Occasional Paper No. 356

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ZOOLOGICAL SURVEY OF INDIA

OCCASIONAL PAPER No. 356

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S.K. PATI[1]*, M.V. RAO[2] AND M. BALAJI[2]*****

[1]Zoological Survey of India, Western Regional Centre
Vidya Nagar, Sector No. 29, P.C.N.T. Post,
Rawet Road, Akurdi, Pune-411044, India
**Corresponding author, e-mail: sameer_pati@yahoo.co.in*
[2]Wood Biodegradation Centre (Marine), Institute of Wood Science and Technology,
Beach Road, via Yoga Village, Andhra University Post,
Visakhapatnam-530003, India
*e-mail: **mvrao@icfre.org; ***mbalaji@icfre.org*

Edited by
The Director, Zoological Survey of India, Kolkata

Zoological Survey of India
Kolkata

CITATION

Pati, S.K., Rao, M.V. and Balaji, M. 2014. Macrodeteriogens of wood at Visakhapatnam harbour, east coast of India. *Rec. zool. Surv. India, Occ. Paper No.*, **356** : 1-44. (Published by the Director, *Zool. Surv. India*, Kolkata)

Published : September, 2014

ISBN 978–81–8171–380–3

PRICE
India : ₹ 270/-
Foreign : $ 15; £ 10

Published at the Publication Division by the Director, Zoological Survey of India, M-Block, New Alipore, Kolkata-700 053 and printed at East India Photo Composing Centre, Kolkata-700 006.

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ZOOLOGICAL SURVEY OF INDIA
OCCASIONAL PAPER

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INTRODUCTION

Wood, due its various properties such as light weight, high strength, non-corrosiveness, non-magnetic nature and fidelity to be shaped, bent or jointed (Borges *et al*., 2009), retained status of a pristine structural material. However, wood is subjected to marine deterioration mainly due to macroscopic fouling and boring organisms, though many microscopic forms do contribute their might in hastening material deterioration. These macro- and microscopic organisms involved in deterioration processes are known as wood deteriogens.

Forms, usually animals, attached to or penetrating into hard substrata in marine environment are often vaguely referred to as foulers and borers, respectively, by neonatologists despite ample scope for coining new scientific terms specific to each context. Also, many ecologists mostly distinguish the forms that attach or drill into a wide range of substrata as epiflora/ epifauna and infauna, respectively. Thus, Taylor and Wilson (2002) nullified the inadequacy of terms to properly designate marine forms dwelling upon or in hard substrata of both natural and anthropogenic origin. According to their terminology, attaching forms are called as episclerobiont and drilling forms are referred to as endosclerobionts. Since all sedentary benthic forms attaching to natural and artificial fall into the same category (Episclerobiont), it seems reasonable to modify the above terms further to distinguish sedentary benthic forms from the so called ‘foulers’ and as well it is felt worth simplifying them by restricting the use of the term ‘biont’ to the forms that just attach to the substratum while introducing another term ‘trepan’ (means borer in Greek) to designate the forms that drill into the substratum. Similarly, it may be convenient to restrict the use of the term ‘skeleto’ to dead hard material and use ‘techno’ to define all anthropogenic material. In doing so, the prefixes or the first roots ‘epi’ and ‘endo’ can be avoided and the terms ‘episclerobiont’ and ‘endosclerobiont’ can be simplified as ‘sclerobiont’ and ‘sclerotrepan’, respectively. While so modifying the terms, no sense is felt lost as neither the old term ‘episclerobiont’ nor the new term ‘sclerobiont’ does denote the conjunction ‘attachment’ between the form and the substratum. Against this backdrop, some more terms are proposed to supplement the ones already proposed by Taylor & Wilson (2002). Detailed scheme of terminology for marine organisms found attached to or boring into a hard substratum is presented in Table-1.

Marine fouling organisms comprise several benthic fauna right from Phylum Protozoa to Chordata besides few plant components such as diatoms, seaweeds, etc. These life forms develop on a variety of substratum like hulls of ships/boats, harbour structures, coastal

Table-1 : Moderation of terminology to designate marine forms dwelling on or in hard substratum.

Nature of substratum	Nature of organism		
	Attached forms		Borers
	Any Organism	Plant/Animal	Animal
Any hard substratum	Sclerobiont	Sclerophyte Sclerozoan	Sclerotrepan
Plant	Phytobiont	Phytophyte Phytozoan	Phytotrepan
Animal	Zoobiont	Zoophyte Zoozoan	Zootrepan
Wood	Xylobiont	Xylophyte Xylozoan	Xylotrepan
Rock	Lithobiont	Lithophyte Lithozoan	Lithotrepan
Coral	Corrallobiont	Corrallophyte Corrallozoan	Corrallotrepan
Organic hard part (Live)-Shell/ Exoskeleton	Ostracobiont	Ostracophyte Ostracozoan	Ostracotrepan
Organic hard part (Dead)	Skeletobiont	Skeletophyte Skeletozoan	Skeletotrepan
Anthropogenic materials (plastic, cement, rubber, metals, etc.)	Technobiont	Technophyte Technozoan	Technotrepan

installations, etc. (Eguia and Trueba, 2007). Fouling accumulations on any marine vessel/ craft fundamentally led to frictional resistance thereby depleting propeller efficiency, reducing the vessel/craft speed and increasing manpower requirement/fuel consumption further to malfunctioning of acoustic systems, etc. (Yan and Yan, 2003). As serious pests, invasion of fouling organisms not only mounts up the economic burden several fold but also can affect local flora and fauna through proliferative and over-competitive characteristics (Anil *et al*., 2002).

In addition to the forms (foulers) that merely attach to the periphery of the wood, certain animals penetrate into the very core of the material thereby adapting to a boring mode of life within the wood. These organisms are known as 'wood borers'. Though wood boring animals cause massive monetary as well as material losses, they actually play a key role in the recycling of matter by catalyzing microlevel natural processes that convert the material back to elemental level. Wood borers as invasive species can become an additional burden to the economy of a country.

Wood, being an important and precious forest resource, needs to be conserved and utilized judiciously. Information on marine wood deteriogens will help in evolving effective control measures against biodeterioration of wood in sea water. This basic information also helps in manoeuvering biological introductions that are likely to pose environmental and economical threats to the nation. Since introduction of wood deteriogens is of serious concern to the ecological soundness of native marine ecosystems, present study on macrodeteriogens of wood (now onwards xylozoans and xylotrepans) assumes great significance and relevance.

Several studies were conducted on fouling/technobionts world over. Some of the recent works are that of Chaplygina (1999), Koçak (2007), Bastida-Zavala (2008), Montelli and Lewis (2008) and Swami and Udhayakumar (2008). Pioneering systematic works on marine wood borers/xylotrepans are credited to Krishna Pillai (1961), Turner (1966), Jones and Eltringham (1971), Turner and Santhakumaran (1989) and Cookson (1991). Besides, several past studies in India (Santhakumaran, 1994), recent works on xylotrepans belong to Tarakanadha and Satyanarayana Rao (2006), Pachu *et al*. (2008), Rao *et al*. (2008 and 2013) and Nayak *et al*. (2012). While Ganapati *et al*. (1958) and Balaji (1988) have studied on technobionts at Visakhapatnam harbour, Ganapati and Nagabhushanam (1955) and Nagabhushanam (1955 and 1960a) reported xylotrepans. Since several physical, chemical and biological changes have been taking place in Visakhapatnam harbour, a systematic study on macrodeteriogens of wood (xylozoans and xylotrepans) was conducted in order to give the latest information on these economically as well as ecologically important forms.

MATERIAL AND METHODS

Study was carried out in Visakhapatnam harbour (17°40´N and 83°16´E) (Fig. 1) at three stations, namely, Slipway Complex (SWC), Ore Berth (OB) and Marine Foreman Jetty (MFJ) by deploying wooden panels (150 × 80 × 20 mm size) in the form of vertical ladders containing 6 panels each (of which one panel lied in the intertidal zone and remaining panels were kept 0.3 meter below lowest water mark) for two years from February 2007 to January 2009. While the former two stations are located in the relatively pollution free outer harbour, the latter station is situated in the polluted inner harbour. For short-term observations, one ladder (*Bombax ceiba* test panels) was immersed at each station and retrieved after a period of one month whereas for long-term observations, twelve ladders (*Pinus roxburghii* test panels) each were deployed at each station in the beginning of each study year and removed at the end of each successive months till rescue of the last ladder.

Fouling accumulation on each panel was carefully removed, segregated into individual species, narcotized, preserved in glycerin modified 70% ethyl alcohol and identified. Wood borers were also extracted from rescued panels. First limnoriids in the tunnels were disturbed by a gentle jet of freshwater and animal emerged out on to the timber collected with a fine brush. Then, pholadid and teredinid wood borers were extracted by carefully dissecting out the timber material around them. All the borers were preserved in 70% ethyl alcohol modified with glycerin and identified.

In addition, surface seawater was sampled from each of the three stations during each month for a period of two years from February 2007 to January 2009 coinciding with the retrieval of test panels and analyzed for temperature, pH, salinity, dissolved oxygen (DO), biological oxygen demand (BOD) and nutrients (nitrite, phosphate and silicate) following standard procedures (Food and Agricultural Organization, 1975; Parsons *et al*., 1984 and Grasshoft *et al*., 1999).

RESULTS

Physico-chemical Parameters

Sea water temperature ranged from 26.00°C to 33.00°C with an average of 29.07°C at Slipway Complex; from 25.50°C to 34.10°C averaging at 29.65°C at Ore Berth and from 26.30°C to 34.90°C with a mean of 29.79°C at Marine Foreman Jetty (Table-2). Salinity varied between 20.20PSU to 36.04PSU with an average of 32.59PSU at Slipway Complex; between 23.04PSU to 38.11PSU averaging at 31.70PSU at Ore Berth and between 19.14PSU to 33.77PSU with a mean of 29.19PSU at Marine Foreman Jetty. pH fluctuated from 7.60 to 8.40 with an average of 7.95 at Slipway Complex; between 7.50 to 8.40 averaging at 7.98 at Ore Berth and between 7.30 to 8.30 with a mean of 7.59 at Marine Foreman Jetty. Dissolved oxygen lied between 2.82mg.L^{-1} to 5.74mg.L^{-1} with an average of 4.05mg.L^{-1} at Slipway Complex; between 2.59mg.L^{-1} to 7.98mg.L^{-1} averaging at 4.82mg.L^{-1} at Ore Berth and between nil to 11.42mg.L^{-1} with a mean of 2.80mg.L^{-1} at Marine Foreman Jetty. BOD varied from 1.08mg.L^{-1} to 2.48mg.L^{-1} with an average of 1.92mg.L^{-1} at Slipway Complex; from 2.14mg.L^{-1} to 4.24mg.L^{-1} averaging at 3.05mg.L^{-1} at Ore Berth and from 7.05mg.L^{-1} to 29.00mg.L^{-1} with a mean of 17.24mg.L^{-1} at Marine Foreman Jetty. Nitrite extended from 0.10µmol.L^{-1} to 2.53µmol.L^{-1} with an average of 1.18µmol.L^{-1} at Slipway Complex; from 0.23µmol.L^{-1} to 6.49µmol.L^{-1} averaging at 2.60µmol.L^{-1} at Ore Berth and from 0.46µmol.L^{-1} to 8.81µmol.L^{-1} with a mean of 4.01µmol.L^{-1} at Marine Foreman Jetty. Phosphate raised from 0.18µmol.L^{-1} to 4.80µmol.L^{-1} with an average of 2.10µmol.L^{-1} at Slipway Complex;

Table-2 : Physico-chemical parameters of seawater at three stations in Visakhapatnam harbour during February 2007 to January 2009.

