B. carinata*.

3. *Teredora malleolus* (Turton, 1822) Figure 4

Synonyms:

Teredo thomsonii Tryon 1863: 280, figs. 2: 3-5

Teredora malleolata 'Turton' Locard 1886: 364

Teredora maleolus 'Turton' Clessin 1893: 69

Distinctive characters: Pallet broadly oval, thin, leaf-like; blade (of adult specimens) entirely calcareous, shiny, wedge-like, distal end rounded, proximal end conical; dorsal face of blade with thumb-like depression, two finger-like projections arising from the depression and marked concentric growth lines; ventral face almost flat; stalk usually small and straight.

Material examined: WBCMM-36, 24 pallets from 'Masula', Kapula uppada, 17°50′37″ N, 83°24′39″ E, M V Rao and M Balaji, 2004; WBCMM-135, 5 pallets from drift wood, Chippada-Rambilli stretch, 17°28′00″ N, 82°59′00″ E-17°28′00″ N, 82°58′41″ E, M V Rao, 2005.

Measurements: Total length-1.2 to 2.9 (2.06)mm, Blade length-0.6 to 1.8 (1.19)mm, Blade width-0.3 to 1.0 (0.61) mm and Stalk length-0.6 to 1.1 (0.87)mm.

Distribution: England (Turton 1822), Massachusetts (Tryon 1863), France (Locard 1886) and Ivory Coast (Rancurel 1955). Atlantic, temperate to tropical (Turner 1971).

Status: Since this species is known so far from "Tropical Atlantic" and "Temperate Northern Atlantic" realms alone, present status of the species with regard to India might be cryptic.

Remarks: Pallets of this species exhibit wide variation as they grow. While young pallets appear like double tubes, adults have broad blade with thumbnail-like depression, finger-like projections, but old ones show only concentric growth lines and no finger-like tubes (Rancurel 1955, Turner 1966). The pallets obtained during the present collection represented these different growth stages. Other wood borers found occurring along with this species were *T. princesae*, *N. norvagica*, *L. bipartitus*, *L. pedicellatus* and *U. panamensis*.

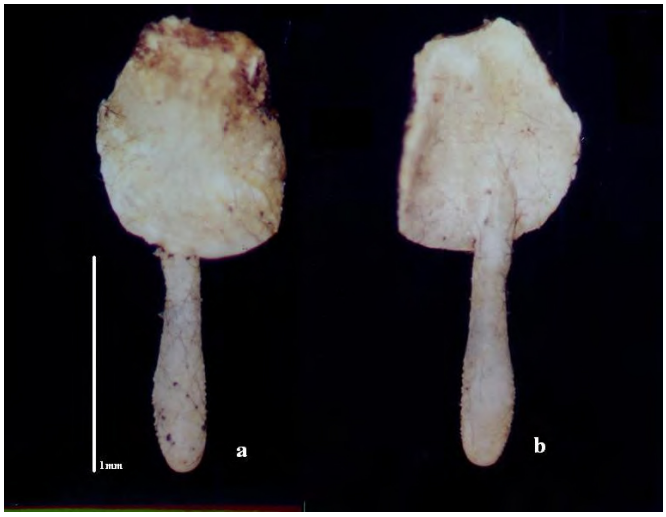


Figure 3. *Uperotus lieberkindi*, pallet, A. Dorsal view, B. Ventral view.

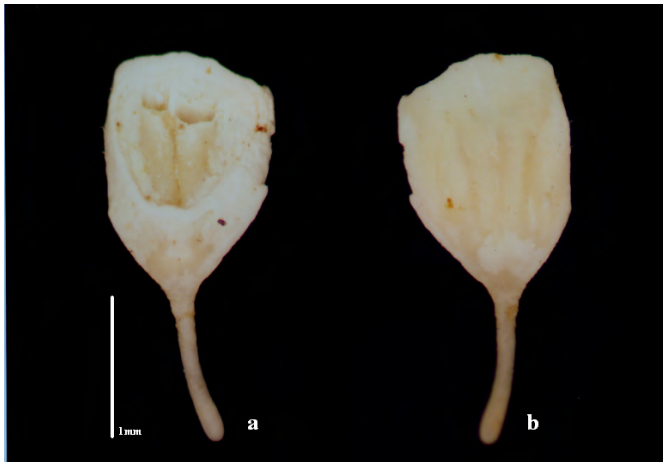


Figure 4. *Teredora malleolus*, pallet, A. Dorsal view, B. Ventral view.

