

AN APPEAL

Zoological Survey of India (ZSI) is a premier taxonomic research organization, under the Ministry of Environment, Forests and Climate Change (MoEF&CC), Govt. of India, engaged in zoological research and documentation of the faunal resources of the country. It was established on 1st July 1916 to promote the survey, exploration and research on the fauna of the Indian Region.

Zoological Survey of India at the time of its inception had inherited enormous collection of zoological specimens/ exhibits from the erstwhile Asiatic Society of Bengal and the Indian Museum, Kolkata. Since then the Survey has been acting as the custodian of this heritage collection, caring and maintaining them. The collection, comprising the zoological specimens of all groups of animals from microscopic protozoa to huge elephants and whales, is a priceless wealth of the country and is called the “National Zoological Collection” (NZC).

Zoological Survey of India has been making all efforts to enrich its zoological collections by accepting the ‘types’ and other identified faunal materials from animal taxonomists and biodiversity researchers of various zoological institutions and universities in the country and abroad. Zoological Survey of India, Kolkata, including its Regional Centres, has been designated by MoEF&CC to act as the ‘National Repository’ for all faunal groups from India, under the Act, in exercise of the powers conferred by sub-section (1) of Section 39 of the Biological Diversity Act, 2002, read with sections 6 and 12 of Notification S.O. 1911 (E), dated 8th November, 2006.

The zoological collection under the custody of ZSI has grown over the years to become the best and the largest one in South-East-Asia, with the well-represented collections of the fauna of India and adjacent countries, even that of the distant Kampuchea in Southeastern Asia. ZSI has at present in its NZC holding nearly 4.5 million specimens of about 70,000 species, out of the approximately 96,373 species (nearly 8 per cent of the world fauna) so far realized from the Indian Region. Among this collection includes about 18,000 ‘type’ specimens, such as holotypes, paratypes, syntypes, etc., which are unique and of highest scientific importance. They are the original specimens, serving as the voucher specimens, on which new species descriptions have been based. The ‘type specimens’ typify and fix the species/genus name for all time, and remain available for examination, comparison and correction in future studies.

Type specimens and identified reference collections are invaluable to researchers for any taxonomic work as they form the basis for accurate and reliable identification; they are also the fundamental units of bio-resource for new analytical techniques related to higher-level research on taxonomy and systematics (e.g. molecular taxonomy). They represent the irreplaceable national/international asset in perspectives of zoological research and biodiversity informatics.

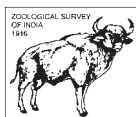
ZSI intends to augment its zoological collection to make it a more complete one, enriching it with species not represented in the collection. Zoological Survey of India is therefore soliciting the

cooperation of the animal taxonomists, biodiversity researchers, scientists and naturalists, appealing to them to deposit their ‘type’ materials—holotype or paratype(s)—and other identified specimens to the ‘National Repository’ of Zoological Survey of India. The researchers may deposit their ‘material’ to ZSI in the following address:

Officer-in-Charge, Identification and Advisory Section,
Zoological Survey of India, M-Block, New Alipore,
Kolkata – 700 053.

The ‘type’ and other identified specimens will be duly registered, and the data will be computerized. The researchers may use the Registration number of their deposited ‘type’(s) in their publications of the new taxon/ taxa.

Dr. K. Venkataraman
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Zoological Survey of India



PROTOZOANS AND OTHER FAUNA ASSOCIATED WITH SEA GRASS ECOSYSTEMS OF PALK BAY

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INTRODUCTION

Palk Bay is situated in the southeast coast of India between latitude 9° 55' -10° 45' N and longitude 78° 58' -79° 55' E. The Palk Bay itself is about 110 km long and is surrounded on the northern and western sides by the coastline of the state of Tamil Nadu in the mainland of India. Palk Bay is a shallow and flat basin, the depth hardly exceeds 9 metres on an average. The Palk bay has landmarks between the Point Calimere and Rameswaram island as northern and southern borders, respectively. The eastern part of the bay is connected with Srilanka whereas the western part of the bay is the border of the Indian subcontinent. The plants and animals of this bay are dependent on various physicochemical factors including nutrients which are responsible for the fertility of the water masses (Harvey, 1995). The areas are rich in biological diversity and have a long history of human settlement, use and exploitation. They contain diversified and productive ecosystems such as estuaries, salt marshes, seagrass beds and mangroves that are sensitive to human activities.

Seagrasses are specialized marine flowering plants classified under the superorder Alismatiflorae, belonging to the class Monocotyledonae adapted to the near shore environment. These form extensive meadows supporting rich biodiversity (Connolly *et al.*, 1999). These plants regulate water column dissolved oxygen, modify their physical and chemical

environments, and reduce suspended sediments, chlorophyll and nutrients in the water column (Nair and Gopinathan, 1983). Seagrasses stabilize sediments, slow water movements and trap heavy metals and nutrient rich runoff, thus improving the water quality for corals and other fauna. From the Indian coast, 14 species of sea grasses under seven genera have been reported and grow in shallow and sheltered coastal waters, anchored in sandy or muddy bottoms. Sea beds on which they form complex ecosystems harbour a variety of organisms and function as nursery grounds for many commercially important species. The major seagrass meadows in India occurs along the Gulf of Mannar and Palk Bay. The regions of India that are colonized by seagrasses support rich and diverse fauna like corals, sea anemones, mollusks and microorganisms. The seagrass species diversity is high in Gulf of Mannar and Palk Bay and the seagrasses are one of the important producer in the marine environment from extensive meadows supporting high biodiversity; serves as feeding and nursery habitat. Although many studies have been done on different seagrass associated faunal groups, the study of microfauna is almost lacking. The taxonomic inventorization and systematics of protozoa and other organisms with reference to the major sea grass areas is a lacuna so far for these important ecosystems in India. In this context the present study of protozoa and associated organisms of sea grass ecosystems was proposed and 21 species of sea grass associated rhizopods belonging to 8 genera and 6 families; 29 species

of foraminifera coming under 25 genera and 16 families and 9 species of nematodes under 9 genera and 6 families have been identified and reported herewith.

MATERIAL AND METHODS

The survey covered different seagrass areas of Palk Bay like Thondi, Thiruppalaikkudi, Devipatinam, S.P. Patinam, Mimisel, Pasipatinam, Panaikulam and Attankarai, of Tamil Nadu state. Collected sand samples and water samples with sea grass from different sea grass beds using standard methods for the study of protozoa and other organisms. 5 species of sea grasses were identified from the study areas as *Cymodocea rotundata*, *Cymodocea serrulata*, *Halodule uninervis*, *Syringodium isoetifolium* and *Halophila ovata*.

SYSTEMATIC ACCOUNT

The systematic account of the identified groups are given below

1. Rhizopods

Subkingdom PROTOZOA
Phylum SARCOMASTIGOPHORA
Class LOBOSEA
Order TESTACEALOBOSA
Family ARCELLIDAE

1. *Arcella discoides* Ehrenberg 1843

1843. *Arcella discoides* Ehrenberg, Ber K. Akad. Wiss., Berlin, p. 139.

1928. *Arcella discoides* Ehrenberg: Deflandre, Arch. Protistenkd., 64, p. 256

Material examined: 1ex., Thondi, 29. x. 2010, K. Venkatraman and party; 2exs., Thondi, 5. x. 2011, Bindu. L and party; 2exs., Athankarai, 4. ii. 2012 Bindu. L and party; 3exs., Mimisel, 3. ii. 2012, Bindu. L and party.

Diagnosis: Test light yellow, smooth, flattened, circular in front view and planoconvex in lateral view with a rounded border, height of test about one-third to one-fourth the diameter, oral aperture large and circular.

Distribution: Cosmopolitan.

Remarks: First record associated with seagrass.

Family CENTROPYXIDAE

2. *Centropyxis aculeata* (Ehrenberg 1832) Stein 1857

1832. *Arcella* Ehrenberg, Abh. Preuss. Akad. Wiss., Berlin, p. 40.

1857. *Centropyxis aculeata* Stein, Sitz. Bohm. Gesellsch. Wiss., Prague, 5(10), p. 41

Material examined: 3 exs., Adirampatinam, 30. x. 2010, K. Venkatraman and party; 2exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 2exs., Devipatinam, 5. x. 2011, Bindu. L and party; 1ex., Adirampatinam, 6. x. 2011, Bindu. L and party.