Parameter	Slipway Complex			Ore Berth			Marine Foreman Jetty		
	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Temperature (°C)	26.00	33.00	29.07	25.50	34.10	29.65	26.30	34.90	29.79
Salinity (PSU)	20.20	36.04	32.59	23.04	38.11	31.70	19.14	33.77	29.19
pH	7.60	8.40	7.95	7.50	8.40	7.98	7.30	8.30	7.59
D.O (mg.L^{-1})	2.82	5.74	4.05	2.59	7.98	4.82	0.00	11.42	2.80
B.O.D (mg.L^{-1})	1.08	2.48	1.92	2.14	4.24	3.05	7.05	29.00	17.24
Nitrite (µmol.L^{-1})	0.10	2.53	1.18	0.23	6.49	2.60	0.46	8.81	4.01
Phosphate (µmol.L^{-1})	0.18	4.80	2.10	0.92	67.32	22.91	18.52	66.51	46.15
Silicate (µmol.L^{-1})	4.01	78.08	13.85	0.53	44.98	13.35	6.53	113.38	47.15

from 0.92µmol.L^{-1} to 67.32µmol.L^{-1} averaging at 22.91µmol.L^{-1} at Ore Berth and from 18.52µmol.L^{-1} to 66.51µmol.L^{-1} with a mean of 46.15µmol.L^{-1} at Marine Foreman Jetty. Silicate ranged between 4.01µmol.L^{-1} to 78.08µmol.L^{-1} with an average of 13.85µmol.L^{-1} at Slipway Complex; between 0.53µmol.L^{-1} to 44.98µmol.L^{-1} averaging at 13.35µmol.L^{-1} at Ore Berth and between 6.53µmol.L^{-1} to 113.38µmol.L^{-1} with a mean of 47.15µmol.L^{-1} at Marine Foreman Jetty.

Xylozoans

In all, 100 marine fouling organisms (Xylozoans) belonging to 8 major and 2 minor Phyla were encountered at Visakhapatnam harbour from both short-term and long-term panels (Table-3). Among major Phyla, the Phylum Cnidaria was expressed by 2 Classes, 3 Orders, 7 Families, 8 Genera, 7 identified/5 unidentified species and 2 unidentified hydrozoans. Between the two Classes, the Class Hydrozoa; among the 3 Orders, the Order Leptothecata; among the 7 Families, the Family Campanulariidae and among the 8 Genera, the Genera *Clytia* were represented by maximum number (4) of species. The Phylum Annelida was exemplified by a single Class the Polychaeta with 5 Orders, 6 Families, 4 Genera, 10 identified/4 unidentified species and 4 unidentified polychaetes. Among the 5 Orders, the Order Sabellida; among the 6 Families, the Family Serpulidae and among the 4 Genera, the Genus *Hydroides* were depicted by maximum number (6) of species. The phylum Arthropoda was typified by 3 Classes, 6

Table-3 : Inventory and spatial distribution of Xylozoans at Visakhapatnam harbour.

Phylum	Class	Order	Family	Fouling Species	Station
Porifera	-	-	-	1. Sponge-1 (Unidentified)	SWC, OB
Cnidaria	Hydrozoa	Anthoathecata	Bougainvilliidae	2. *Bimeria vestita* Wright, 1857	SWC
		Leptothecata	Campanulariidae	3. *Clytia gracilis* (Sars, 1850)	SWC, OB
				4. *Clytia hendersoni* Torrey, 1904	SWC, OB
				5. *Clytia linearis* (Thornely, 1900)	OB
				6. *Clytia noliformis* (McCrady, 1858)	OB
				7. *Obelia bidentata* Clarke, 1876	OB
				8. *Obelia dichotoma* (Linnaeus, 1758)	SWC
			Haleciidae	9. *Halecium* sp.	SWC
	-	-		10. Hydrozoan-1 (Unidentified)	SWC
	-	-		11. Hydrozoan-2 (Unidentified)	SWC
	Anthozoa	Actiniaria	Actiniidae	12. *Anthopleura* sp.	SWC
			Aiptasiidae	13. *Aiptasia* sp.	SWC
			Diadumenidae	14. *Diadumene* sp.	MFJ
			Metridiidae	15. *Metridium* sp.	SWC, OB, MFJ
Platyhelminthes	Turbellaria	Polycladida	-	16. Polyclad-1 (Unidentified)	SWC, OB, MFJ
Entoprocta	Gymnolaemota	Coloniales	Pedicellinidae	17. *Pedicellina cernua* (Pallas, 1774)	SWC

Table-3 : *Contd.*

Phylum	Class	Order	Family	Fouling Species	Station
Ectoprocta	Gymnolaemata	Cheilostomatida	Bugulidae	18. *Bugula neritina* (Linnaeus, 1758)	SWC, OB
			Bitectiporidae	19. *Hippoporina americana* (Verrill, 1875)	SWC, OB
			Hippopodinidae	20. *Hippopodina feegeenensis* (Busk, 1884)	OB
			Membraniporidae	21. *Jellyella tuberculata* (Bosc, 1802)	SWC
				22. *Membranipora* sp.	OB
			Thalamoporelli-dae	23. *Thalamoporella gothica* (Busk) var. *indica* (Hincks, 1880)	SWC
			-	24. Bryozoan-1 (Unidentified)	SWC, OB
			-	25. Bryozoan-2 (Unidentified)	OB
		Ctenostomatida	Vesiculariidae	26. *Bowerbankia gracilis* Leidy, 1855	SWC, OB
				27. *Zoobotryon verticillatum* (delle Chiaje, 1828)	SWC
Annelida	Polychaeta	Phylodocida	Nereidae	28. Nereid-1 (Unidentified)	SWC, OB, MFJ
		Eunicida	Eunicidae	29. *Eunice afra* Peters, 1854	MFJ
				30. *Eunice laticeps* Ehlers, 1868	SWC, OB, MFJ
		Spionida	Spionidae	31. *Polydora* sp.	SWC, OB, MFJ

Table-3 : *Contd.*

Phylum	Class	Order	Family	Fouling Species	Station
Annelida	Polychaeta	Spionida	Cirratulidae	32. *Cirratulus* sp.	SWC
				33. Cirratulid-1 (Unidentified)	SWC
		Sabellida	Sabellidae	34. *Dasychone cingulata* Grube, 1878	SWC, OB, MFJ
				35. Sabellid-1 (Unidentified)	SWC
				36. Sabellid-2 (Unidentified)	OB, MFJ
			Serpulidae	37. *Serpula vermicularis* Linnaeus, 1758	SWC, OB
				38. *Hydroides brachyacanthus* Rioja, 1863	SWC, OB
				39. *Hydroides diramphus* Mörch, 1863	SWC
				40. *Hydroides elegans* (Haswell, 1883)	SWC, OB, MFJ
				41. *Hydroides operculatus* (Treadwell, 1929)	SWC
				42. *Hydroides vizagensis* Lakshamana Rao, 1969	SWC
				43. *Hydroides* sp.-1	SWC
				44. *Hydroides* sp.-2	SWC
				45. *Ficopomatus enigmaticus* (Fauvel, 1923)	SWC, OB

Table-3 : *Contd.*

Phylum	Class	Order	Family	Fouling Species	Station
Arthropoda	Maxillopoda	Sessilia	Balanidae	46. *Balanus amphitrite amphitrite* Darwin, 1854	SWC, OB, MFJ
				47. *Balanus variegatus* Darwin, 1854	SWC, MFJ
	Malacostraca	Tanaidacea	Tanaidae	48. *Tanais philetaerus* Stebbing, 1904	OB
		Amphipoda	Corophiidae	49. *Corophium triaenonyx* Stebbing, 1904	SWC, OB, MFJ
		Isopoda	Cirolanidae	50. *Cirolana* (*Anopsilana*) *willeyi* (Stebbing, 1904)	OB
				51. *Cirolana bovina* Barnard, 1940	SWC, OB
				52. *Cirolana fluviatilis* Stebbing, 1902	MFJ
				53. *Cirolana* sp.	OB
			Sphaeromatidae	54. *Sphaeroma walkeri* Stebbing, 1905	SWC
				55. *Paracerceis* sp.	SWC
		Decapoda	Calappidae	56. *Calappa* sp.-2	SWC
			Majidae	57. *Doclea* sp.	OB
			Parthenopidae	58. *Platylambrus prensor* (Herbst, 1803)	OB
			Portunidae	59. *Scylla* sp.-1	SWC
				60. *Portunus pelagicus* (Linnaeus, 1758)	SWC
				61. *Charybdis helleri* (A. Milne Edwards, 1867)	SWC
				62. *Charybdis* sp.	SWC
				63. *Thalamita crenata* (Latreille, 1829)	SWC

Table-3 : *Contd.*

Phylum	Class	Order	Family	Fouling Species	Station
Arthropoda	Malacostraca	Decapoda	Xanthidae	64. *Macromedaeus crassimanus* (A. Milne Edwards, 1867)	OB
			Menippidae	65. *Myomenippe hardwicki* (Gray, 1831)	OB
			Pinnotheridae	66. Pinnotherid-1 (Unidentified)	OB
			-	67. Crab-1 (Unidentified)	SWC, OB
			-	68. Crab-3 (Unidentified)	OB
			Alpheidae	69. *Synalpheus brevicarpus* (Herrick, 1891)	SWC, OB, MFJ
	Pycnogonida	Pantopoda	Pycnogonidae	70. *Pycnogonum* sp.	SWC
Mollusca	Aplacophora	-	-	71. Nudibranch-1 (Unidentified)	SWC
	Gastropoda	Mesogastropoda	Littorinidae	72. *Littoraria* (*Littorinopsis*) *scabra scabra* (Linneus, 1758)	SWC
			Assimineidae	73. *Assiminea* sp.	OB
			Cypraeidae	74. *Cypraea arabica* Linnaeus, 1758	SWC
			Vermetidae	75. Vermetid-1 (Unidentified)	SWC
		Neogastropoda	Columbellidae	76. *Anachis terpsichore* Sowerby, 1832	SWC
			Muricidae	77. *Thais* (*Stramonita*) *rugosa* (Born, 1778)	OB
			Buccinidae	78. *Nassarius* sp.	MFJ
		-	-	79. Gastropod-1 (Unidentified)	MFJ
		-	-	80. Gastropod-2 (Unidentified)	SWC, OB

Table-3 : *Contd.*

Phylum	Class	Order	Family	Fouling Species	Station
Mollusca	Bivalvia	Mytiloida	Mytilidae	81. *Perna viridis* (Linnaeus)	OB
				82. *Modiolus philippinarum* Hanley, 1844	SWC
				83. *Modiolus striatulus* (Hanley, 1844)	OB
		Pterioida	Pteriidae	84. *Pinctada fucata* (Gould, 1850)	SWC
			Pinnidae	85. *Pinna* sp.	OB
		Ostreoida	Ostreidae	86. *Crassostrea cuttackensis* (Newton and Smith, 1912)	SWC, OB
				87. *Saccostrea cucullata* (Born, 1778)	SWC, OB
			Anomiidae	88. *Anomia achaeus* Gray, 1850	OB
				89. *Anomia* sp.	OB
		Veneroida	Dreissenidae	90. *Mytilopsis sallei* (Recluz, 1849)	SWC, OB, MFJ
			Trapeziidae	91. *Trapezium sublaevigatum* (Lamarck, 1819)	SWC
				92. *Trapezium* sp.	OB
		Pholadomyoida	Laternulidae	93. *Laternula* sp.	OB
Echinodermata	Ophiuroidea	Ophiurida	Ohiuridae	94. Ophiurid-1 (Unidentified)	OB
Chordata	Ascidiacea	Enterogona	Ascidiidae	95. *Ascidia gemmata* Sluiter, 1895	SWC, OB
		Pleurogona	Styelidae	96. *Styela canopus* (Savigny, 1816)	SWC, OB
				97. *Symplegma oceania* Tokioka, 1961	SWC, OB
		-	-	98. Ascidian-1 (Unidentified)	SWC, OB
	Actinopterygii	Perciformes	Gobiidae	99. Gobiid-1 (Unidentified)	SWC
				100. Gobiid-2 (Unidentified)	MFJ