4. *Teredo poculifer* Iredale 1936 (Figure 5)

Synonyms: *Teredo (Pingoteredo) poculifer* Iredale 1936: 33, figs. 1: 1-9

Distinctive characters: Pallet shovel-like stout; blade longer than wide with the widest point about midway and tapering gradually to stalk, lateral margins convex; distal margin of calcareous base slightly concave; periostracal sheath golden yellow in colour and covering the entire blade; periostracal cup large, dark banded, all around; outer and inner distal margins of blade more or less straight; stalk shorter than blade, stout, more or less straight and translucent.

Material examined: WBCMM-56, 2 pallets from mangrove drift wood, Bhimunipatnam, 17°53′02″ N, 83°27′07″ E, M. V. Rao and M. Balaji, 2004; WBCMM-105, 12 pallets from mangrove stumps, Nachugunta, 15°45′35″ N, 80°56′32″ E, MVR and AVP, 2006.

Measurements: Total length-1.9 to 2.9 (2.40)mm, Blade length-0.9mm, Blade width-0.9 to 1.0 (0.95)mm and Stalk length-1.0 to 1.5 (1.25)mm.

Distribution: Australia (Iredale 1936) and Papua New Guinea (Rayner 1979).

Status: This is perhaps a native species as the same was recorded from "Central Indo-Pacific" to "Western Indo-Pacific" realms.

Remarks: Pallets of this species can be distinguished

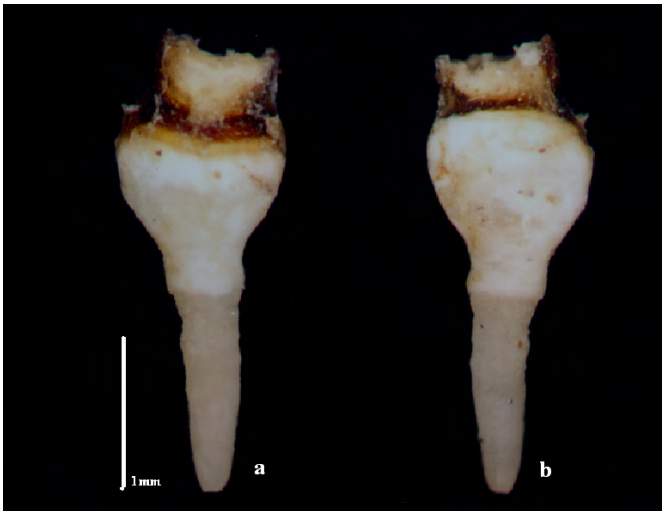


Figure 5. *Teredora poculifer*, pallet, A. Dorsal view, B. Ventral view

from *T. aegypos* Moll by their shape. Other wood borers found occurring along with this species were *B. thoracites*, *D. manni*, *T. bartschi*, *L. pedicellatus* and *Bankia* spp.

5. *Nototeredo norvagica* (Spengler, 1792) (Figure 6)
Synonyms:

Teredo norvagicus Spengler 1792: 102, figs. 2: 4-7
Teredo navalis Montagu 1803: 257
Teredo norvegica Schumacher 1817: 102, figs. 2: 4-6
Teredo nigra Blainville 1828: 267
Teredo bruguierii Delle Chiaje 1829: 28, 32, 115, figs. 54: 6, 12-13
Teredo navalis Deshayes 1839: 59, figs. 3: 1-9
Teredo senegalensis Laurent 1849: 359
Teredo fatalis Quatrefages 1849: 23, figs. 1: 1, 2: 2
Teredo deshaii Quatrefages 1849: 26
Teredo divaricata 'Deshayes' Fischer 1856: 137, figs. 7: 7-9
Teredo utriculus 'Gmelin' Hanley 1882: 541, figs. 12: 9-12

Distinctive characters: Pallet large, leaf-like, oblong, completely calcareous, dorsally convex, ventrally concave, distally broad, proximally tapering; segments fused, indistinct; blade completely covered by periostracal sheath, distal half of dorsal side scaly with a small thumb nail depression towards apex, proximal half smooth with laterally radiating ribs originating from the middle; stalk long running almost throughout length of blade but short, delicate and blunt below.

Material examined: WBCMM-43, 3 pallets from 'Masula', Kapula uppada, 17°50′37″ N, 83°24′39″ E, M V Rao and M Balaji, 2004; WBCMM-64, 9 pallets from mangrove drift wood, Bhimunipatnam, 17°53′02″ N, 83°27′07″ E, M V Rao and M Balaji, 2004; WBCMM-79, 18 pallets from canoes, Sorlagondi, 15°49′30″ N, 80°58′53″ E, MVR and AVP.