Diagnosis: Test compressed in ventral view, cap-shaped in lateral view; fundus obtusely rounded and furnished with few spines (usually 4-6), divergent at the border of the test, arranged in a single somewhat regular row; aperture eccentric and circular or oval, test brownish, frequently encrusted with quartz crystals and sometimes with sand particles.

Distribution: Cosmopolitan.

Remarks: First record associated with seagrass.

3. *Centropyxis aerophila* Deflandre, 1929

1929. *Centropyxis aerophila* Deflandre, Arch. Protistenkd., 67, p. 330

Material examined: 4exs., S. p. Patinam, 7. x. 2011, Bindu. L and party; 2exs., Devipatinam, 5. x. 2011, Bindu. L and party; 2exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 1ex., Athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: Test ovoid in ventral view and pear shaped in lateral view; flank of posterior part of the test little arched, often almost straight, fundus spheroidal with dorsal face strongly flattened towards oral aperture; test hyaline, yellowish or yellowish brown, chitinous, finely punctuate and rough bearing foreign particles, usually vegetable fragments; aperture semi-circular or elliptical.

Distribution: Cosmopolitan.

Remarks: First record associated with seagrass.

4. *Centropyxis constricta* (Ehrenberg, 1841)
Penard, 1902

1841. *Arcella constricta* Ehrenberg, *Abh. Akad. Wiss. Berlin*.

1929. *Centropyxis constricta* Deflandre, *Arch. Protistenkd.*, 67, p. 340.

Material examined: 3exs., Pasipatinam, 3. ii. 2012, Bindu. L and party; 1ex., Mallipatinam, 6. x. 2011, Bindu. L and party.

Diagnosis: Test elliptical or oval and elongated in ventral view, its anterior border largely elliptical, sometimes nearly circular and posterior part strongly arched; test grayish in colour and covered with sand particles and one or a few stony particles often attached with its posterior most border; in lateral view test sufficiently elevated at posterior part; aperture eccentric, largely elliptical, sometimes circular and located near the anterior border of the test.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

5. *Centropyxis minuta* Deflandre, 1929

1929. *Centropyxis minuta* Deflandre, *Arch. Protistenkd.*, 67, p. 366.

1902. *Diffugia constricta* Penard, *Fauna Rhizopodique du bassin du Leman*, Geneve, p. 299, figs. 13-14.

Material examined: 1ex., Thondi, 29. x. 2010, K. Venkatraman and party; 2exs., Mimisel, 7. x. 2011, Bindu. L and party; 2exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 3exs., Thirupalaikkudy, 5. x. 2011, Bindu. L and party; 1ex., Athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: Test small, grayish or brown, less conspicuous, more or less circular in ventral view with slightly more elevated posterior part; aperture circular, eccentric and in general obliquely invaginated, test encrusted with siliceous particles.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

6. *Centropyxis orbicularis* Deflandre, 1929

1929. *Centropyxis orbicularis* Deflandre, *Arch. Protistenkd.*, 67, p. 334.

Material examined: 1ex. Mimisel, 3. ii. 2012, Bindu. L and party; 2exs., Thondi., 2. ii. 2012, Bindu. L and party; 2exs., Mimisel, 7. x. 2011, Bindu. L and party.

Diagnosis: Test brownish, almost circular in ventral view, ventral surface flat; in lateral view test semi-circular, displaying considerable invagination towards the oral aperture; oral aperture nearly semi-circular, plagiostomic; test encrusted with large stony particles on its dorsal border.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

7. *Cyclopyxis* sp. Deflandre, 1929

1929. *Centropyxis* (*Cyclopyxis*) Deflandre, *Arch. Protistenkd.*, 67, pp. 330, 337

Material examined: 1ex., Thondi, 29. x. 2010, K. Venkatraman and party; 2exs., Thirupalaikkudy, 2. ii. 2012, Bindu. L and party; 1ex., Devipatinam, 5. x. 2011, Bindu. L and party.

Diagnosis: Test regularly arched, oral aperture centrally located.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

Family DIFFLUGIIDAE

8. *Diffugia acuminata* Ehrenberg, 1838

1838. *Diffugia acuminata* Ehrenberg, *Infusionsthierehen*, p. 131, pl. 9, fig.3.

Material examined: 8exs., Devipatinam, 5. x. 2011, Bindu. L and party; 5 exs., Devipatinam, 2. ii. 2012, Bindu. L and party; 3exs., Thondi, 2. ii. 2012, Bindu. L and party; 2exs., Mimisel, 3. ii.

2012, Bindu. L and party; 3exs., S. P. Patinam, 3. ii. 2012, Bindu. L and party

Diagnosis: Test cylindrical, without any collar and with pointed horn like extension at the base; horn straight and differentiated from the base. Quartz crystals of test big; some even projecting out of the margin of the test giving an irregular appearance of its margin.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

9. *Diffflugia globulosa* Dujardin, 1837

1837. *Diffflugia globulosa* Dujardin, *Ann. Sci. nat. zool.* (2) 8, p. 310, pl. 9. fig. 1.

Material examined: 1ex., Athankarai, 4. ii. 2012, Bindu. L and party; 2exs., Devipatinam, 5. x. 2011, Bindu. L and party.

Diagnosis: Test slightly ovoidal; pseudostome circular; its diameter about half of that of the test; diversified material like clay, mineral platelets, vegetable fragments etc, embedded in brownish chitinous membrane.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

10. *Diffflugia lobostoma* Leidy, 1879

1879. *Diffflugia lobostoma* Leidy, *Freshwater Rhizopods of North America*, p. 112

Material examined: 3exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 1ex., Mimisel, 7. x. 2011, Bindu. L and party.

Diagnosis: Test ovoidal, oral aperture usually quadrilobed in the form of a cross and sometimes trilobed, not enclosed by collar, test covered with angular quartz particles.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass

11. *Diffflugia lucida* Penard, 1890

1890. *Diffflugia lucida* Penard *Mem. Soc. Phys. et. Hist. Nat. Geneve*, 31, p. 145.

1958. *Diffflugia lucida* Gauthier-Lievre and Thomas, *Arch. Protistenkd.*, 103, p. 294.

Material examined: 1ex., Thondi, 29. x. 2010., K. Venkatraman and party; 2exs., Devipatinam, 5. x. 2011, Bindu. L and party; 1ex., Athankarai, 4. ii. 2012, Bindu. L and party; 3exs., Panaikulam, 4. ii. 2012, Bindu. L and party.

Diagnosis: Test elongate, transparent, slightly compressed, covered with flat quartz particles.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

12. *Diffflugia oblonga* Ehrenberg, 1838

1838. *Diffflugia oblonga* Ehrenberg, *Infusionsthierchen*, p. 131, pl. 2, figs. 3a-d.

Material examined: 4exs., Devipatinam, 5. x. 2011, Bindu. L and party; 2exs., Sp. Patinam, 7. x. 2011, Bindu. L and party; 2exs., Mimisel, 3. ii. 2012, Bindu. L and party; 1ex., Athankarai, 4. ii. 2012, Bindu. L and party

Diagnosis: Test typically oblong, crown(post-oral portion) usually rounded, composed of big angular quartz crystals; pseudostome circular.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

13. *Diffflugia tuberculata* Wallich 1864.

1864. *Diffflugia proteiformis* sub sp. *Globularis* var. *tuberculata* Wallich, *Ann. Mag. Nat. Hist.* (3) 13, p. 241, pl. 15, fig. 48 and pl. 16, fig. 18.

Material examined: 1ex., Thirupalaikkudy, 29. x. 2010, Dr. K. Venkatraman and party; 3exs., Thondi, 5. x. 2011, Bindu. L and party; 2exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 2exs., S. P. Patinam, 3. ii. 2012, Bindu. L and party; 1ex., Athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: Test ovoidal with wide base; pseudostome hexagonal in outline with obtuse angles surrounded by a short collar; test yellowish or chocolate brown, covered with tubercles or

disc-shaped protuberances and composed of small platelets perfectly uniting the tubercles.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

Family NEBELIDAE

14. *Nebela dentistoma* Penard, 1890

1890. *Nebela dentistoma* Penard, Mem. Soc. Phys. et Hist. Nat. Geneve, 31, p. 162.

1879. *Nebela collaris* (Partim) Leidy, Freshwater Rhizopods of North America, pl. 24, fig. 12.

Material examined: 2exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 3exs., S. P. Patinam, 7. x. 2011, Bindu. L and party.