Orders, 14 Families, 17 Genera, 15 identified/7 unidentified species and 3 unidentified crustaceans. Among the 3 Classes, the Class Malacostraca; among the 6 Orders, the Order Decapoda; among the 14 Families, the Family Portunidae and among the 17 Genera, the Genus *Cirolana* were portrayed by maximum number (3) of species. The Phylum Mollusca was reflected by 3 Classes, 7 Orders, 15 Families, 16 Genera, 13 identified/6 unidentified species and 4 unidentified molluscs. Among the 3 Classes, the Class Gastropoda; among the 7 Orders, the Order Mesogastropoda; among the 15 Families, the Family Mytilidae and among the 16 Genera, the Genus *Modiolus* was represented by maximum number (2) of species. The Phylum Chordata was characterized by 2 Classes, 3 Orders, 3 Families, 3 Genera, 3 identified species and 3 unidentified chordates. Between the 2 Classes, the Class Ascidiacea; among the 3 Orders, the Order Pleurogona; among the 3 Families, the Family Styelidae and each of the 3 Genera were represented by one species each. Other three major Phyla, namely, Porifera, Platyhelminthes and Echinodermata were expressed by one unidentified fauna each. Between the two minor Phyla, the Phylum Ectoprocta was characterized in the present instance by a single Class the Gymnolaemata with 2 Orders, 6 Families, 8 Genera, 7 identified/1 unidentified species and 2 unidentified bryozoans. Between the two Orders, the Order Cheilostomatida; among the 6 Families, the Family Thalamoporellidae was expressed by 1 Genus and Species each and 2 unidentified Genera. The other minor Phylum Entoprocta was depicted by a single species, namely, *Pedicellina cernua* (Pallas, 1774).

Among 100 fouling organisms noticed at Visakhapatnam harbour, 68 taxa were represented from Slipway Complex and 57 species from Ore Berth, but only 18 taxa from Marine Foreman Jetty (Table-3). Of these, while 31 species were common to Slipway Complex and Ore Berth, 11 taxa each were so to Slipway Complex-Marine Foreman Jetty and Ore Berth-Marine Foreman Jetty.

As low as 8 fouling species, namely, *Metridium* sp., Polyclad-1, *Polydora* sp., *D. cingulata*, *B. a. amphitrite*, *C. triaenonyx*, *S. brevicarpus* and *M. sallei* were found to be occurring in common at the three test stations in Visakhapatnam harbour. In contrast, as many as 36 taxa of foulers, *viz.*, *B. vestita*, *O. dichotoma*, *Halecium* sp., Hydrozoan-1, Hydrozoan-2, *Anthopleura* sp., *Aiptasia* sp., *P. cernua*, *J. tuberculata*, *T. g. indica*, *Z. verticillatum*, *Cirratulus* sp., Cirratulid-1, Sabellid-1, *H. diramphus*, *H. operculatus*, *Hydroides* sp.-1, *Hydroides* sp.-2, *S. walkeri*, *Paracerceis* sp., *Calappa* sp.-2, *Scylla* sp., *P. pelagicus*, *C. helleri*, *Charybdis* sp., *T. crenata*, *Pycnogonum* sp., Nudibranch-1, *L. s. scabra*, *C. arabica*, Vermetid-1, *A. terpsichore*, *M. philippinarum*, *P. fucata*, *T. sublaevigatum* and Gobiid-1 exclusively occurred at Slipway Complex. Similarly, 25 species of fouling organisms, namely, *C. linearis*, *C. noliformis*, *O. bidentata*, *H. feegeenensis*, *Membranipora* sp., Bryozoan-2, *C.* (*A.*) *willeyi*, *Cirolana* sp., *T. philetaerus*, *Doclea* sp., *P. prensor*, *M. crassimanus*, *M. hardwicki*, Pinnotherid-1, Crab-3, *Assiminea* sp., *T. rugosa, P. viridis, M. striatulus, Pinna* sp., *A. achaeus, Anomia* sp., *Trapezium* sp., *Laternula* sp. and Ophiurid-1 were confined to Ore Berth. On the other hand, only 6 fouling species, *viz*., *Diadumene* sp., *E. afra, C. fluviatilis, Nassarius* sp., Gastropod-1 and Gobiid-2 were restricted in their occurrence to Marine Foreman Jetty.

From the inventory of marine fouling organisms at Visakhapatnam harbour, 18 taxa of foulers were found to be new arrivals. Of these, 7 taxa (one each of *Anthopleura*, *Aiptasia*, *Diadumene*, *Cirolana*, *Paracerceis* and two of *Hydroides*) could be identified up to generic level. However, most of these genera and species were reported earlier elsewhere in the country, but for *Hydroides operculatus* (Serpulidae : Polychaeta) that forms a first record from Indian waters. A systematic account of only new arrivals is given as follows :

SYSTEMATIC ACCOUNT

Phylum CNIDARIA

Class HYDROZOA

Order ANTHOATHECATA

Suborder ATHECATA

Family BOUGAINVILLIIDAE

1. ***Bimeria vestita*** Wright, 1859

(Plate-1, Fig. 1)

1859. *Bimeria vestita* Wright, *Edinb. New Phil. J.*, **10** : 109.

1927. *Bimeria amoyensis* Hargitt, *Bull. Mus. Comp. Zool. Harv.*, **67**(16) : 492.

Description : Colonies of *Bimeria* appear yellowish with polyps usually scarcely branched and with 10-20 short and stout tentacles each. Hydranth covered by a perisarc which forms a sheath and covers part of the tentacles. Hydrocaulus branched; hydranth borne on moderately long pedicles, with 3-4 proximal annulations and a single annulation at the distal end. Periderm thick reaching up to the middle of the tentacle like a ‘half globe’. Gonophores short, stalked, spherical or egg shaped, arising from peduncles of hydranth.

Distribution : India : Pamban, Cape Comorin and Thankassery.

Elsewhere : Calbuco, Canal Vicuña, Belgium, ERMS scope, Mediterranean Sea, North West Atlantic, Villefranche-Sur-Mer, Trinidad, Virgin Islands, Panama, Venezuela, Colombia, Belize and Puerto Rico.

Remarks : Cosmopolitan distribution.

Suborder LEPTOTHECATA

Family CAMPANULARIIDAE

2. ***Clytia gracilis*** (Sars, 1850)

(Plate-1, Fig. 2)

1850. *Laomedea gracilis* Sars, *Nyt. Mag. Naturvidensk.*, **6** : 138.

1991. *Clytia gracilis* Calder, *Roy. Ontario Mus., Life Sci. Contrib.*, **154** : 54.

Description : Hydrotheca twice as long as broad. Hydrothecal margin serrated with 10-13 spines.

Distribution : India : Quilon (from drift weeds), Kovilam and Bombay.

Elsewhere : Caribbean waters (Venezuela, Virgin Islands, Panama, Guatemala and Colombia), Barents Sea, Beaufort, Belgium, Dutch, ERMS scope, Faeroes, Georges Bank, Iceland, Italy, Mediterranean Sea, North West Atlantic, Norway, Oestergronden, Oostende, South Africa, South Coast of England, Sweden, Villefranche-Sur-Mer, Wimereux and Woods Hole.

Remarks : Widely distributed.

3. ***Clytia hendersoni*** Torrey, 1904

(Plate-1, Fig. 3)

1904. *Clytia hendersoni* Torrey, *Univ. Calif. Publs. Zool.*, **2** (1) : 18.

Description : Hydrothecal margin dentate. Hydrothecal teeth broadly triangular and keeled.

Distribution : India : Vizhinjam, Cochin (from submerged timber), Port Blair (Andamans), off Puri and Chandipore (Odisha).

Elsewhere : San Diego (California).

4. ***Clytia linearis*** (Thornely, 1900)

(Plate-1, Fig. 4)

1900. *Obelia linearis* Thornely, In: *Zoological results based on material from New Britain, New Guinea, Loyalty Islands and elsewhere, Part-IV* (A, Willey, Ed.), Cambridge Univ. Press, Cambridge : 453.

1991. *Clytia linearis* Calder, *Roy. Ontario Mus., Life Sci. Contrib.*, **154** : 62.

Description : Hydrothecal margin toothed. Teeth not bicuspidate but bluntly pointed.

Distribution : India : Unkonwn.

Elsewhere : Caribbean waters (Puerto Rico, Virgin Islands, Colombia and Belize), Beaufort, Brazil, ERMS scope, Mediterranean Sea, North West Atlantic and Torre Inserraglio.

Remarks : Distributed in tropical and subtropical waters.

5. ***Obelia dichotoma*** (Linnaeus, 1758)

(Plate-1, Fig. 5)

1758. *Sertularia dichotoma* Linnaeus, *Sys. Nat.* : 812.

1991. *Obelia dichotoma* Clader, *Roy. Ontario Mus., Life Sci. Contrib.*, **154** : 72.

Description : Hydrothecal margin entire, not toothed, not everted. Perisarc of hydrocaulus only slightly thickened immediately below the insertion of the hydrothecal peduncles.

Distribution : India : Bombay.

Elsewhere : Caribbean waters (Bonaire, Aruba, Haiti, Venezuela, Colombia and Belize), Guaitecas Islands, Melinka, Tocopilla, Coquimbo and San Vincente Bays, Seno Reloncavi, Golfo de Ancud, Baltic sea, Belgium, Blankenberge, British Isles, Dutch, ERMS scope, Mediterranean Sea, North West Atlantic, Oostende, Otranto, Red Sea, South Africa, Villefranche-Sur-Mer and Wimereux.

Remarks : Cosmopolitan in tropical and temperate waters of the Atlantic, Pacific, and Indian oceans.

Class ANTHOZOA

Order ACTINIARIA

Family ACTINIIDAE

6. ***Anthopleura*** sp.

(Plate-1, Fig. 6a and b)

1860. *Anthopleura* Duchassaing de Fonbressin and Michelotii, *Mém. Ac. Sc. Turin*, **XIX** (II) : 48.

Description : Column, with verrucae arranged in more or less distinct longitudinal rows; with broad base as well as oral disc and colour creamy brown. Number of tentacles indefinite.

Distribution : India : First time recorded at Visakhapatnam harbour.

Elsewhere : This genus has worldwide distribution.

Remarks : This species could be identified up to generic level. However, specific characters noted in the specimens are given in description.

Family AIPTASIIDAE

7. ***Aiptasia*** sp.

(Plate-1, Fig. 7a and b)

1858. *Aiptasia* Goose, *Ann. Mag. Nat. Hist.*, **1** (3) : 416.

Description : Base strongly adhesive and irregular in outline. Radial lines of intersections of the mesenteries prominent. Column not divisible into scapus and capitulum. Column not very long. Margin tentaculate. Colour of the column faint brown. Light purple longitudinal stripes are clear and evenly spread throughout the length of the column. Oral disc almost as wide as the base and circular in outline. Tentacles sort and tapering.

Distribution : India : First time recorded at Visakhapatnam harbour.

Elsewhere : This genus has worldwide distribution.

Remarks : This species could be identified up to generic level. However, specific characters noted in the specimens are given in description.

Family DIADUMENIDAE

8. ***Diadumene*** sp.

(Plate-1, Fig. 8)

1920. *Diadumene* Stephenson, *Quart. J. Microsc. Sci.*, **64** : 521.

Description : Column smooth with cinclides and a definite collar separating scapus and capitulum. Colour of the column yellowish brown. Wall of the capitulum thinner than that of the scapus. Base well developed and strongly adhesive. Its diameter not greater than that of the column. Oral disc wider than column, circular in outline. Colour same as the column. Tentacles numerous arranged in cycles.

Distribution : India : First time recorded at Visakhapatnam harbour.