Measurements: Total length-2.10 to 10.0 (4.80)mm, Blade length-1.90 to 7.50 (3.53)mm, Blade width-1.00 to 4.00 (2.21)mm and Stalk length-0.20 to 2.50 (1.27)mm.

Distribution: Norway, Scotland (Spengler 1792), England (Montagu 1803), Denmark (Schumacher 1817), Italy (Delle St. Chiaje 1829), France (Laurent 1849), Algeria (Quatrefages 1849), Sicily, now Sicilia (Fischer 1856), Ukraine: Crimea (Moll 1941) and Western Atlantic (Rosenberg 2009). Eastern Atlantic, from Norway to the Mediterranean (Turner 1971).

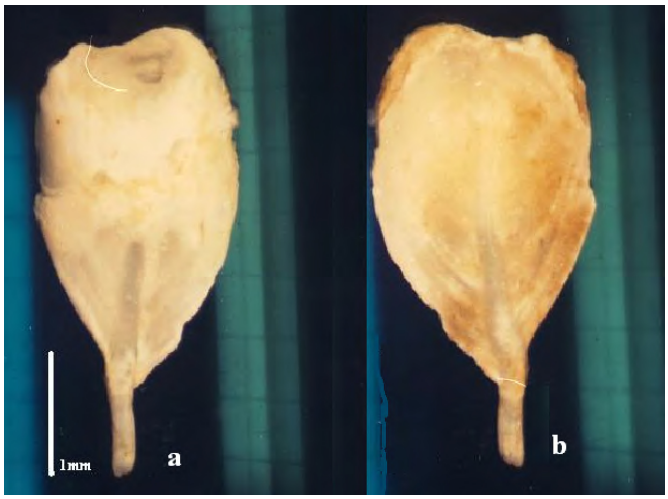


Figure 6. *Nototeredo norvagica*, pallet, A. Dorsal view, B. Ventral view .

Status: Since this species was reported so far from "Temperate Northern Atlantic" to "Tropical Atlantic" realms, the same might be a cryptic species to India.

Remarks: Pallets of this species can be easily distinguished from *N. knoxi* (Bartsch) and *N. edax* from the broad distal and tapering proximal ends coupled with prominent ribs radiating from the stalk. Other wood borers found occurring along with this species were *T. matocotana*, *T. excavata*, *Teredo clappi*, *L. pedicellatus* and *B. carinata*.

New records to Indian mainland

1. *Teredo mindanensis* Bartsch 1923 (Figure 7)
Synonyms:

Teredo (Coeloteredo) mindanensis Bartsch 1923: 99
Teredo (Coeloteredo) mindanensis Bartsch 1927: 539, figs. 53: 10, 12; 56: 6; 60: 4, 8, 12
(?) *Teredo (Coeloteredo) bayeri* Roch 1955: 130, figs. 4a-g

Distinctive characters: Pallet small; blade inverted cone-like, hallow to stalk, slightly distorted to one side, slightly enveloping stalk, outer and inner distal margins concave; periostracum thin golden yellow, completely covering blade, slightly extending beyond calcareous base and with a dark distal band; stalk short (3/4 of blade), irregular, stout and swollen (knobby) at proximal end..

Material examined: WBCMM-24, 2 pallets from driftwood, Rishikonda, 17°46′53″ N, 83°23′08″ E, M V Rao and M Balaji, 2004; WBCMM-42, 4 pallets from driftwood, Kapula uppada, 17°50′37″ N, 83°24′39″ E, M V Rao and M Balaji, 2004; WBCMM-59, 3 pallets from mangrove driftwood, Bhimunipatnam, 17°53′02″ N, 83°27′07″ E, M V Rao and M Balaji, 2004.

Measurements: Total length-1.0 to 2.5 (1.53)mm, Blade length-1.3mm, Blade width-0.7 to 1.1 (0.94)mm and Stalk length-0.1 to 1.0 (0.68)mm.

Distribution: Philippines (Bartsch 1923), Indonesia (Roch 1955), India: Lakshadweep Archipelago (Balakrishnan Nair and Dharmaraj 1983) and Western Atlantic (Rosenberg 2009). New Guinea, Java and tropical Australia (Turner 1971).

Status: As this species was recorded from "Tropical Atlantic, Western Indo-Pacific and Central Indo-Pacific" realms, the same might be also native to India.