Diagnosis: Test variable, ovoid to pyriform, compressed, without any neck, margin of aperture crenulate, test covered with small, circular, polygonal or oval transparent platelets, usually of uniform size or mixed with angular platelets or short rods of chitinous or siliceous substance.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

15. *Nebela walesi* Deflandre, 1936

1936. *Nebela walesi* Deflandre, Ann. Protist. 5, p. 265.

1911. *Nebela lageniformis* var. minor Wailes, proc. R. Irish Acad., 31, p. 157

Material examined: 2exs., Mimisel, 7. X. 2011, Bindu. L and party; 2exs., S. P. Patinam, 7. x. 2011, Bindu. L and party; 2exs., Mimisel, 3. ii. 2012, Bindu. L and party; 3exs., Athankarai, 4. ii. 2012, Bindu. L and party; 1ex., Panaikulam, 4. ii. 2012. Bindu. L and party.

Diagnosis: Test flask-shaped with a torulose neck, aperture slightly arched and bordered by thickened organic collar; in lateral view test vase-shaped but slightly compressed; test covered with elliptical, polygonal or rounded platelets of mixed sizes.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

Family CYPHODERIIDAE

16. *Cyphoderia ampulla* (Ehrenberg, 1840) Leidy, 1878

1840. *Diffugia ampulla* Ehrenberg, Bericht press. Akad. Wis., p. 199.

1878. *Cyphoderia ampulla* Leidy, Proc. Akad. Nat. Sci. Philad. P. 173.

Material examined : 2exs., Mallipatinam, 6. x. 2011, Bindu. L and party.

Diagnosis: Test yellowish or brownish, translucent, covered with distinct circular or oval scales or plates lying appreciably apart, aperture circular, terminal, placed obliquely with a curved neck, fundus of the present materials obtusely rounded.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

Family EUGLYPHIDAE

17. *Euglypha acanthophora* (Ehrenberg, 1842) Perty, 1849

1842. *Diffugia acanthophora* Ehrenberg, Abh. Acad. Berlin, 1842, pp. 413, 444, pl 4., fig. 36.

1915. *Euglypha acanthophora* : Cash, Wailes and Hopkinson, *The British Freshwater Rhizopoda and Heliozoa*, 3, p. 8.

Material examined: 2exs., Thondi, 5. x. 2011, Bindu. L and party; 2exs., Devipatinam, 5. x. 2011, Bindu. L and party; 1ex., S. P. Patinam, 3. ii. 2012, Bindu. L and party; 2exs., Athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: Test ovoid or slightly elongated towards aperture, not compressed; aperture circular, bordered by one or occasionally two rows of finely serrated apertural platelets; test platelets elliptical, some platelets of posterior half and at the base of fundus prolonged into spines, spines usually 4-7 in number.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

18. *Euglypha cristata* Leidy, 1874

1874 (1875). *Euglypha cristata* Leidy, Proc. Acad. Philad., p. 226.

1915. *Euglypha cristata* : Cash, Wailes and Hopkinson, The British Freshwater Rhizopoda and Heliozoa, 3, p. 19, pl. 34, figs. 1-2, pl. 35, figs. 6-8, text-fig. 115.

1988. *Euglypha cristata*: Luftenegger *et al.*, Arch. Protistenkd., 136, p. 172, figs. 15 & 26.

Material examined: 2exs., S. P. Patinam, 7. x. 2011, Bindu. L and party; 6exs., Thondi, 2. ii. 2012, Bindu. L and party; 4exs., Devipatinam, 2. ii. 2012, Bindu. L and party.

Diagnosis: Test elongated, colourless, slightly compressed, fundus hemispherical, furnished with a bunch of 3-8 long curved spines; aperture circular bordered by a single row of 6 elongated denticulated platelets, each with one inwardly bent median tooth and 3 pairs of lateral teeth.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

19. *Euglypha rotunda* Wailes and Penard 1911

1911. *Euglypha rotunda* Wailes and Penard, Proc. R. Irish Acad., 31, pp.17, 41, 60-62, pl. 4, Figs. 19a-g.

1915. *Euglypha rotunda* : Cash, Wailes and Hopkinson, The British Freshwater Rhizopoda and Heliozoa, 3, p. 31. Pl. 34, fig. 9; pl. 35, figs. 14-16, text-fig.121.

Material examined: 2exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 1ex., Mimisel, 7. x. 2011, Bindu. L and party

Diagnosis: Test small, oviform, glabrous, compressed, test platelets oval, about twice as long as broad, slightly imbricated, aperture circular, bordered by 8 apertural platelets; apertural platelets with one median tooth bent towards interior of the aperture and two pairs of lateral teeth, platelets of the test oval and imbricated.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

20. *Trinema enchelys* (Ehrenberg, 1838) Leidy, 1878

1838. *Diffugia enchelys* Ehrenberg (Partim), *Infusionsth.*, p. 132, pl. 9, Figs. 4 a-b.

1878. *Trinema enchelys* Leidy, Proc. Acad. Philad., p. 172.

1915. *Trinema enchelys* : Cash, wailes and Hopkinson, The British Freshwater Rhizopoda and Heliozoa, 3, p. 86, pl. 47, figs. 1-10, pl. 48, figs. 1-3, text-figs. 1-3.

Material examined: 2exs., Thondi, 5. x. 2011, Bindu. L and party; 3exs., Devipatinam, 5. x. 2011, Bindu. L and party; 2exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 2exs., Mimisel, 3. ii. 12, Bindu. L and party; 2exs., Athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: Test hyaline, elliptic, formed of siliceous circular large particles, scarcely overlapping, as well as smaller platelets of different sizes in between large ones; aperture circular, oblique, invaginated, bordered by toothed apertural platelets.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass

21. *Trinema lineare* Penard, 1890

1890. *Trinema lineare* Penard, *Mem. Soc. Geneve*, 31, p. 187, pl. 11., Figs. 5-17.

1915. *Trinema lineare* : Cash, Wailes and Hopkinson, *The British Freshwater Rhizopoda and Heliozoa*, 3, p. 91, pl. 47, figs. 11-21.

Material examined: 2exs., Thondi, 5. x. 2011, Bindu. L and party; 1ex., Devipatinam, 5. x. 2011, Bindu. L and party; 3exs., S. P. patinam, 3. ii. 2012, Bindu. L and party; 1ex., athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: Test hyaline, elliptic or elongate, formed of circular platelets of different sizes, almost invisible in vivo, aperture circular, oblique, invaginated, bordered by toothed apertural platelets.

Distribution: Cosmopolitan

Remarks: First record associated with seagrass.

2. Foraminifera

Kingdom PROTOCTISTA

Phylum GRANULORETICULOSA

Class FORAMINIFERA

Order LITUOLIDA

Family : Ammodiscidae

1. *Glomospira* sp. Rzehak, 1888

1992. Loeblich and Tappan. Foraminiferal genera and their classification, pp. 829.

Material examined: 3exs., Thondi, 2. ii. 2012, Bindu. L and party; 3exs., Thondi, 2. ii. 2012, Bindu. L and party.

Diagnosis: Test free, with a proloculum and long, tubular, undivided, second chamber winding about its earlier coils in various planes; wall arenaceous with much cement; aperture at the end of the tube – Silurian to Recent.

Distribution: Cosmopolitan

Family HAPLOPHRAGMOIDIDAE

2. *Haplophragmoides* sp. Cushman, 1910

1992. Loeblich and Tappan. Foraminiferal genera and their classification, pp. 829.

Material examined: 2exs., Devipatinam, 5. x. 2011, Bindu. L and party.

Diagnosis: Test free, planispiral, of several coils, usually not completely involute; chambers simple; wall single, arenaceous or with sponge spicules, firmly cemented, amount of cement varying greatly in different species; aperture simple, at the base of the apertural face of the chamber.-Carboniferous to Recent.

Distribution: Cosmopolitan

Order TROCHAMMINIDA

Family TROCHAMMINIDAE

3. *Ammoglobigerina* sp. Eimer and Fickert, 1899

1899. Eimer, G.H.T., Fickert, C.. *Die Artbildung und Verwandtschaft bei den Foraminiferen. Entwurf einer naturlichen Eintheilung derselben.* Zeitschrift fuer Wissenschaftliche Zoologie 65, 599-708

2001. Gross, O. *Foraminifera*, in: Costello, M.J. *et al.*, (Ed.) (2001). *European register of marine species: a checklist of the marine species in Europe and a bibliography of guides to their identification.* Collection Patrimoines Naturels, 50: pp. 60-75.