Elsewhere : This genus has worldwide distribution.

Remarks : This species could be identified up to generic level. However, species characters noted in the specimens are given in description.

Phylum ANNELIDA

Class POLYCHAETA

Order CANALIPALPATA

Family SERPULIDAE

9. ***Hydroides operculatus*** (Treadwell, 1929)

(Plate-2, Fig. 9)

1929. *Eupomatus operculata* Treadwell, *Am. Mus. Novit.*, **392** : 12.

2006. *Hydroides operculatus* Çinar, *Aquatic Invasions*, **1** (4) : 229.

Description : Funnel of operculum with 36 radii of pointed tips. Verticil with 8 to 9 spines, which are strongly curved inwards. Dorsal spine larger than others. Other spines small and equal in size with pointed tip. Each spine with one short basal internal spinule.

Distribution : India : First time being recorded in India at Visakhapatnam harbour.

Elsewhere : Coast of Somalia, Gulf of Aden, Mediterranean Sea, Levantine coast of Turkey and Israel.

10. ***Hydroides*** sp. 1
(Plate-2, Fig. 10)

1768. *Hydroides* Gunnerus, *K. Norske Vid. Selsk. Skrifter*, **4** : 52.

Description : Central crown of operculum with 4 spines. Dorsal spine is larger than other spines.

Distribution : India : First time recorded at Visakhapatnam harbour.

Elsewhere : This genus has worldwide distribution.

Remarks : This species could be identified up to generic level. However, specific characters noted in the specimens are given in description. This unidentified species is given number 1 to distinguish it from another unidentified species of the genera *Hydroides*.

11. ***Hydroides*** sp. 2
(Plate-2, Fig. 11)

1768. *Hydroides* Gunnerus, *K. Norske Vid. Selsk. Skrifter*, **4** : 52.

Description : Central crown of operculum with 9 equal spines.

Distribution : India : First time recorded at Visakhapatnam harbour.

Elsewhere : This genus has worldwide distribution.

Remarks : This species could be identified up to generic level. However, specific characters noted in the specimens are given in description.

Phylum ARTHROPODA

Class MALACOSTRACA

Order ISOPODA

Suborder FLABELLIFERA

Family CIROLANIDAE

12. ***Cirolana willeyi*** Stebbing, 1904
(Plate-2, Fig. 12)

1904. *Cirolana willeyi* Stebbing, *Spolia Zeylan.*, **II** (5) : 11.
1935. *Cirolana willeyi* Barnard, *Rec. Indian Mus.*, **37** : 312.

Description : Telson triangular, apex narrow and rounded. Second to fourth pleon segments with five teeth each and fifth segment with three teeth; the median tooth on each pleon segment slightly larger.

Distribution : Brackish waters especially in Kerala and Chilika Lake.

Elsewhere : Indo-West Pacific, East Africa, Queensland and Thailand.

13. ***Cirolana bovina*** Barnard, 1940
(Plate-2, Fig. 13)

1940. *Cirolana bovina* Barnard, *Ann. S. Afr. Mus.*, **32** : 400.

Description : Telson triangular, with the lateral sides prominently sinuous at the base; dorsal side with 2 large submedian conical teeth at the base.

Distribution : India : Kerala and Madras.

Elsewhere : Kenya and South Africa.

14. ***Cirolana*** sp.
(Plate-2, Fig. 14)

1818. *Cirolana* Leach, In : *Dictionnaire des sciences naturelles* (F. Cuvier, Ed.), Paris : 347.

Description : Telson broadly triangular without any teeth or tubercles.

Distribution : India : First time recorded at Visakhapatnam harbour.

Elsewhere : This genus has worldwide distribution.

Remarks : This species could be identified up to generic level. However, specific characters noted in the specimens are given in description.

Family SPHAEROMATIDAE

15. ***Paracerceis*** sp.
(Plate-2, Fig. 15)

1905. *Paracerceis* Hansen, *Quart. J. Micr. Sci., New Ser.,* **49** (1) : 77.

Description : Pleon having 3 tubercles where as pleotelson has 3 prominent longitudinal ridges. Pleotelson has toothed notch which projects beyond endopods in males. Exopod is larger than endopod.

Distribution : India : First time reported from India at Visakhapatnam harbour.

Elsewhere : This genus has worldwide distribution.

Remarks : This species could be identified up to generic level. However, specific characters noted in the specimens are given in description. One of the species [*Paracerceis sculpta* (Holmes, 1904)] is widely distributed in the World due to ship borne translocation between ports (Montelli and Lewis, 2008).

Phylum CHORDATA

Subphylum TUNICATA

Class ASCIDIACEA

Suborder PHLEBOBRANCHIA

Family ASCIDIIDAE

16. ***Ascidia gemmata*** Sluiter, 1895

(Plate-2, Fig. 16)

1895. *Ascidia gemmata* Sluiter, In: *Zoologische Forschungsreisen in Australien und den malagischen Archipel., Denkschr. Med. Naturw. Ges. Jena* (R. Semon, Ed.), **8** : 177.

1985. *Ascidia gemmata* Kott, *Mem. Queensl. Mus.*, **23** : 37.

Description : Body long and relatively narrow; dorsoventrally flattened; usually fixed by large part of the left side of the test, which is often spread out from the sides of the body where it is fixed to the substrate. Small number of long stigmata, orange pigmentation and posteriorly oriented atrial siphon and posterior position of neural ganglion are the important features.

Distribution : India : Tuticorin and Gulf of Mannar.

Elsewhere : Central Indo-Pacific, Western Australia, Victoria, Queensland, New South Wales, Arafura Sea, Indonesia, Palau Island, Noumea.

Suborder STOLIDOBRANCHIA

Family STYELIDAE

17. ***Styela canopus*** (Savigny, 1816)

(Plate-2, Fig. 17)

1816. *Cynthia canopus* Savigny, *Memoirs sur les animaux sans vertebres, Paris*, **2** : 154.

1985. *Ascidia gemmata* Kott, *Mem. Queensl. Mus.*, **23** : 112.

Description : Sessile, often occurs in aggregates, test is leathery and pinkish brown. Siphons very short, warty and fairly close together on the upper surface. Gut loop deeply curved, 2 gonads on right and 2 gonads on left side of the body. Body musculature confined to longitudinal bands, siphonal scales continued to the outer surface of the apertures and the brownish stripes extend from around the outside of the apertures and into the siphonal lining.

Distribution : India : Tuticorin, Gulf of Mannar, Kerala, Vizhinjam Bay and Azhickal.

Elsewhere : Cobscook Bay, ERMS scope, Greens Point, Gulf of Maine, Mediterranean Sea, Mozambique, North Africa, North West Atlantic, South Africa, South Coast of England, Western South Atlantic, Western Australia, Queensland, Coral Sea, New Caledonia, Ascension

Island, western coast of France, Sea of Japan, Indonesia, Western Indian Ocean, Persian Gulf, Gulf of Siam, Philippines, Hongkong.

18. ***Symplegma oceania*** Tokioka, 1961

(Plate-2, Fig. 18)

1961. *Symplegma oceania* Tokioka, *Publ. Seto Mar. Biol. Lab. Kyoto Uviv.*, **9** (1) : 114.

1985. *Ascidia gemmata* Kott, *Mem. Queensl. Mus.*, **23** : 207.

Description : Species green with white rims around aperture. Colony various coloured, test transparent. Gastric caecum is long and curved. Two gastro-intestinal connectives are present. Gonads consist of a small rounded ovary, with 2 or 3 eggs. Two pyriform male follicles (one anterior and one posterior to ovary) are present. Ducts of these follicles join at the base of the short oviduct to form a fairly long, narrow vas deferens that projects free into the atrial cavity.

Distribution : India : Tuticorin, Gulf of Mannar, Mumbai, Kerala, Vizhinjam Bay and Colechel.

Elsewhere : Indo-West Pacific, Western Australia, Southern Australia, Queensland, Victoria, Indonesia, Noumea, Palau Island, Fiji, Thailand, Hongkong, China, Sri Lanka, Indian Ocean.

Xylotrepans

A total of 29 species marine wood borers (Xylotrepans) belonging to two Phyla *viz*. Arthropoda and Mollusca were recorded at Vishakhapatnam harbour (Table-4). The phylum Arthropoda represented by Class Malacostraca, Order Isopoda, Family Limnoriidae and Genus *Limnoria* encompassed only 1 species, *i.e.*, *L. indica*. Phylum Mollusca was represented by the Class Bivalvia, Order Myoida and two Families, Pholadidae and Teredinidae. Of the two families, pholadidae was depicted by a single genus *Martesia* with three species, *viz.*, *M. fragilis*, *M. striata* and *M. nairi* and an unidentified species. The family Teredinidae portrayed five Genera (*Lyrodus*, *Dicyathifer*, *Teredo*, *Nausitora* and *Bankia*) with 24 species, namely, *L. massa*, *L. affinis*, *L. takanoshimensis*, *L. singaporeana*, *L. pedicellatus*, *L. bipartitus*, *L. medilobatus*, *D. manni*, *T. parksi*, *T. furcifera*, *T. bartschi*, *T. navalis*, *T. clappi*, *T. somersi*, *N. dunlopei*, *B. carinata*, *B. brevis*, *B. campanellata*, *B. gouldi*, *B. gracilis*, *B. rochi*, *B. philippinensis*, *B. fimbriatula* and *B. zeteki*.

Out of the 29 species of borers recorded from the present study, 20 species (1 limnoriid, 3 pholadids and 16 teredinids) were collected from Slipway Complex, 25 taxa (1 limnoriid, 3 pholadids and 21 teredinids) from Ore Berth, but only 2 species (teredinids) from Marine Foreman Jetty (Table-4). Of these, while 16 species were common to Slipway Complex and Ore Berth, 2 taxa each were so to Slipway Complex-Marine Foreman Jetty and Ore Berth-Marine Foreman Jetty.

Table-4 : Inventory and spatial distribution of Xylotrepans at Visakhapatnam harbour.

Phylum	Class	Order	Family	Wood boring species	Station
Arthropoda	Malacostraca	Isopoda	Limnoriidae	1. *Limnoria indica* Kampf and Becker, 1958	SWC, OB
Mollusca	Bivalvia	Myoida	Pholadidae	2. *Martesia* (*Martesia*) *fragilis* (Verrill and Bush, 1898)	OB
				3. *Martesia* (*Martesia*) *striata* (Linnaeus, 1758)	SWC, OB
				4. *Martesia* (*Particoma*) *nairi* Turner and Santhakumaran, 1989	SWC, OB
				5. *Martesia* sp.	SWC
			Teredinidae	6. *Lyrodus massa* (Lamy, 1923)	SWC, OB
				7. *Lyrodus affinis* (Deshayes, 1863)	SWC, OB
				8. *Lyrodus takanoshimensis* (Roch, 1929)	SWC, OB
				9. *Lyrodus singaporeana* (Roch, 1935)	SWC, OB
				10. *Lyrodus pedicellatus* (Quatrefages, 1849)	SWC, OB
				11. *Lyrodus bipartitus* (Jeffreys, 1860)	SWC, OB
				12. *Lyrodus medilobatus* (Edmondson, 1942)	SWC
				13. *Dicyathifer manni* (Wright, 1866)	OB

Table-4 : *Contd.*

Phylum	Class	Order	Family	Wood boring species	Station
Mollusca	Bivalvia	Myoida	Teredinidae	14. *Teredo parksi* Bartsch, 1921	SWC, OB
				15. *Teredo furcifera* von Martens, 1894	SWC, OB
				16. *Teredo bartschi* Clapp, 1923	SWC, OB
				17. *Teredo navalis* Linnaeus, 1758	SWC
				18. *Teredo clappi* Bartsch, 1923	OB
				19. *Teredo somersi* Clapp, 1924	SWC
				20. *Nausitora dunlopei* Wright, 1864	OB
				21. *Bankia carinata* (Gray, 1827)	SWC, OB
				22. *Bankia brevis* (Deshayes, 1863)	SWC, OB, MFJ
				23. *Bankia campanellata* Moll and Roch, 1931	SWC, OB, MFJ
				24. *Bankia gouldi* (Bartsch, 1908)	OB
				25. *Bankia gracilis* Moll, 1935	OB
				26. *Bankia rochi* Moll, 1931	OB
				27. *Bankia philippinensis* Bartsch, 1927	SWC, OB
				28. *Bankia fimbriatula* Moll and Roch, 1931	OB
				29. *Bankia zeteki* Bartsch, 1921	OB

Only 2 species, namely, *B. brevis* and *B. campanellata* were found ubiquitous in Visakhapatnam harbour (*i.e.*, occurring at the three stations). While, as low as 4 wood boring species, namely, *Martesia* sp., *L. medilobatus*, *T. navalis* and *T. somersi* were limited in their occurrence to Slipway Complex. As many as 9 species, *viz.*, *M. fragilis*, *D. manni*, *T. clappi*, *N. dunlopei*, *B. gouldi*, *B. gracilis*, *B. rochi*, *B. fimbriatula* and *B. zeteki* exclusively occurred at Ore Berth.