Remarks: Pallets of this species can be readily identified

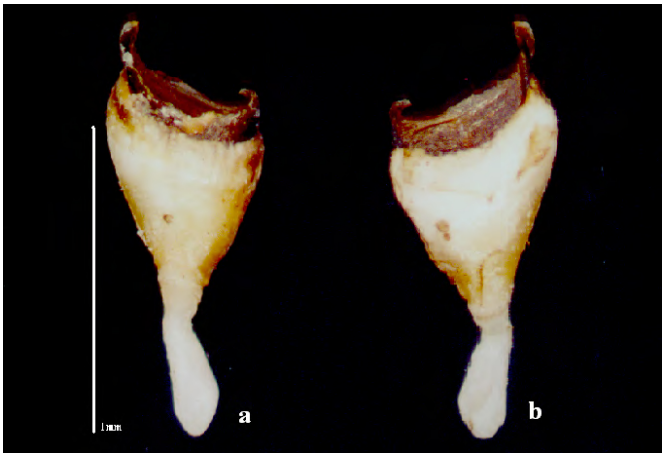


Figure 7. *Teredo mindanensis*, pallet, A. Dorsal view, B. Ventral view

from *T. triangularis* Edmondson by their conical shaped blade and stout swollen stalk. Other wood borers found occurring along with this species were *T. clappi*, *T. bartschi*, *T. fulleri* and *L. pedicellatus*.

***2. Teredo portoricensis* Clapp 1924** (Figure 8)

Synonyms: *Teredo (Teredo) portoricensis* Clapp 1924a: 2, figs. 1: 1-7

Distinctive characters: Pallet long, narrow; blade slender, long relatively narrow, widest at mid point; outer margin of blade moderately 'U' shaped, inner margin "U-V" shaped; periostracum dark brown covering entire blade and extends distally as lateral horns, calcareous portion showing through; stalk very long, irregular and round proximally.

Material examined: WBCMM-61, 1 pallet from mangrove drift wood, Bhimunipatnam, 17°53′02″ N, 83°27′07″ E, M V Ra o and M Balaji, 2004; WBCMM-89, 8 pallets from mangrove wood, Sorlagondi, 15°49′30″ N, 80°58′53″ E, MVR and AVP.

Measurements: Total length-5.6mm, Blade length-1.7mm, Blade width-0.9mm and Stalk length-3.9mm.

Distribution: Puerto Rico (Clapp 1924a) and India: Lakshadweep Archipelago (Balakrishnan Nair and Salim 1994). Western Atlantic, tropical to sub-tropical (Turner 1971).

Status: As this species was recorded from "Tropical Atlantic and Western Indo-Pacific" realms, the species might be also native to India.

Remarks: Pallets of this species be carefully distinguished from *L. pedicellatus* , *T. furcifera* and *T. parksi* by the slender nature of the pallet, shape of outer and inner margins of blade and long stalk. Other wood borers found occurring along with this species were *D. manni*, *U. lieberkindi*, *T. bartschi*, *L. pedicellatus* and *Bankia* spp.

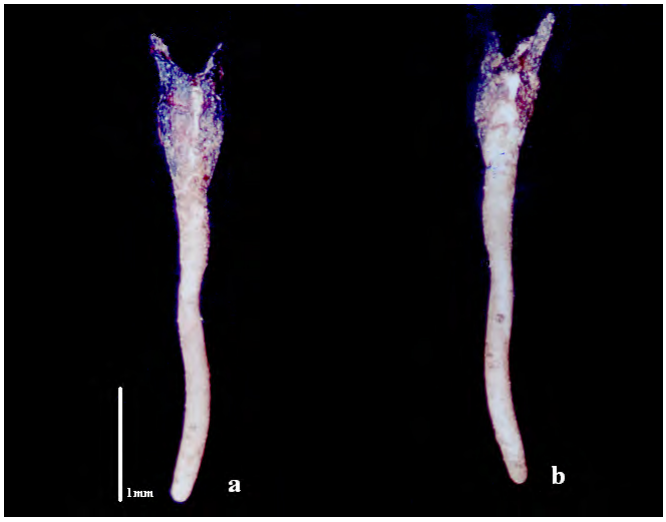


Figure 8. *Teredo portoricensis*, pallet, A. Dorsal view, B. Ventral view.

3. *Teredo somersi* Clapp 1924 (Figure 9)

Synonyms: *Teredo (Zopoteredo) somersi* Clapp 1924b: 284, figs. 2:7-12, 3: 15-16

Teredo (Teredo) radicis Moll 1937: 182

Distinctive characters: Pallet medium sized; blade nearly as wide as long, parallel sided with small distal constriction; outer margin of blade deep and concave, inner margin shallow and straight; periostracum golden yellow covering the entire blade with a dark brown distal band; stalk longer than blade, irregular, stout and blunt proximally.

Material examined: WBCMM-63, 3 pallets from mangrove drift wood, Bhimunipatnam, 17°53′02″ N, 83°27′07″ E, M V Ra o and M Balaji, 2004.