Material examined: 2exs., Devipatinam, 2. ii. 2012, Bindu. L and party.

Diagnosis: Test free or adherent, spiral, trochoid all chambers visible from dorsal side, only those of the last-formed whorl from the ventral, varying from much compressed to nearly globular; wall arenaceous, with chitinous base, amount of cement very variable; aperture an arched slit at the inner margin of the ventral side of the chamber.-Silurian to Recent.

Distribution: Cosmopolitan

4. *Trochamina inflata* (Montagu,1808)

2009. B. K. Sen Gupta, L. E. Smith, and M. L. Machain-Castillo *Foraminifera of the Gulf of Mexico*, Pp. 87–129 in Felder, D.L. and D.K. Camp (eds.), *Gulf of Mexico—Origins, Waters, and Biota*.

Material examined : 2exs., Thondi, 5. x. 2011, Bindu. L and party; 2exs., Devipatinam, 5. x. 2012, Bindu. L and party; 3exs., Mimisel, 3. ii. 2012, Bindu. L and party; 2exs., S. P. Patinam, 3. ii. 2012, Bindu. L and party.

Diagnosis: The small subtrochoid test is unequally biconvex. The inflated chambers are increasing in size gradually in the earlier whorls, but rapidly in the final whorl. The distinct sutures are depressed both ventrally and dorsally. Umbilical depression is deep. The rounded periphery is lobulate. The thin arenaceous wall has smoothly cemented fine sand grains. The narrow slit like aperture is on the ventral side of the apertural face.

Distribution: Cosmopolitan

Order TEXTULARIIDA

Family : Eggerellidae

5. *Eggerella bradyi* (Cushman, 1911)

2001. Gross, O. *Foraminifera*, in: Costello, M.J. *et al.*, (Ed.) (2001). *European register of marine species: a checklist of the marine species in Europe and a bibliography of guides to their identification.* Collection Patrimoines Naturels, 50: pp. 60-75

2004. Cornelius, N., Gooday, A.J. 'Live'(stained) deep-sea benthic foraminiferans in the western Weddell Sea: trends in abundance, diversity, and taxonomic composition along a depth transect. *Deep-Sea Research II* 51, 1571-1602.

Material examined: 2exs., Thondi., 2. ii. 2012, Bindu. L and party; 3exs., Devipatinam, 2. ii. 2012, Bindu. L and party; 2exs., Mimisel, 3. ii. 2012, Bindu. L and party.

Diagnosis: Test with a small lip around the aperture, wall very fine grained and smooth.

Distribution: Cosmopolitan

6. *Textularia* sp. Defrance, 1824

1996. Gooday, A.J., Bowser, S.S., Bernhard, J.M. Benthic foraminiferal assemblages in Explorers Cove, Antarctica: a shallow-water site with deep-sea characteristics. *Progress in Oceanography* 37, 117-166.

Material examined: 3exs., Thondi, 5. x. 2011, Bindu. L and party; 2exs., S. P. Patinam, 7. x. 2011, Bindu. L and party; 3exs., Thondi, 2. ii. 2012, Bindu. L and party; 1ex., Devipatinam, 2. ii. 2012, Bindu. L and party.

Diagnosis: Test free, elongate, tapering, typically compressed with the zigzag line between the chambers on the middle of the flattened side, early chambers on the middle of the flattened side, early chambers in the microscopic form usually planispirally coiled, later biserial, chambers simple, not labyrinthic; wall arenaceous, cement of various sorts, the relative amount variable; aperture, typically an arched slit at the inner margin of the chamber, occasionally in the apertural face.-Cambrian, Devonian to Recent.

Distribution: cosmopolitan

Order MILIOLIDA

Family MILIOLIDAE

7. *Triloculina trigonula* (Lamarck, 1804)

1992. Loeblich and Tappan. Foraminiferal genera and their classification, pp. 829.

Material examined: 7exs., Thondi, 5. x. 2011, Bindu. L and party; 3exs., Devipatinam, 5. x. 2011, Bindu. L and party; 3exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 3exs., Mimisel, 3. ii. 2012, Bindu. L and party; 4exs., Athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: The small test is longer than broad and subtriangular in apertural view. Some specimens are short and as long as broad. The externally visible three triloculine chambers are tubular and slightly inflated. The distinct sutures are depressed. The periphery is subrounded. The smooth calcareous porcelaneous wall is smooth, polished and shining. The large elongate aperture at the distal end of the end chamber has a prominent bifid tooth.

Distribution: Cosmopolitan

Family CORNUSPIRIDAE

8. *Cornuspira* sp.

2001. Gross, O. Foraminifera, in: Costello, M.J. *et al.*, (Ed.) (2001). European register of marine species: a checklist of the marine species in Europe and a bibliography of guides to their identification. *Collection Patrimoines Naturels*, 50: pp. 60-75.

2003. Barun K. Sen Gupta, Modern foraminifera, pp. 369.

Material examined: 3exs., Adirampatinam, 6. x. 2011, Bindu. L and party.

Diagnosis: Test free, with a proloculum and long, planispirally coiled, second chamber, rounded or complanate; wall calcareous, imperforate; aperture formed by the open end of the chamber, sometimes constricted and with a thickened lip.-Carboniferous to Recent.

Distribution: Cosmopolitan

Family CRIBROLINOIDIDA

9. *Adelosina laevigata* d'Orbigny, 1826

1826. *Adelosina laevigata* d'Orbigny, p.303. - Barker. 1960, p. 6. pl.3, figs.10-11. 12a-c. - Yassini and Jones, 1995, p. 80. figs. 135-136.

1998. *Adelosina laevigata* d'Orbigny. Rao, p. 69. pl. 8, figs. 9-10.

Material examined: 3exs., Thondi, 5. X. 2011, Bindu. L and party; 2exs., Mallipatinam, 6. X. 2011, Bindu. L and party; 2exs., S. P. Patinam, 7. X. 2011, Bindu. L and party; 3exs., Mimisel, 3. ii. 2012, Bindu. L and party

Diagnosis: This species is similar to *Quinqueloculina*. The test is rounded in shape without any striations.

Distribution: Cosmopolitan

Family HAUERINIDAE

10. *Hauerina complanata* Dakin, 1906

2011. Hayward, B. *Hauerina complanata*. In: Hayward, B.W., Cedhagen, T., Kaminski, M., Gross, O. *World Modern Foraminifera Database*.

Material examined: 2exs., Thondi, 5. x. 2011, Bindu. L and party; 2exs., Mimisel, 7. x. 2011, Bindu. L and party; 1ex., Thondi, 2. ii. 2012, Bindu. L and party.

Diagnosis: species has the characteristic planospiral porcelaneous test, milioline only in the very early convolutions. It is very thin, with practically circular convolutions. Four of these, with indications of a fifth, are present, the outer, or last, consisting of 4 chambers.

Distribution: cosmopolitan

11. *Miliolinella circularis* (Bornemann, 1855)

2009. Sen Gupta, B. K., L. E. Smith, and M. L. Machain-Castillo.. Foraminifera of the Gulf of Mexico, Pp. 87–129 in Felder, D.L. and D.K. Camp (eds.), Gulf of Mexico—Origins, Waters, and Biota. *Biodiversity*. Texas A & M Press, College Station, Texas.

Material examined: 3exs., Thondi, 5. x. 2011, Bindu. L and party; 2exs., Devipatinam, 5. x. 2011, Bindu. L and party; 4exs., Devipatinam, 2.ii. 2012, Bindu. L and party; 2exs., Mimisel, 3. ii. 2012, Bindu. L and party; 3exs., Athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: Test ovate, periphery rounded, chambers distinct, inflated, sutures distinct, slightly depressed, wall smooth; aperture demilunar, with a broad, very short, thin tooth.

Distribution: Cosmopolitan

12. *Quinqueloculina seminula*
(Linnaeus, 1758)

1758. Linnaeus, C. *Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Editio decima, reformata*. Laurentius Salvius: Holmiae. ii, 824 pp.

2009. Sen Gupta, L. E. Smith, and M. L. Machain-Castillo.. Foraminifera of the Gulf of Mexico, Pp. 87–129 in Felder, D.L. and D.K. Camp (eds.), Gulf of Mexico—Origins, Waters, and Biota. *Biodiversity*. Texas A&M Press, College Station, Texas.