From the inventory of marine wood boring organisms at Visakhapatnam harbour, 13 taxa (1 limnoriid, 2 pholadids and 10 teredinids) were found to be new occurrences. Most of these species were reported during earlier occasions from different localities in India, but for an unidentified pholadid of the genus *Martesia*. Systematic account of these newly recorded borers is given as follows :

SYSTEMATIC ACCOUNT

Phylum ARTHROPODA

Class MALACOSTRACA

Order ISOPODA

Family LIMNORIIDAE

1. ***Limnoria indica*** Kampf and Becker, 1958

(Plate-3, Fig. 1a-c)

1958. *Limnoria* (*Limnoria*) *indica* Kampf and Becker (in Becker and Kampf), *Z. Angew. Zool.*, **45** : 1-9.

1988. *Limnoria simulate* Miller, *Senckenb. Biol.*, **69** : 397-403.

Description : Male : Pleonite 5 dorsomedially with two subparallel longitudinal carinae, which converge slightly posteriorly. Pleotelson with 2 pairs of anteromedial puncta, one pair directly behind the other, without carinae behind posterior pair of puncta, with anterolateral pair of long setae. Dorsal row of tubercles extend from lateral crests to posterior margin of pleotelson. Posterior margin fringed with 4 large stout setae between, which are scale spikes and short sheathed setae.

Female : Female with pair of anteromedial puncta followed posteriorly by long carinae, pleotelson without other puncta. Posterior margin of ventral pleopedal cavity more posterior than in males.

Distribution : India : Andamans, Mumbai, Chennai, Mandapam and Ramnad.

Elsewhere : Hong Kong, Philippines (Manila), Japan (Koniya), Malaysia (Penang), Belize, Admiralty Islands, Queensland.

Phylum MOLLUSCA

Class BIVALVIA

Order PHOLADACEA

Family PHOLADIDAE

Subfamily MARTESIINAE

2. ***Martesia* (*Particoma*) *nairi*** Turner and Santhakumaran, 1989

(Plate-3, Fig. 2a-d)

1989. *Martesia* (*Particoma*) *nairi* Turner and Santhakumaran, *Ophelia*, **30** (3) : 155-186.

Description : Mesoplax inflated, usually rounded posteriorly, laterally lobed anteriorly and sculptured with irregular wrinkles. Metaplax and hypoplax long, narrow, pointed anteriorly, forked posteriorly and extending over the lobes of the siphonoplax. Siphonoplax with a large squarish central lobe bordered by triangular dorsal and ventral lobes.

Distribution : India : Cochin, Mangalore, Panaji, Krishnapatnam, Krishna estuary and Rishikonda.

Elsewhere : Australia (Northern Territory, Queensland and northern New South Wales).

3. ***Martesia*** sp.

(Plate-3, Fig. 3a-d)

1824. *Martesia* Sowerby, *Gen. Shells,* (23) *Pholas* : 2, 4.

Description : Two valves with three accessory plates, namely, mesoplax, metaplax and hypoplax. Shell with a callum, ventral condyle, umbonal-ventral sulcus and umbonal-ventral ridge.

Distribution : India : This species is recorded for the first time at Visakhapatnam.

Elsewhere : The genus has cosmopolitan distribution.

Phylum MOLLUSCA

Class BIVALVIA

Order MYOIDA

Family TEREDINIDAE

Subfamily TEREDININAE

4. ***Lyrodus massa*** (Lamy, 1923)

(Plate-4, Fig. 4a-b)

1923. *Teredo massa* Lamy, *Bull. Mus. Natl. Hist. Nat. (Paris),* **29** : 176.

1935. *Teredo infundibulata* Roch (in Roch and Moll), *Sitzungsber. Akad. Wiss. Wien*, **144** : 265.

Description : Periostracal cup inserted in calcareous base. Periostracum of pallet brown in colour.

Distribution : India : Panaji, Vembanad lake, Porto Novo, Krishnapatnam, Krishna estuary, Kothakoduru, Bangarammapalem, Rishikonda and Lakshadweep.

Elsewhere : Cosmopolitan, tropical to subtropical.

5. ***Lyrodus takanoshimensis*** (Roch, 1929)

(Plate-4, Fig. 5a-b)

1929. *Teredo takanoshimensis* Roch (in Roch and Moll), *Mitt. Zool. Staatsinst. Zool. Mus. Hamburg*, **44** : 10.

1929. *Teredo dicroa* Roch (in Roch and Moll), *Mitt. Zool. Staatsinst. Zool. Mus. Hamburg*, **44** : 14.

Description : Distal margin of calcareous base nearly straight. Distal margin of inner face U-shaped and that of outer face V-shaped.

Distribution : India : Krishna estuary, Sagar Nagar, Rishikonda, Kapula Uppada and Bhimunipatnam.

Elsewhere : Probably world-wide in tropical and sub-tropical areas.

6. ***Lyrodus medilobatus*** (Edmondson, 1942)

(Plate-4, Fig. 6a-b)

1942. *Teredo* (*Cornuteredo*) *medilobata* Edmondson, *Occ. Pap. B.P. Bishop Mus.*, **17** : 119.

Description : Distal margin of outer face nearly straight and that of inner face deeply U-shaped with median lobate process.

Distribution : India : Veraval, Okha, Porto Novo.

Elsewhere : Indo-Pacific, tropical to subtropical.

7. ***Teredo somersi*** Clapp, 1924

(Plate-4, Fig. 7a-b)

1924. *Teredo* (*Zopoteredo*) *somersi* Clapp, *Proc. Amer. Acad. Arts and Sci. (Cambridge)*, **59** (12) : 284.

1937. *Teredo* (*Teredo*) *radicis* Moll (in Moll and Roch), *Mitt., Zool. Mus. Berlin*, **22** : 182.

Description : Stalk equal to or shorter than blade. Proximal half of calcareous blade somewhat globoid. Distal half of the blade covered by periostracum.

Distribution : India : Bhimunipatnam and Lakshadweep.

Elsewhere : Western Atlantic, tropical to subtropical.

Subfamily BANKIINAE

8. ***Bankia brevis*** (Deshayes, 1863)

(Plate-4, Fig. 8a-b)

1863. *Teredo brevis* Deshayes, *Catalogue des Mollusques de I'île de la Réunion*. In : *Notes sur I'île de la Réunion* (Maillard, Ed.), **2** : 6.

Description : Embryonic cones crowded and covered with periostracum forming compact tip. Awns of cone long and recurved.

Distribution : India : Krishna estuary and Bangarammapalem mangroves.

Elsewhere : Indo-Pacific, tropical to subtropical.

9. ***Bankia gouldi*** (Bartsch, 1908)

(Plate-4, Fig. 9a-b)

1908. *Xylotrya gouldi* Bartsch, *Proc. Biol. Soc. Washington*, **21** : 211.

1935. *Bankia schrencki* Moll (in Roch and Moll), *Sitzungsber. Akad. Wiss. Wien*, **144** : 275.

Description : Awns fine without any strengthening ribs. Narrow periostracal margin of outer face without longitudinal striations.

Distribution : India : Kothakoduru mangroves.

Elsewhere : Western Atlantic, tropical to temperate.

10. ***Bankia gracilis*** Moll, 1935

(Plate-4, Fig. 10a-b)

1935. *Bankia gracilis* Moll (in Roch and Moll), *Sitzungsber. Akad. Wiss. Wien*, **144** : 274.

Description : Serrations on outer face long, wide and blunt; on inner face, long and vey narrow. Awns long.

Distribution : India : Andamans and Bangarammapalem mangroves.

Elsewhere : Indo-Pacific, tropical to subtropical.

11. ***Bankia philippinensis*** Bartsch, 1927

(Plate-4, Fig. 11a-b)

1927. *Bankia (Bankia) philippinensis* Bartsch, *Bull. U.S. Natl. Mus.*, **100** (2) : 534.

1928. *Bankia tenuis* Sivickis, *Philippine Jour. Sci.*, **37** : 287.

Description : Serrations on both inner and outer face, fine and of equal strength.

Distribution : India : Krishna estuary.

Elsewhere : Philippines, Malaya, New Guinea, Northern Australia.

12. ***Bankia fimbriatula*** Moll and Roch, 1931

(Plate-4, Fig. 12a-b)

1931. *Bankia fimbriatula* Moll and Roch, *Proc. Malac. Soc. London*, **19** : 213.

1944. *Bankia canalis* Bartsch, *Smithson. Misc. Coll.*, **104** (8) : 1.

Description : Calcareous portion deeply U-V shaped on both the inner and outer face. Awns long, serrations on outer face short while long on inner face.

Distribution : India : Mahanadi estuary and Krishna estuary.

Elsewhere : Tropical to subtropical, Worldwide.

13. ***Bankia zeteki*** Bartsch, 1921

(Plate-4, Fig. 13a-b)

1921. *Bankia* (*Neobankia*) *zeteki* Bartsch, *Proc. Biol. Soc. Washington*, **34** : 26.

Description : Cones widely spaced, wine glass shaped. Distal margin on inner face nearly straight; on outer face slightly concave. Serrations fine short on outer face, long and thin on inner face.

Distribution : India : Kothakoduru mangroves.

Elsewhere : Western Atlantic and eastern Pacific, tropical.

DISCUSSION

Physico-chemical parameters

No marked difference in average temperature values was observed among the stations. Salinity showed a decreasing trend from Slipway Complex to Ore Berth to Marine Foreman Jetty. pH and DO values were more or less same for Slipway Complex and Ore Berth, but they were very low at Marine Foreman Jetty as compared to other two stations. BOD and nitrite values gradually increased from Slipway Complex to Ore Berth and then suddenly raised from Ore Berth to Marine Foreman Jetty. Phosphate value sharply increased from Slipway Complex to Ore Berth to Marine Foreman Jetty. Silicate values at Slipway Complex and Ore Berth are comparable, but the same was too high for Marine Foreman Jetty. Some important observations were made from the comparison of the present data on water qualities with the results from previous studies (Raman, 1980; Phaniprakash, 1989; Balaji, 1988 and Tripathy *et al*., 2005). The two chief physico-chemical parameters, namely, temperature and salinity of this harbour appeared to have remained fairly stable over the last three decades. Overall increase in pH factor over the years seems to be a result of pollution control measure implemented before discharge of effluents by the adjacent industries. But, DO content of the harbour water recorded a decline even though pollution abatement. Relative reduction in BOD values over three decades also indicate curtail of pollution through checking of effluent/ sewage discharge into harbour waters. Reduced waste inputs from fertilizer industries followed by discontinued sewage discharge through city's main drainage system 'Southern Lighter Channel' were the probable contributors to reduction in eutrophication over the years. Although some signs of improvement in water qualities were seen over three decades, Visakhapatnam harbour waters are still under severe pollution (particularly due to eutrophication) but with a decreasing gradient from Marine Foreman Jetty to Ore Berth to Slipway Complex.