Measurements: Total length-2.3 to 2.5 (2.4)mm, Blade length-1.2 to 1.3 (1.25)mm, Blade width-1.0mm and Stalk length-1.1 to 1.2 (1.16)mm.

Distribution: Bermuda Island, Ireland (Clapp 1924b), England, South Africa (Moll 1937) and India: Lakshadweep Archipelago (Balakrishnan Nair and Dharmaraj 1983). Western Atlantic, tropical to sub-tropical (Turner 1971).

Status: As this species was recorded from "Tropical Atlantic and Western Indo-Pacific" realms, the species might be also native to India.

Remarks: Pallets of this species can be distinguished from that of *T. clappi* by their shape, concave form of outer margin of blade and short stout stalk. Periostracum partially lost in the specimens collected. Other wood borers found occurring along with this species were *N. norvagica*, *T. matocotana*, *T. excavata*, *L. pedicellatus* and *B. carinata*.

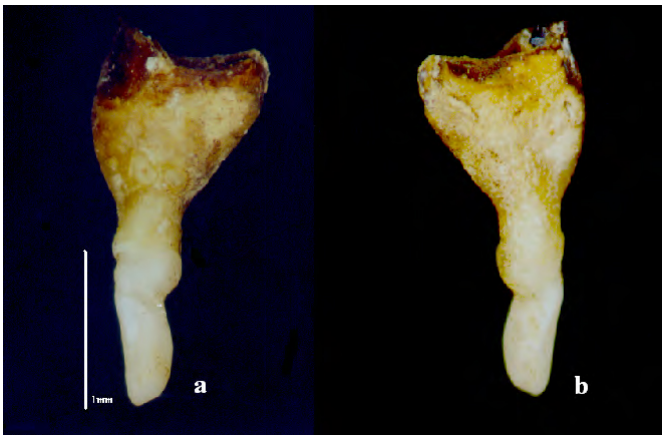


Figure 9. *Teredo somersi*, pallet, A. Dorsal view, B. Ventral view.

New records to Indian East Coast

1. *Teredothyra matocotana* (Bartsch, 1927) (Figure 10)

Synonyms:

Teredo (Ungoteredo) matocotana Bartsch 1927: 544, 545

Teredo (Ungoteredo) chamberlaini Bartsch 1927: 546, figs. 54: 12, 57: 5, 60: 9-11

Teredo (Ungoteredo) pujadana Bartsch 1927: 547, figs. 54: 8, 10; 57: 3, 60: 1-3

Teredo unguiculata Roch 1935: 264, figs. 1: 1

Distinctive characters: Pallet small, chalky white and translucent, distally narrow, proximally wide; blade wider than long, composed of basal and inner cups; inner cups hallow and medially divided; stalk delicate, short, irregular, proximally knobbed extending upto the base of inner cup.

Material examined: WBCMM-49, 5 pallets from mangrove drift wood, Bhimunipatnam, 17°53′02″ N, 83°27′07″ E, M V Rao and M Balaji, 2004.

Distribution: Philippines (Bartsch 1927), Madagascar (Roch 1935), Panama and Off Florida (Turner 1966). Probably world-wide, tropical to sub-tropical (Turner 1971).

Status: As this species was recorded from "Western Indo-Pacific and Central Indo-Pacific" realms, the same might be also native to India.

Remarks: Pallets of this species can be easily distinguished from *T. excavata* by their small size. Unluckily, all the five pallets collected were lost while washing due to their translucent nature and therefore a hand drawing made prior to this could only be included. Other wood borers found occurring along with this species were *T. clappi*, *N. norvagica*, *T. excavata*, *L. pedicellatus* and *B. carinata*.

The study indicates potential diversity of marine wood borers harboured by the tropical waters surrounding the Indian sub-continent and its islands and calls for more investigations on these economically important group of marine pests. With these records, the total number of wood borers reported from Indian waters stands at 71 (6 sphaeromatids, 9 limnorids, 12 pholadids and 53 teredinids).

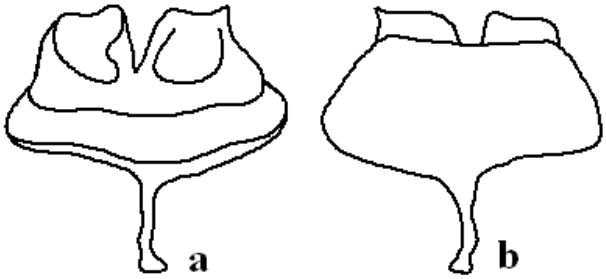


Figure 10. *Teredothyra matocotana*, pallet, dorsal and ventral views (not to scale).

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