Material examined: 8exs., Thondi, 5. x. 2011, Bindu. L and party; 4exs., Devipatinam, 5. x. 2011, Bindu. L and party; 6exs., Thondi, 2. ii. 2012, Bindu. L and party; 4exs., Mimisel, 3. ii. 2012, Bindu. L and party; 3exs., Athankarai, 4. ii. 2012, Bindu. L and party

Diagnosis: Recognised by the elongate, porcelaneous test; narrowly rounded periphery; distinct sutures; and large aperture having simple tooth. Miocene to recent.

Distribution: Cosmopolitan

13. *Quinqueloculina laevigata* d'Orbigny, 1839

2009. Sen Gupta, L. E. Smith, and M. L. Machain-Castillo.. Foraminifera of the Gulf of Mexico, Pp. 87–129 in Felder, D.L. and D.K. Camp (eds.), Gulf of Mexico—Origins, Waters, and Biota. *Biodiversity*. Texas A&M Press, College Station, Texas.

Material examined: 5exs., Thondi, 5. x. 2011, Bindu. L and party; 4exs., Thirupalaikkudy, 5. x. 2011, Bindu. L and party; 4exs., Mallipatinam, 6. x. 2011, Bindu. L and party; 3exs., Thondi, 2. ii. 2012, Bindu. L and party.

Diagnosis: Mostly coastal, in strandline or tidepool deposits, uncommon, epifaunal, sometimes free or cling to plants or sediments, herbivore.

Distribution: Cosmopolitan

14. *Quinqueloculina bradyana* Cushman, 1917

2009. Sen Gupta, L.E. Smith, and M.L. Machain-Castillo.. Foraminifera of the Gulf of Mexico, Pp. 87–129 in Felder, D.L. and D.K. Camp (eds.), Gulf of Mexico—Origins, Waters, and Biota. *Biodiversity*. Texas A&M Press, College Station, Texas.

Material examined: 2exs., Thondi, 5. x. 2011, Bindu. L and party; 2exs., S. P. Patinam, 7. x. 2011, Bindu. L and party; 3exs., Mimisel, 3. ii. 2012, Bindu. L and party.

Diagnosis: Test stout, usually but slightly longer than broad, chambers angular, more or less plicated laterally, the outer peripheral angle usually sinuous, apertural end extended to any considerable length, aperture usually narrow with a simple tooth.

Distribution: Cosmopolitan

Family PENEROPLIDAE

15. *Peneroplis* sp. de Montfort, 1808

2001. Gross, O. Foraminifera, *in*: Costello, M.J. *et al.*, (Ed.) (2001). European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification. *Collection Patrimoines Naturels*, 50: pp. 60-75.

Material examined: 3exs., Mallipatinam, 6. x. 2011, Bindu. L and party.

Diagnosis: Test free and compressed; younger chambers planispirally arranged and later portion much complanate and spreading out, reaching back on both sides towards earlier chambers, but not entirely embracing; sutures distinct, depressed and somewhat limbate; wall very distinctly striate; the striae numerous and nearly parallel to periphery; aperture simple, at base of apertural face.

Distribution: Cosmopolitan

16. *Spirolina arietina* (Batsch, 1791)

2001. Gross, O. Foraminifera, *in*: Costello, M.J. *et al.*, (Ed.) European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification. *Collection Patrimoines Naturels*, 50: pp. 60-75.

Material examined: 2exs., Devipatinam, 2. ii. 2012, Bindu. L and party; 2exs., Mimisel, 3. ii. 2012, Bindu. L and party.

Distribution: cosmopolitan

Order LAGENIDA

Family ELLIPSOLEGENIDAE

17. *Fissurina laevigata* Reuss, 1850

2001. Gross, *Foraminifera*, *in*: Costello, M.J. *et al.*, (Ed.) (2001). European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification.
2009. Sen Gupta, L. E. Smith, and M. L. Machain-Castillo. Foraminifera of the Gulf of Mexico, Pp. 87–129 in Felder, D.L. and D.K. Camp (eds.), Gulf of Mexico—Origins, Waters, and Biota. *Biodiversity*. Texas A&M Press, College Station, Texas.

Material examined: 3exs., Mimisel, 3. ii. 2012, Bindu. L and party; 2exs., Athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: The small, suboval test is slightly compressed, longer than broad with an

entosolenian tube. It tapers towards the apertural end from the broadly rounded initial end. The subacute periphery has a smooth marginal keel which continues upto the aperture and merges with it. The terminal, narrow elliptical aperture is in the median line. The thin calcareous hyaline wall is smooth and translucent.

Distribution: cosmopolitan

Order LAGENIDA

Family VAGINULINIDAE

18. *Lenticulina limbosa* (Reuss, 1863)

1758. Linnaeus, C. *Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Editio decima, reformata. Laurentius Salvius: *Holmia* 824.

Material examined: 2exs., Adirampatinam, 6. X. 2011, Bindu. L and party; 2exs., Mimisel, 3. ii. 2012, Bindu. L and party.

Distribution: cosmopolitan

Order ROTALIIDA

Family ROTALIIDAE

19. *Ammonia beccari* (Linnaeus, 1758)

1758. Linnaeus, C. *Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Editio decima, reformata. Laurentius Salvius: *Holmiae*, ii, 824 pp.
2001. Gross, O. *Foraminifera*, *in*: Costello, M.J. *et al.*, (Ed.) (2001). European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification. *Collection Patrimoines Naturels*, 50: pp. 60-75.

Material examined: 2exs., Devipatinam, 5. x. 2011, Bindu. L and party; 3exs., Mallipatinam, 6.x.2011, Bindu. L and party; 3exs., Thondi, 2. ii. 2012, Bindu. L and party; 2exs., Devipatinam, 2. ii. 2012, Bindu. L and party; 2exs., Athankarai., 4. ii. 2012, Bindu. L and party.

Diagnosis: Test trochoid, with convex dorsal side and spirally arranged chambers; on the ventral side only the last coil with an open umbilical slit and wart-like ornamentation is visible. The test shape in *Ammonia beccarii* is dependent on ecological factors.

Distribution: Cosmopolitan

20. *Ammonia tepida* (Cushman, 1926)

2001. Gross, Foraminifera, *in*: Costello, M.J. *et al.*, (Ed.) (2001). European register of marine species: a checklist of the marine species in Europe and a bibliography of guides to their identification. *Collection Patrimoines Naturels*, **50**: pp. 60-75.
2009. Sen Gupta, L. E. Smith, and M. L. Machain-Castillo. Foraminifera of the Gulf of Mexico, Pp. 87–129 in Felder, D.L. and D.K. Camp (eds.), Gulf of Mexico—Origins, Waters, and Biota. Biodiversity. Texas A&M Press, College Station, Texas.

Material examined: 2exs., Thondi, 5. x. 2011, Bindu. L and party; 3exs., Devipatinam, 5. x. 2011, Bindu. L and party; 1ex., Thondi, 2. ii. 2012, Bindu. L and party.

Diagnosis: The small, subcircular test is trochoid and almost equally biconvex, the ventral side being more so. Dorsally, the chambers are slightly inflated, higher than broad and gradually increase in size. Ventrally, about 7-8 subtriangular chambers of the last-formed whorl alone are visible. Dorsally, the sutures are raised in the early portion, whereas slightly depressed and arcuate in the final whorl, while they are radial, excavated and thus a shallow cavity are formed around the umbilical region on ventral side. The rounded periphery is lobulate. The thin calcareous wall is finely perforate. The small elongate ventral aperture is interiomarginal.

Distribution: Cosmopolitan

21. *Pararotalia nipponica* Asano, 1936

2011. Hayward, B. *Pararotalia nipponica* Asano, 1936. *In*: Hayward, B.W., Cedhagen, T., Kaminski, M., Gross, O. (2011) *World Modern Foraminifera Database*.

Material examined: 2exs., Thondi, 5. x. 2011, Bindu. L and party, 2exs., S. P. Patinam, 7. x. 2011, Bindu. L and party.

Diagnosis: Test free, biconvex to-plano-convex, low trochospiral coil of three volutions; periphery weakly keeled, peripheral outline slightly lobulate or smooth in adult, but with a short and solid spine on each chamber in many young specimens; spiral sutures limbate and flush on surface, sometimes remaining spinate protrusions encrusted with secondary deposition of shell materials in earlier parts; chambers numerous, increase with shell-growth from six

or seven up to nine and half per one volution; intercameral sutures limbate and flush on spiral side, deeply depressed on umbilical side. forming open ventral fissures: intercameral septum imperforate, secondarily double. leaving open space on umbilical side. but perfectly closed on spiral side, towards which anterior lamella thins out.