Xylozoans

The inventory of fouling organisms during the present study exclusively made on consistent habitat (planted wooden coupons) yielded a total of 100 species from three test stations in Visakhapatnam harbour. During earlier studies of similar kind at various harbours, etc. in the country 10 taxa were recorded at Mangalore (Menon *et al*., 1977); 30 at Madras (Ismail and Azariah, 1978); 65 at Cochin (Nair and Nair, 1987); 95 at Bombay (Venugopalan, 1987); 42 at Goa (Anil and Wagh, 1988); over 23 at Ratnagiri (Alam *et al*., 1988); 37 at Kakinada (Satyanarayana Rao and Balaji, 1988); 28 at Krishnapatnam (Ramamurthi *et al*., 1990); 53 at Tuticorin (Radhakrishnan *et al*., 1992); 105 at Kalpakkam (Rajagopal *et al*., 1997); 106 at Kudankulam (Satheesh, 2006); 43 at Mumbai harbour (Gaonkar *et al*., 2008) and 120 at Mormugao port (Kolwalkar *et al*., 2008). Such contrast in fouling inventory from coastal localities far and wide in the country is as per expectations, although certain ubiquitous species get represented in common. This variability though attributed by Rajagopal *et al*. (1997) and Satheesh (2006) to the methodologies and substrata adopted, chiefly arises out of geographical distinctions, ecosystem identities and niche specificities.

Even at Visakhapatnam harbour, earlier, Balaji (1988) had recorded as many as 121 forms, but from heterogeneous habitats (*i.e*., collectively from harbour structures and introduced wooden test panels). However, only 2 (Slipway Complex and Marine Foreman Jetty) of the 3 test stations selected during both works were common while the third was different. The third station, Ore Berth of the present investigations is located midway between the other two test sites, whereas D.C. Jetty selected during the said earlier work (Balaji, 1988) lies more close to Marine Foreman Jetty. Since the composition of fouling assemblages significantly differs from station to station and substratum to substratum (Pomerat and Weiss, 1946; McGuiness, 1989; Anderson and Underwood, 1994 and Koçak, 2007), a direct comparison of the results of the two works is not appropriate. Habitat heterogeneity incorporated in the earlier work is also known to promote biological diversity (Rosenzweig, 1995). Spatial and temporal differences are also well known to influence the fouling compositions (Brown and Swearingen, 1998 and Koçak, 2007). However, an attempt is made to draw certain acceptable parallels between the two studies.

As in the present instance, a gradual decline in species count from Slipway Complex to Ore Berth to Marine Foreman Jetty was noticed by Balaji (1988) also and the attributed reason of ‘the existence of a gradient of pollution’ (Raman and Ganapati, 1983) stands good in the present context also as such a gradient still prevails in Visakhapatnam harbour waters.

The number of taxa occurring in common at the three stations and each of the two successively spaced stations is almost in tune with the species richness at each station. Such similarity seems to be in accordance with the variability of environmental features including pollution that are greatly influenced by adjacent bay waters and to a limited extent by inputs (mostly polluted) from a freshwater stream 'Mehadrigedda' besides tolerance limits of individual species to different water quality parameters. More successful spatial competitors such as mussels and barnacles frequently overgrow or displace other fouling species (Richmond and Seed, 1991) because of which distantly spaced but diverse fouling communities also attain certain degree of similarity, especially at 'multiple stable points' during fouling development. However, various biological processes in operation in the entire ecosystem, though highly complicated to be comprehended will have their own effect in determining the species composition (Heck Jr. and Valentine, 2007).

Exclusive occurrence of certain species at each of the three stations might be due to their preference for specific environmental regimes (Yan *et al*., 1999) arising as a result of adaptation of individual species, particularly to salinity and pollution. While more of stenohaline forms are likely to be confined to the respective regimes or test stations, euryhalines are capable of occurring at all stations. At this conjecture, it is also important to note that community composition, population abundance, species diversity, etc. in most habitats and ecosystems show a wide range of variation both on spatial and temporal scales and that heterogeneity exists in the physical factors, resource availability and biological interactions (Underwood and Chapman, 2000).

Thus, much similar to the observations of Koutsoubas *et al*. (2000) and Mistri *et al*. (2001) in a Mediterranean lagoon, three groups of fouling species, *viz.*, (1) marine species commonly found in low water dynamic environments, (2) opportunistic species with different degrees of tolerance to organic enrichment and (3) typical euryhaline (brackish water species) were recognized in Visakhapatnam harbour waters.

A total of 18 fouling organisms were identified as new introductions to Visakhapatnam harbour during the present study. Of these 7 taxa, namely, *Anthopleura* sp., *Aiptasia* sp., *Diadumene* sp., *Hydroides* sp. 1, *Hydroides* sp. 2, *Cirolana* sp. and *Paracerceis* sp. are to be considered as 'Species Indeterminata' because of incomplete taxonomic identity.

During recent studies of similar kind, Kolwalkar *et al*. (2008) found 20 species as new records to hard substratum communities at Mormugao Port. Similarly, while Gaonkar *et al*., (2008) reported 15 species as new arrivals of hard substratum dwellers at Mumbai harbour, Swami and Udhayakumar (2008) found them to be 16 from the same harbour including nearshore waters.

Except *C. hendersoni*, *C. willeyi* and *C. bovina*, rest of the species (*B. vestita*, *C. gracilis*, *C. linearis*, *O. dichotoma*, *H. operculatus*, *A. gemmata*, *S. canopus* and *S. oceania*) should be regarded as non-indigenous species (NIS) in the absence of any earlier records (Ganapati *et* *al*., 1958 and Balaji, 1988) of these taxa from Eastern India ecoregion in the Bay of Bengal province under Western Indo Pacific realm as distinguished by Spalding *et al*. (2007). The species, *viz., B. vestita, C. gracilis, C. linearis, A. gemmata, S. canopus* and *S. oceania* are native to the neighboring Southern India and Sri Lanka ecoregion. *Obelia dichotoma* is reportedly distributed worldwide (Medel and Vervoort, 2000) except from Eastern India ecoregion. However the presence of its recognition now in this ecoregion probably indicates that this taxon has slipped from being recognized so far. Although, *H. operculatus* is a native of 'Western Indo Pacific' realm, the species is mostly restricted to Central Somali Coast ecoregion of Somali/Arabian province and Gulf of Aden ecoregion of Red Sea and Gulf of Aden province. Çinar (2006) has recently reported its occurrence in Levantine Sea ecoregion of Mediterranean Sea province in Temperate Northern Atlantic realm. He opined that ship-borne transportation is the only factor responsible for this spread rather than natural dispersal as the same species was not noticed in Red Sea so far. Present record of this alien in Eastern India ecoregion may also be due to the same reason.

Xylotrepans

Altogether a total of 24 wood boring taxa (2 sphaeromatids, 2 pholadids and 20 teredinids) were reported from Visakhapatnam harbour so far (Nagabhushanam, 1955, 1960a; Becker, 1958; Krishna Pillai, 1961; Purushotham and Satyanarayana Rao, 1971; Satyanarayana Rao *et al*., 1989 and Tarakanadha *et al*., 2004). Among them, as many as 16 species, namely, *M. fragilis, M. striata, L. affinis, L. singaporeana, L. pedicellatus, L. bipartitus, D. manni, T. parksi, T. furcifera, T. bartschi, T. navalis, T. clappi, N. dunlopei, B. carinata, B. campanellata* and *B. rochi* were recorded during the present investigations also. But, the remaining 8 species, *viz*., *Sphaeroma terebrans* Bate, *S. annandalei* (Stebbing), *Bactronophorus thoracites* (Gould), *Nototeredo edax* (Hedley), *Teredora princesae* (Sivickis), *Uperotus clavus* (Gmelin), *Teredo triangularis* Edmondson and *B. bipennata* (Turton) were not encountered during the present work. However, in addition, a total of 13 species, namely, *L. indica, M. nairi, Martesia* sp., *L. massa, L. takanoshimensis, L. medilobatus, T. somersi, B. brevis, B. gouldi, B. gracilis, B. philippinensis, B. fimbriatula* and *B. zeteki* hitherto not recorded at this harbour were found for the first time during the present study. Such drastic changes particularly an increment in species composition of the wood borers in Visakhapatnam harbour is quite unanticipated. Although spatial and temporal variation in species composition of the marine forms are not uncommon, the present findings are very surprising especially in the light of anecdotal reports of reduced timber utility for harbour structures, improved adoption of FRP coatings/metal sheathings for protecting the mechanized wooden vessels and substitution of traditional wooden craft by FRP boats. Perhaps, the interplay of several factors contributed to the observed richness of species. Mainly, improved water quality of the harbour waters noticed during the present study might have favoured the arrival of more species. The new arrivals may be a result of either natural dispersal mechanisms or anthropogenic introduction (Louis and Menon, 2008) through vessels, trawlers and wooden boats calling on the port from places far and wide or destruction of aboriginal mangrove habitats in the port vicinity (Swain *et al*., 2009) that compelled native species to spread to alternative habitats. During earlier studies on marine borers at various harbours in the country, 5 taxa were reported at Bombay (Palekar and Bal, 1955); 2 at Karwar (Palekar and Bal, 1957); 8 at Cochin (Saraswathy, 1964); 19 at Madras (Krishnan *et al*., 1983); 10 at Gopalpur (Nayak, 1996) and 18 at Krishnapatnam (Tarakanadha and Rao, 2007). Among new arrivals of wood boring organisms at Visakhapatnam harbour, the occurrence of *M. nairi* was recently reported from Krishnapatnam harbour (Tarakanadha and Rao, 2007), Krishna estuary (Pachu *et al*., 2008) and Rishikonda (Rao *et al*., 2008); *L. massa* from Rishikonda (Rao *et al*., 2008) and Kothakoduru and mangroves (Rao *et al*., 2013); *L. takanoshimensis* from Krishna estuary (Pachu *et al*., 2008), Sagar Nagar, Rishikonda, Kapula Uppada and Bhimunipatnam (Rao *et al*., 2008); *T. somersi* from Bhimunipatnam (Rao *et al*., 2008); *B. brevis* from Krishna estuary (Pachu *et al*., 2008) and Bangarammapalem mangroves (Rao *et al*., 2013); *B. gouldi* from Kothakoduru mangroves (Rao *et al*., 2013); *B. gracilis* from Bangarammapalem mangroves (Rao *et al*., 2013); *B. philippinensis* from Krishna estuary (Pachu *et al*., 2008); *B. fimbriatula* from Krishna estuary (Pachu *et al*., 2008) and *B. zeteki* from Kothakoduru mangroves (Rao *et al*., 2013).

A high number of species (16) common to Slipway Complex and Ore Berth, might be due to uniformity in environmental conditions (salinity, pH, dissolved oxygen, BOD and silicate) prevailing at these two stations during most part of the year(s) under consideration and dissimilarity of these parameters between Marine Foreman Jetty and Slipway Complex/Ore Berth. In contrast, exclusive occurrence of certain wood boring forms either at Slipway Complex or at Ore Berth may be a direct result of the environmental sensitivities of certain species which prefer specific marine regimes that existed at the respective stations during certain periods of the year(s).

The very low number (2) of boring organisms found at Marine Foreman Jetty as against relatively high counts at the other two stations is probably due to the impact of severe pollution at this station. As opined by Nagabhushanam (1960b), heavy fouling noticed at this station during the present study may be an important contributing factor. Purushotham and Satyanarayana Rao (1971) and Kalyanasundaram and Ganti (1975) further deciphered that pollution hinders the wood boring activity to a great extent.