Distribution: cosmopolitan

22. *Pararotalia calcar* (d'Orbigny, 1839)

2011. Hayward, B. *Pararotalia nipponica* Asano, 1936. *In*: Hayward, B.W., Cedhagen, T., Kaminski, M., Gross, O. (2011) *World Modern Foraminifera Database*.

Material examined: 2exs., Thondi, 2.ii 2012, Bindu. L and party.

Distribution: Cosmopolitan

23. *Rotalina agglutinans* Pourtales, 1850

2011. Hayward, B. *Rotalina agglutinans* Pourtales, 1850. *In*: Hayward, B.W., Cedhagen, T., Kaminski, M., Gross, O. (2011) *World Modern Foraminifera Database*.

Material examined: 2exs., Thondi., 5. x. 2011, Bindu. L and party; 1ex., S. P. Patinam, 3. ii. 2012, Bindu. L and party.

Diagnosis: Shell rough with grains of sand incrusting; last whorl of the spire nearly covering the other ones; aperture indistinct.

Distribution: Cosmopolitan

24. *Rosalina bradyi* (Cushman, 1915)

2011. Hayward, B. *Rosalina bradyi* (d'Orbigny, 1839). *In*: Hayward, B.W., Cedhagen, T., Kaminski, M., Gross, O. (2011) *World Modern Foraminifera Database*.

Material examined: 2exs., Thirupalakkudy, 5. x. 2011, Bindu. L and party; 3exs., Adirampatinam, 6. x. 2011, Bindu. L and party; 2exs., Mimisel, 3. ii. 2012, Bindu. L and party; 2exs., Athankarai, 4. ii. 2012, Bindu. L and party.

Diagnosis: Trochospiral concavo-convex test; dorsally evolute; chambers 15, slightly inflated; sutures limbate, raised; ventrally involute, slightly concave, chambers 6 with umbilical flaps; umbilicus depressed; periphery keeled; aperture slit-like extended up to periphery, supplementary foramen on chambers irregular and complex, generally a bifurcating indentation extending from

umbilical to peripheral margin; wall calcareous, coarsely perforations on dorsal and fine on ventral side.

Distribution: Cosmopolitan

25. ***Rosalina globularis*** d'Orbigny, 1826

2009. Sen Gupta, L. E. Smith, and M. L. Machain-Castillo.. Foraminifera of the Gulf of Mexico, Pp. 87–129 in Felder, D.L. and D.K. Camp (eds.), Gulf of Mexico—Origins, Waters, and Biota. *Biodiversity*. Texas A&M Press, College Station, Texas.

Material examined: 1ex., Thondi, 5. X. 2011, Bindu. L and party; 2exs., Mallipatinam, 6. X. 2011, Bindu. L and party; 2exs., Devipatinam, 2. ii. 2012, Bindu. L and party.

Distribution: Cosmopolitan

Family PLANULINIDAE

26. ***Hyalinea balthica*** (Schröter, 1783)

2001. Gross, O. Foraminifera, *in*: Costello, M.J. *et al.*, (Ed.) (2001). European register of marine species: a checklist of the marine species in Europe and a bibliography of guides to their identification. *Collection Patrimoines Naturels*, **50**: pp. 60-75.

Material examined: 2exs., S. P. Patinam, 7. X. 2011, Bindu. L and party; 3exs., Mimisel, 7. X. 2011, Bindu. L and party; 2exs., Devipatinam, 2. ii. 2012, Bindu. L and party.

Distribution: Cosmopolitan

Family ELPHIDIDAE

27. ***Elphidium incertum*** (Williamson, 1858)

2001. Gross, O. Foraminifera, *in*: Costello, M.J. *et al.* (Ed.) (2001). European register of marine species: a checklist of the marine species in Europe and a bibliography of guides to their identification. *Collection Patrimoines Naturels*, **50**: pp. 60-75.

Material examined: 2exs., Thondi, 5. 10 2011, Bindu. L and party; 2exs., Mimisel, 3. ii. 2012, Bindu. L and party.

Diagnosis: Test equally biconvex, periphery narrowly rounded, 10-12 in last- formed coil, the periphery varying from even curvature to slightly lobulated in the last formed chambers; sutures indistinct, slightly curved, depressed, each with a single row of numerous small, short and narrow septal depressions.

Distribution: Cosmopolitan

Family NUMMULITIDAE

28. ***Operculina*** sp. d'Orbigny, 1826

1971. Fishelson, L.,. Ecology and distribution of the benthic fauna in the shallow waters of the Red Sea. *Marine Biology*, **10/2**: 113-133.

Material examined: 3exs., Thondi, 2. ii. 2012, Bindu. L and party.

Diagnosis: Test bilaterally symmetrical, planispiral, complanate, usually all coils visible from the exterior, earlier coils sometimes involute, chambers undivided, periphery with a thickened “marginal cord”; wall calcareous, perforate, smooth or ornamented with bosses; aperture single, at the base of the apertural face, median.- Lower Cretaceous to recent.

Distribution: Cosmopolitan

Family DISCORBINELLIDAE

29. ***Discorbinella*** sp. Cushman & Martin, 1935

2001. Gross, O. Foraminifera, *in*: Costello, M.J. *et al.*, (Ed.) (2001). European register of marine species: a checklist of the marine species in Europe and a bibliography of guides to their identification. *Collection Patrimoines Naturels*, **50**: pp. 60-75.

Material examined: 2exs., Thirupalaikkudy, 2. ii. 2012, Bindu. L and party.

Diagnosis: Test trochoid, Discorbis-like; wall calcareous, finely perforate, hyaline; aperture consisting mainly of an elongate opening near the base of the apertural face in the axis of coiling, with a distinctly thickened lip, and a supplementary, often poorly developed aperture, at the inner margin of the ventral face of the last-formed chamber, beneath a distinct, flap like projection of the chamber margin.-Miocene to Recent.

Distribution: Cosmopolitan

3. **Marine Nematodes**

Phylum NEMATODA

Class ADENOPHOREA

Order ENOPLIDA

Family ENOPLIDAE

1. *Enoplus brevis* Bastian

Family ANTICOMIDAE

2. *Anticoma acuminata*

Order CHROMADORIDA

Family CHROMODORIDAE

3. *Chromadora macrolaimus* De Man

Order CHROMODORIDA

Family CERAMONEMATIDAE

4. *Pselionema* sp.

Family CHROMADORIDAE

5. *Neochromadora* sp.

Order DESMODORIDA

Family COMESOMATIDAE

6. *Paracomesoma dubium* (Filipjev)

Family CYATHOLAIMIDAE

7. *Paracanthonchus* sp

Order DESMODORIDA

Family DESMODORIDAE

8. *Desmodora (Desmodora) sanguinea* Southern

Order PLECTIDA

Family LEPTOLAIMIDAE

9. *Camacolaimus barbatus*

1. *Enoplus brevis* Bastian

1865. *Enoplus Brevis* Bastian, *Mem. Mus. r. Hist. Nat. Belg.*, **58**: 1-163.

Material Examined: 2 exs., Devipattinam, 5. x. 2011, Bindu & Party.

Diagnosis: Body is tapering, Head bluntly rounded, no papillae or no setae. Teeth are small and spicules are curved. Tail is sharp and cylindrical.

Distribution: Tamilnadu (Pichavaram mangroves)

2. *Anticoma acuminata*

Material Examined: 2exs. Thondi, 2. ii. 2012, Bindu & Party.

Diagnosis: Spicula curved, with fine velum and short manubrium. Spicular chord almost as long as the anal diameter. Gubernaculum short, of fine texture. Tail gradually tapering to a rather long and filiform flagellum, the latter slightly swollen at its tip.

Distribution: Andaman Nicobar and Pichavaram mangroves (Tamilnadu).

3. *Chromadora macrolaimus* De Man

Material Examined: 7 exs., Adirampattinam, 6. x. 2011, Bindu & Party.

Diagnosis: Cuticle with coarse transverse striation. Head with six short, conical labial papillae; six cephalic setae modified into prominent fleshy ear-like appendages. Amphids transversely oval. Tail conical with a short unstriated tip.

Distribution: Tamilnadu (Pichavaram mangroves).

4. *Pselionema* sp.

Material Examined: 1ex, Mimisal, 7. x. 2011, Bindu & Party.

Diagnosis: Body length 1.4 mm. Cuticle with about 350 annules of which 60 are in the tail region; 8 longitudinal ridges. Four 10 µm cephalic setae. Amphids 15×5 µm, elongate loops. Oesophagus cylindrical throughout. Tail 5.2 µm. Spicules 20 µm in length.

Distribution: Tamilnadu (Pichavaram mangroves).

5. *Neochromadora* sp.

Material Examined: 2 exs., Devipattinam, 2. ii. 2012, Bindu & Party.

Diagnosis: Cuticular ornamentation heterogenous. Tail is conical and tapering.

Distribution: Tamilnadu (Pichavaram mangroves).

6. *Paracomesoma dubium* (Filipjev)

Material Examined: 44 exs, Adirampattinam , 6.x.2011 Bindu & Party.

Diagnosis: Body length 1.6 mm. Cuticle smooth, without punctuation. Six small labial papillae. Six anterior cephalic setae; Amphids spiral, of 3 turns, 7 µm wide. Buccal cavity conical with three small pointed triangular teeth. Tail µm cylindrical, 2.8 a.b.d. Spicules long, 210 µm in length (2.4 a.b.d.), slender, curved with delicate ventral ala.

Distribution: Tamilnadu (Pichavaram mangroves).

7. *Paracanthonchus* sp.

Material Examined: 2 exs, Devipattinam , 2. ii. 2012, Bindu & Party.

Diagnosis: Body in its whole length about evenly thick. Cuticle finely annulated. Head truncate, provided with rather short, clumsy bristles,. Buccal cavity funnel-shaped, in the anterior part supported by ribs, armed with a rather small, acute, dorsal tooth. Tail short, clumsy, conical. Spicules also short, moderately slender and slightly curved.

Distribution: Tamilnadu (Pichavaram mangroves).

8. *Desmodora (Desmodora) sanguinea* Southern

Material Examined: 44 exs, Thirupalakudi, 9. vii. 2006 & 25. xii. 07, Bindu & Party.

Diagnosis: Body length 0.7 mm, narrow. Cuticle thick with coarse striation. Amphids a rounded loop, 8 μ m wide. Tail 33 μ m and conical, and tip untreated.

Distribution: Tamil Nadu

9. *Camacolaimus barbatus*

Material Examined: 4 exs., Thirupalakudi, 2.ii. 2012, Bindu & Party.

Description: Body length 1.2 mm. Cuticle with striations. Amphids spiral, of 2.5 turns, 6 μ m wide. Buccal cavity with a long style-like dorsal tooth, 30 μ m long, with a prominent shoulder near its distal tip. Oesophagus narrows cylindrical. Tail conical with a pointed.

Distribution: Tamil Nadu (Pichavaram mangroves).

SUMMARY

A taxonomic account and distribution of three groups of sea grass associated fauna of Palk Bay viz., rhizopods, foraminifera and nematodes are dealt with in this communication. In all 59 sea grass associated species, rhizopods belonging to 21 species coming under 7 genera and 6 families; foraminiferans coming under 15 families, 24 genera and 29 species; 9 species of marine nematodes belong to 6 orders, 9 families and 9 genera are dealt with. All the species are new records associated with sea grass ecosystem.

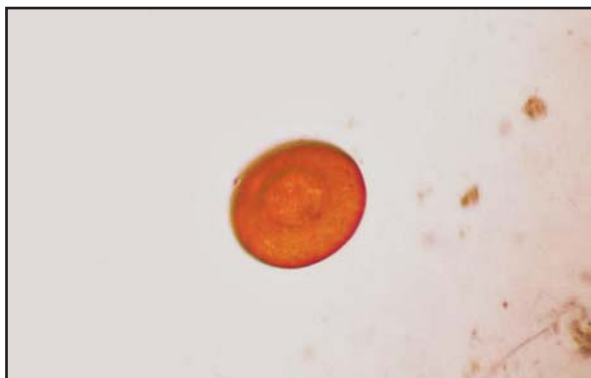
ACKNOWLEDGEMENT

The authors are grateful to the Director, Zoological survey of India, Kolkata for approving the project and are indebted to Officer-in -Charge, Marine Biology Regional Centre, Chennai for providing the necessary facilities. Also wishes to record the sense of gratitude to the members who have participated in the survey during the collection of specimens.

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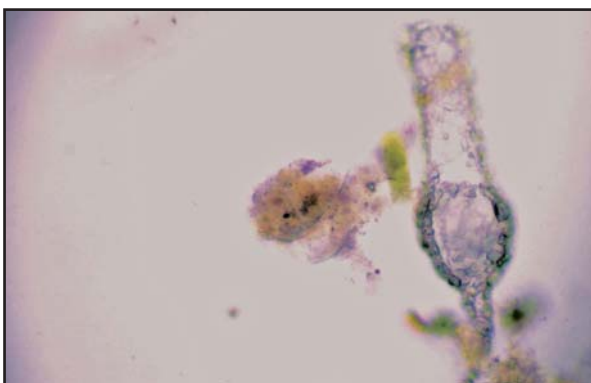
PLATE I