In all, 13 taxa of wood boring organisms were recorded as new arrivals at Visakhapatnam harbour. Of these, the *Martesia* sp. is regarded as 'Species Indeterminata'. Among rest of the species, only *L. indica* is a non-indigenous species because it was not reported from Eastern India ecoregion (recognized by Spalding *et al*., 2007) including Visakhapatnam harbour so far (Nagabhushanam, 1955, 1960a; Becker, 1958; Krishna Pillai, 1961; Purushotham and Satyanarayana Rao, 1971; Satyanarayana Rao *et al.*, 1989 and Tarakanadha *et al*., 2004). This wood borer is distributed in two ecoregions, *viz.*, Western India, Southern India and Sri Lanka of West and South Indian Shelf province and Andaman province in Western Indo Pacific realm. This species is also distributed in South China Sea, Western Coral Triangle, Sunda Shelf and north east Australian Shelf provinces of Central Indo Pacific realm and Cold temperate and North-West Pacific provinces of Temperate Northern Pacific realm. Clearly, this species is a new arrival to Eastern India ecoregion. The species *L. takanoshimensis*, *B. brevis*, *B. gouldi* and *B. philippinensis* were recently documented as new records to Bay of Bengal province in the Eastern India ecoregion. Since, most of the localities in Eastern India ecoregion were not thoroughly explored so far but for Visakhapatnam harbour, the said new arrivals can not be assigned the status of NIS strictly.

The many ramifications of new introductions of this kind were well documented and of these, biodiversity concerns as well as health risks occupy prime place (Subba Rao, 2005). Since, shipping activities take the lion's share in perpetuating this phenomenon, the International Maritime Organization (IMO) set forth several guidelines for ballast water management, which should be strictly adhered to prevent alien introductions by all maritime nations concerned without flaw or fault as 'prevention is better than cure'. However, it is equally important to keep surveillance at all strategic maritime trade centers along the long Indian coast through initiation of biodiversity inventories to generate necessary baseline information on one hand and support sustained biomonitoring programmes to avert any unchallenging consequence and permanent ecological disaster in the long run, on the other.

SUMMARY

A systematic study of marine foulers (xylozoans) and wood borers (xylotrepans) was carried out based on short-term and long-term observations by deploying wooden panels at 3 stations (Slipway Complex, Ore Berth and Marine Foreman Jetty) in Visakhapatnam harbour for a period of two years from February 2007 to January 2009.

Various physico-chemical parameters of surface seawater were analyzed for each of the stations and presented. Results from analyses of physico-chemical parameters indicated that pollution gradient still exists from Slipway Complex to Ore Berth to Marine Foreman Jetty even though there were some improvement in water qualities over a period of three decades.

Xylozoans of Visakhapatnam harbour registered 100 species belonging to 8 major and 2 minor Phyla. As many as 68 species were found at Slipway Complex whereas a total of 57 fouling species at Ore Berth and only 18 taxa at Marine Foreman Jetty were recorded. The inventory of marine fouling organisms was compared with earlier studies at this harbour and other localities in India. A gradual decrease in species count through a pollution gradient from Slipway Complex to Ore Berth to Marine Foreman Jetty was noticed. Cause for such variation is briefly discussed. A total of 18 fouling taxa were found to be new arrivals at Visakhapatnam harbour. Systematic account of all newly recorded xylozoans was furnished. While 7 taxa of xylozoans were regarded as Species Indeterminata, 8 fouling species were considered as NIS. Among the foulers, only *Hydroides operculatus* is a first record to Indian waters.

Xylotrepans of Visakhapatnam harbour were represented by 29 species belonging to 2 phyla. As many as 20 wood boring taxa were found at Slipway Complex whereas a total of 25 species at Ore Berth and only 2 taxa at Marine Foreman Jetty were noted. Comparisons were made among the inventory of marine wood borers at this harbour with various coastal localities in India. Very low number of species at Marine Foreman Jetty may be due to combined effects of pollution and heavy fouling. A total of 13 fouling taxa were found to be new arrivals at Visakhapatnam harbour. Systematic account of all newly recorded marine borers was provided. Only *Limnoria* (*Limnoria*) *indica* was regarded as non-indigenous species whereas an unidentified species of genus *Martesia* was found to be 'Species Indeterminata'.

ACKNOWLEDGEMENTS

The authors are thankful to the authorities of the Indian Council of Forestry Research and Education; Ministry of Shipping, Road Transport and Highways (Government of India); National Institute of Oceanography (Goa) and Visakhapatnam Port Trust for promoting the project and its activities. Many thanks for identification of different groups are given to the following : Dr. Rolando Bastida-Zavala of LABSIM, Ciudad Universitaria, Oaxaca, Mexico for serpulids; Dr. N.V. Subba Rao and Shri K.V. Surya Rao, Scientists (Retd.) of Zoological Survey of India, Dr. Richard Willan of Museum and Art Gallery Northern Territory, Darwin, Australia and Dr. (Mrs.) Shirley Slack-Smith of Western Australian Museum, Welshpool, Australia for molluscs; Dr. Anil Mohapatra, Scientist, Zoological Survey of India for crabs and prawns; Dr. V.K. Meenakshi of Department of Zoology, A.P.C. Mahalaxmi College for Women, Tuticorin for ascidians and Dr. Simon Cragg of University of Portsmouth, U.K. for confirmation of a borer pallet. The senior author is thankful to the Director, Zoological Survey of India, Kolkata for kind support and encouragement. Special thanks to Dr. R.M. Sharma, Officer-in-Charge, Zoological Survey of India, Western Regional Centre, Pune and Dr. L.N.

Santhakumaran, Scientist (Retd.) of Institute of Wood Science and Technology for encouragement and advice.

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PLATE - I

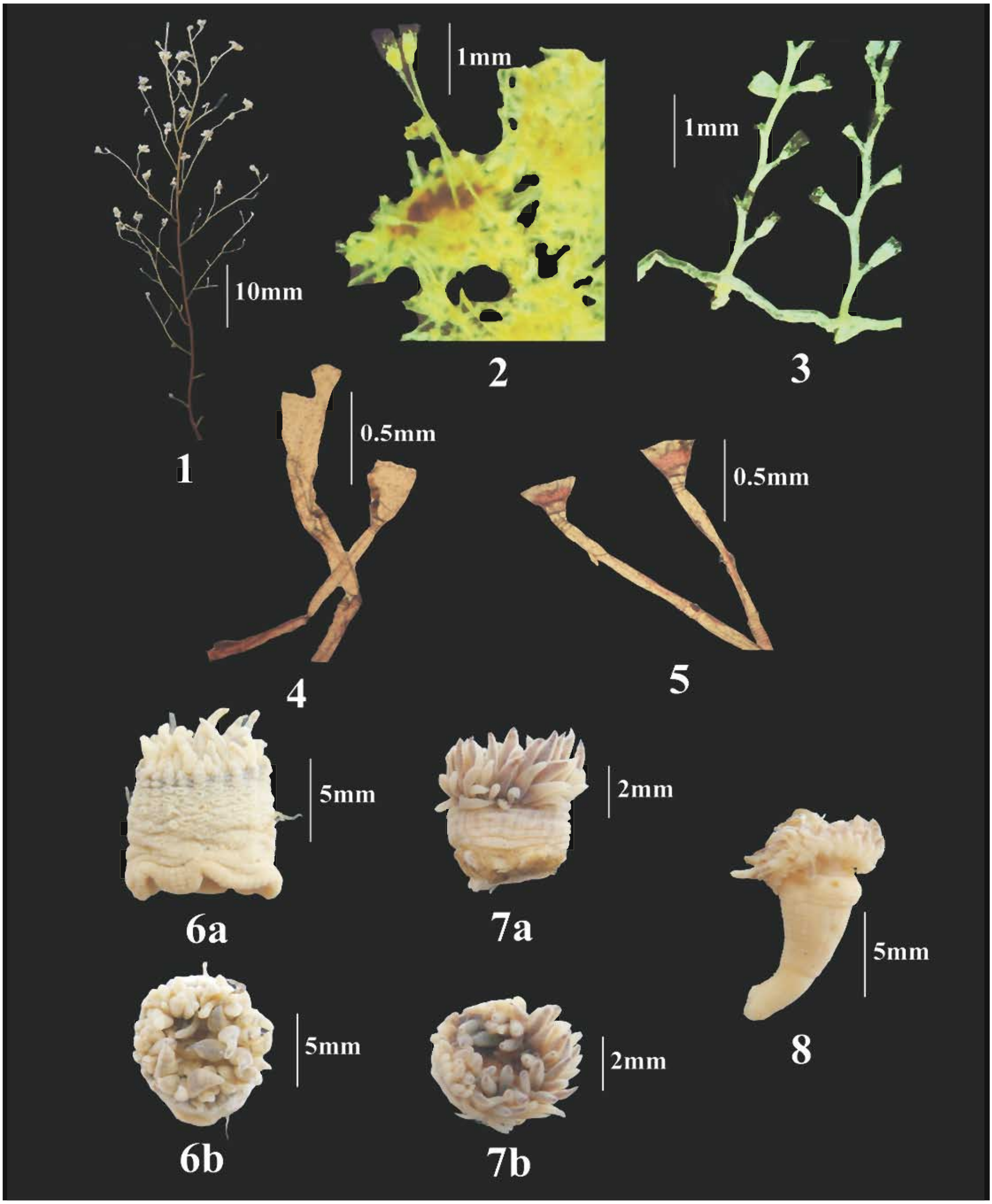

Plate-1 : Newly recorded foulers at Visakhapatnam harbour (Fig. 1-8). 1. *Bimeria vestita*: a single colony; 2. *Clytia gracilis* : part of a colony; 3. *Clytia hendersoni* : part of a colony; 4. *Clytia linearis*: part of a colony; 5. *Obelia dichotoma* : part of a colony; 6. *Anthopleura* sp. : 6a. lateral view and 6b. oral disc; 7. *Aiptasia* sp. : 7a. lateral view and 7b. oral disc; 8. *Diadumene* sp. : lateral view.

PLATE - II

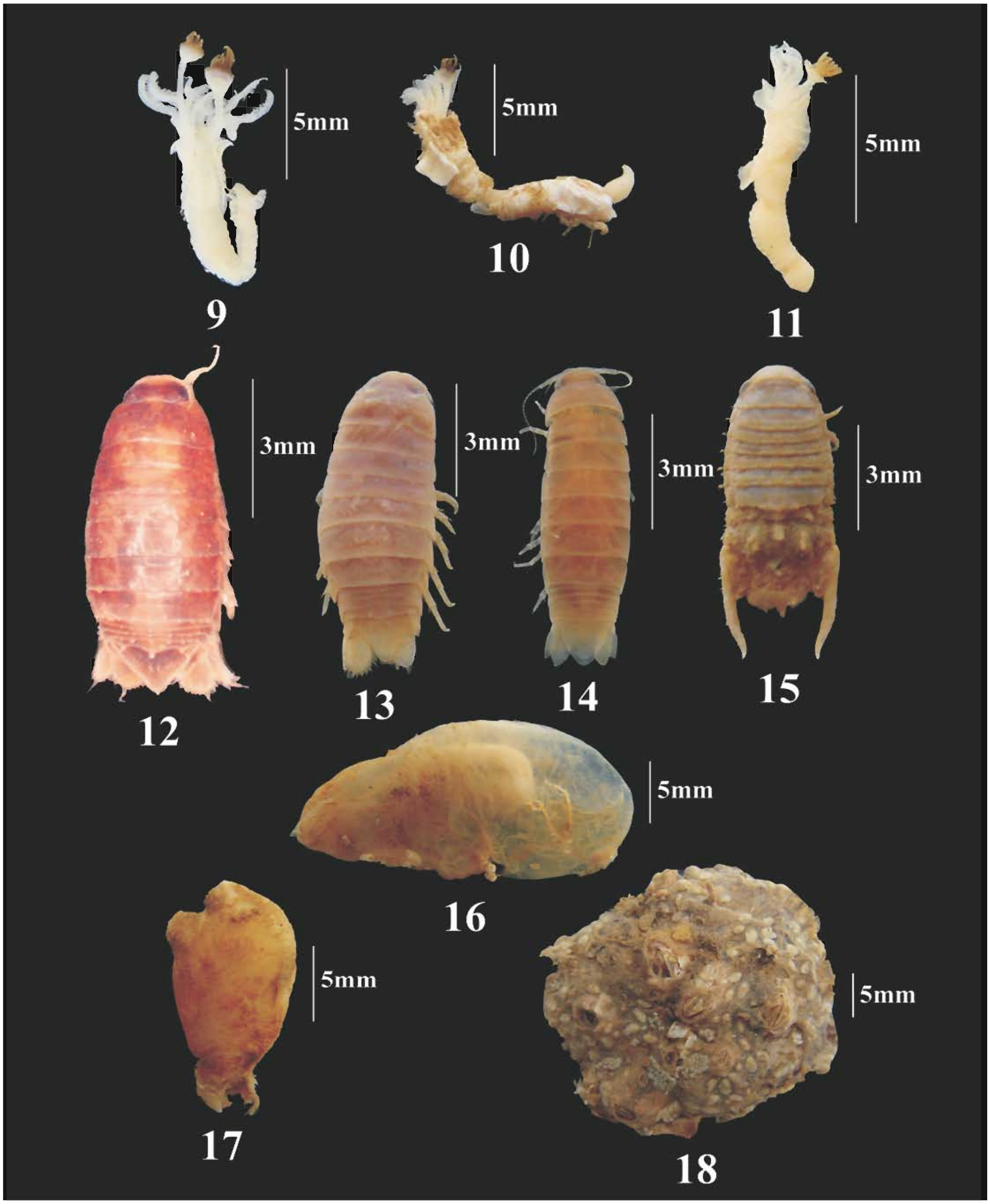

Plate-2 : Newly recorded foulers at Visakhapatnam harbour (Fig. 9-18). 9. *Hydroides operculatus* : whole animal; 10. *Hydroides* sp. 1 : animal with calcareous tube; 11. *Hydroides* sp.-2 : whole animal; 12. *Cirolana willeyi* : dorsal view; 13. *Cirolana bovina* : dorsal view; 14. *Cirolana* sp. : dorsal view; 15. *Paracerceis* sp. : dorsal view; 16. *Ascidia gemmata* : whole animal; 17. *Styela canopus* : whole animal; 18. *Symplegma oceania* : a colony.

PLATE - III

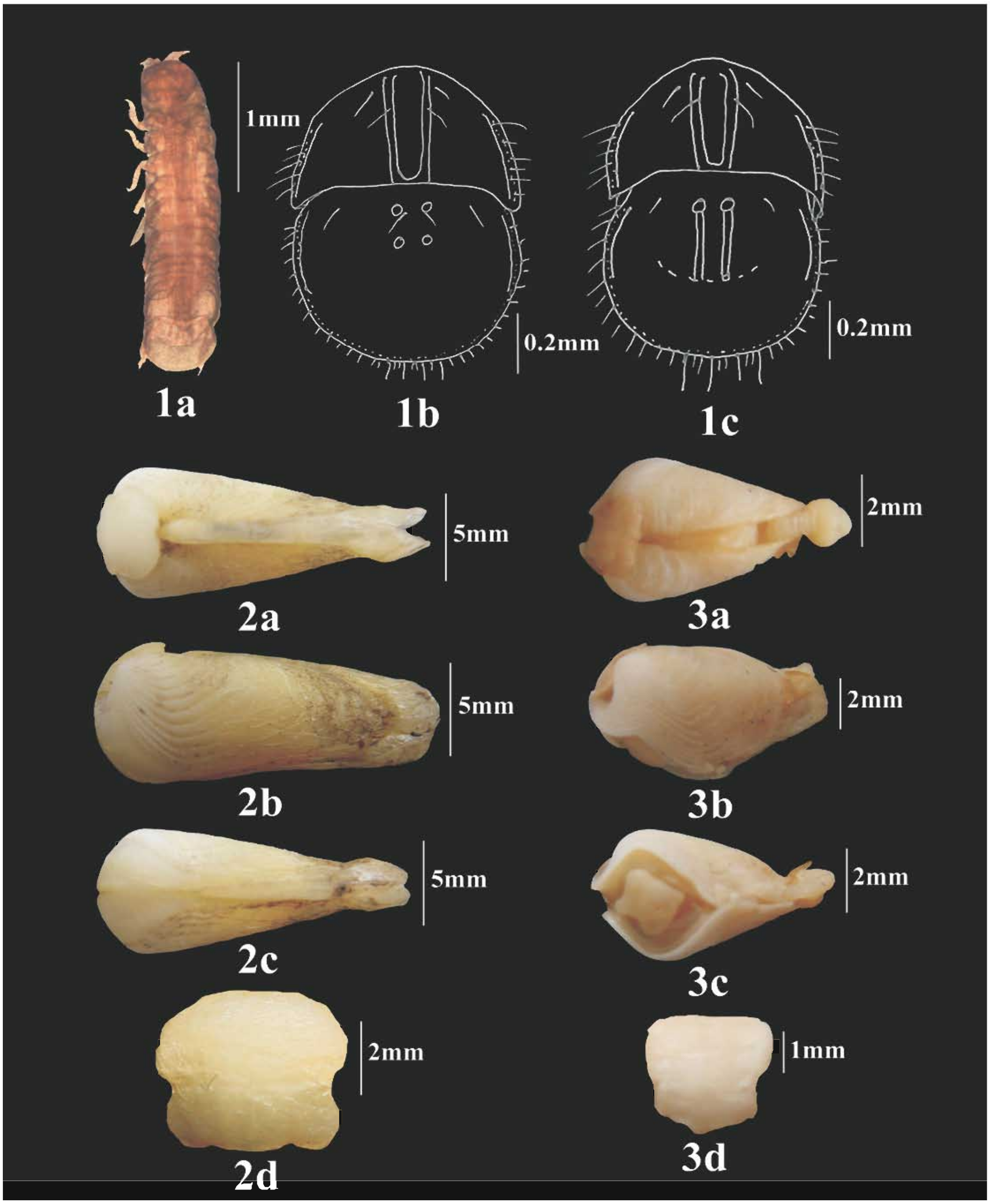

Plate-3 : Newly recorded marine wood borers at Visakhapatnam harbour (Fig. 1-3). 1. *Limnoria indica* : 1a. dorsal view of a male, 1b. pleotelson of a male and 1c. pleotelson of a female; 2. *Martesia* (*Particoma*) *nairi* : 2a. dorsal view, 2b. lateral view, 2c. ventral view and 2d. dorsal view of the mesoplax; 3. *Martesia* sp. : 3a. dorsal view, 3b. lateral view, 3c. ventral view and 3d. dorsal view of the mesoplax.

PLATE - IV

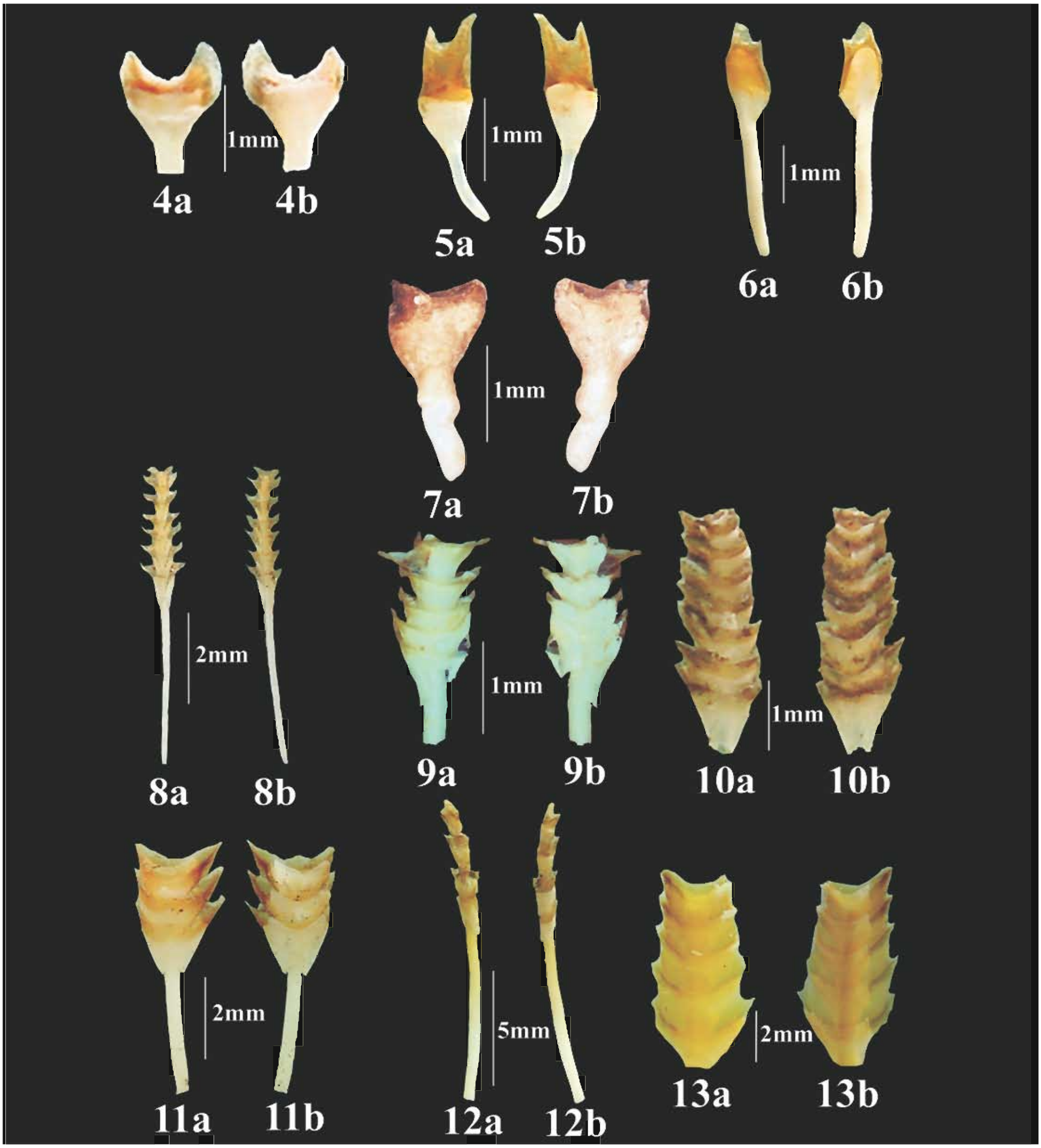

Plate-4 : Newly recorded marine wood borers at Visakhapatnam harbour (Fig. 4-13). 4. *Lyrodus massa* : 4a. outer face of the pallet and 4b. inner face of the pallet; 5. *Lyrodus takanoshimensis* : 5a. outer face of the pallet and 5b. inner face of the pallet; 6. *Lyrodus medilobatus* : 6a. outer face of the pallet and 6b. inner face of the pallet; 7. *Teredo somersi* : 7a. outer face of the pallet and 7b. inner face of the pallet; 8. *Bankia brevis* : 8a. outer face of the pallet and 8b. inner face of the pallet; 9. *Bankia gouldi* : 9a. outer face of the pallet and 9b. inner face of the pallet; 10. *Bankia gracilis* : 10a. outer face of the pallet and 10b. inner face of the pallet; 11. *Bankia philippinensis* : 11a. outer face of the pallet and 11b. inner face of the pallet; 12. *Bankia fimbriatula* : 12a. outer face of the pallet and 12b. inner face of the pallet; 13. *Bankia zeteki* : 13a. outer face of the pallet and 13b. inner face of the pallet.