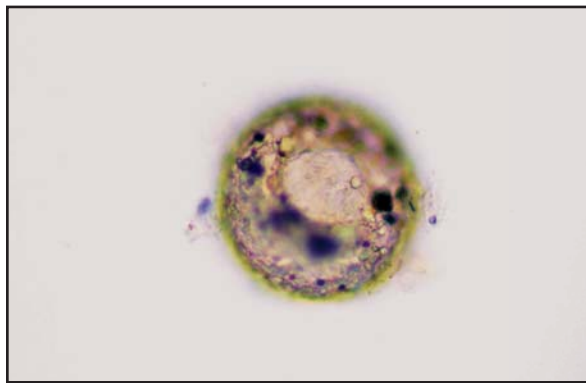
Arcella discoides



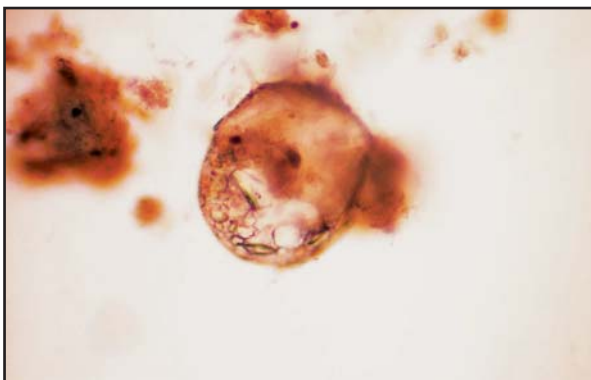
Cyphoderia ampulla



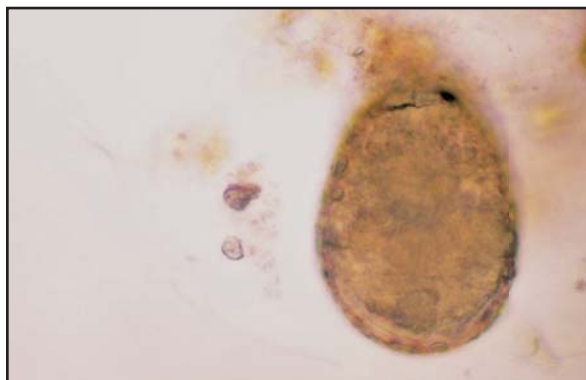
Diffugia acuminata



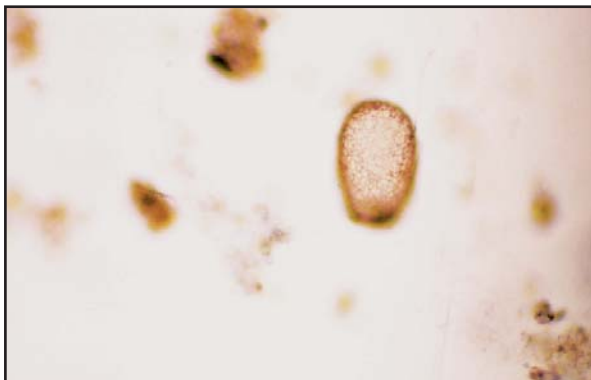
Diffugia globulosa



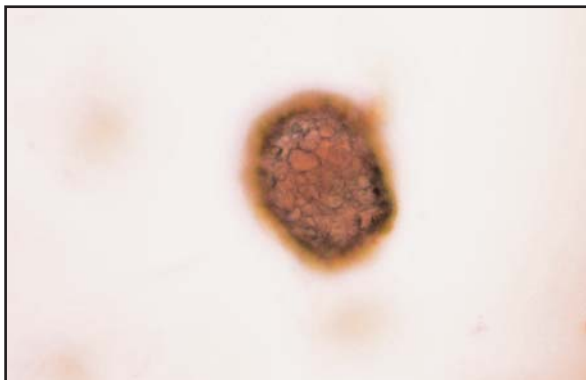
Diffugia gramen



Diffugia limnetica



Diffugia lobostoma



Diffugia lucida

PLATE II

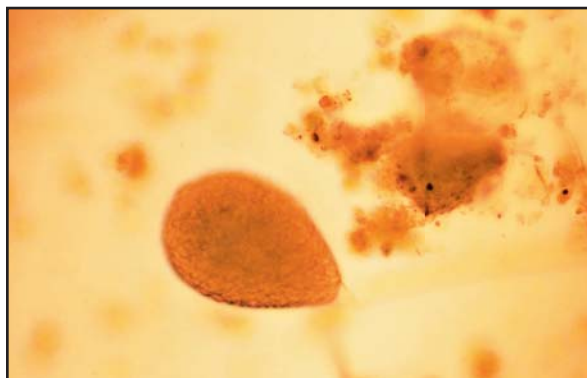
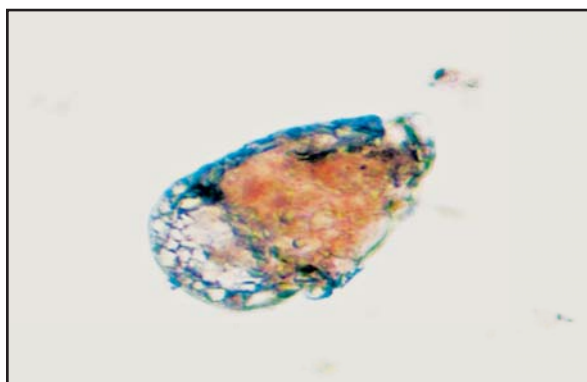
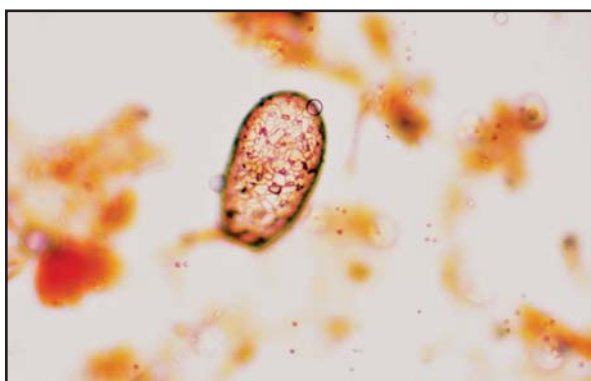
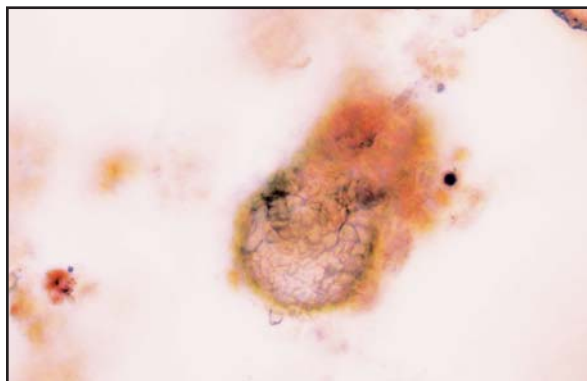
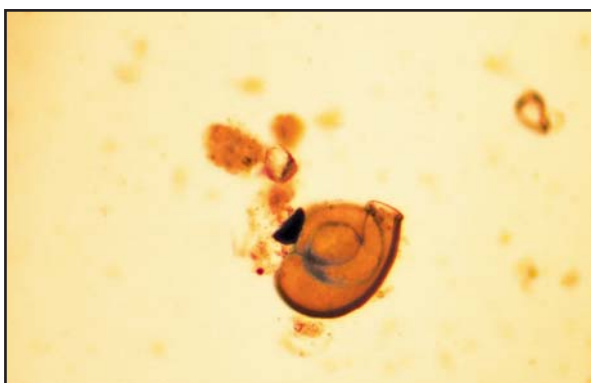
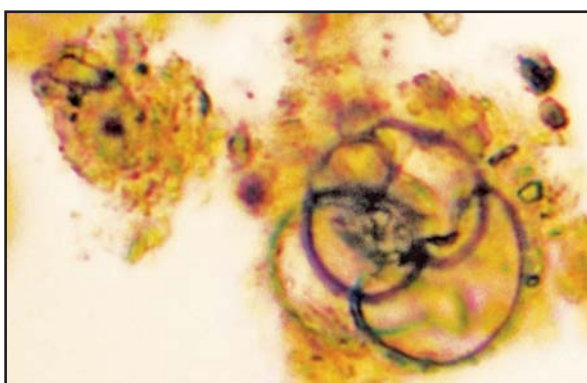
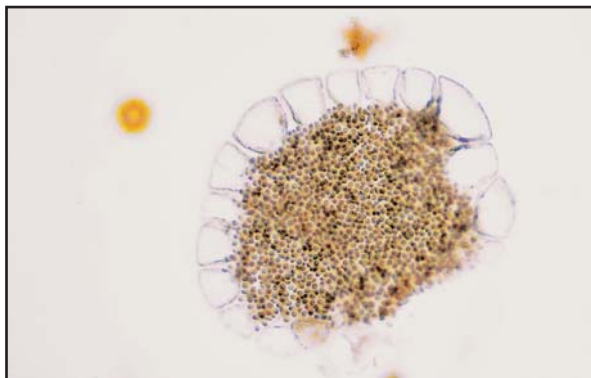
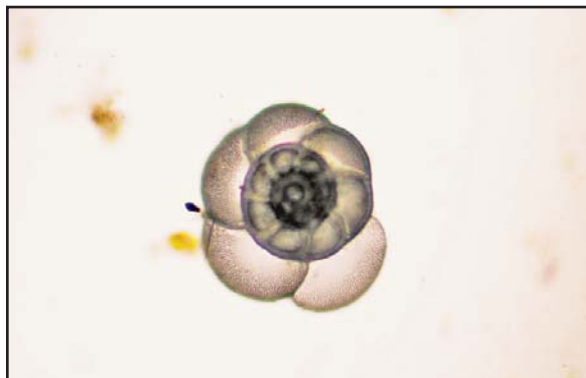
*Diffugia tuberculata**Euglypha cristata**Euglypha rotunda**Nebela denticulata**Nebela dentistoma**Nebela walesi**Adelosina laevigata**Ammoglobigerina*

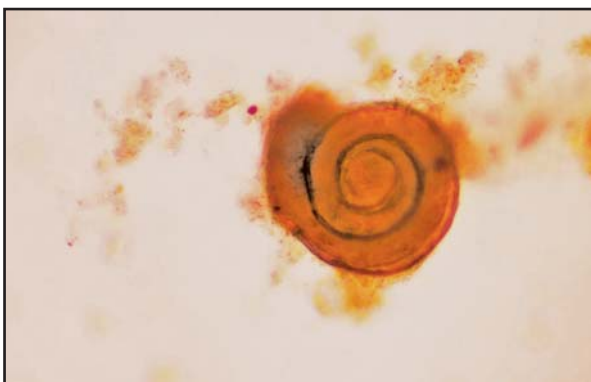
PLATE III



Ammonia beccari



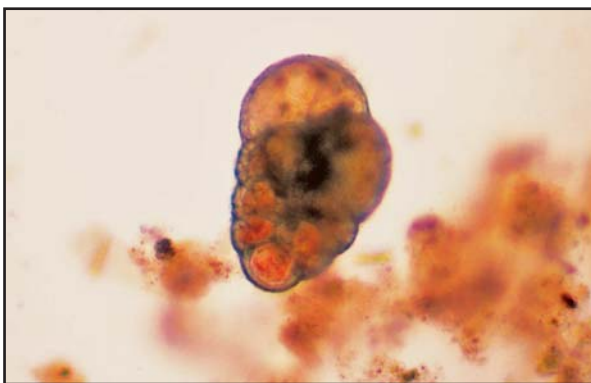
Ammonia lepidi



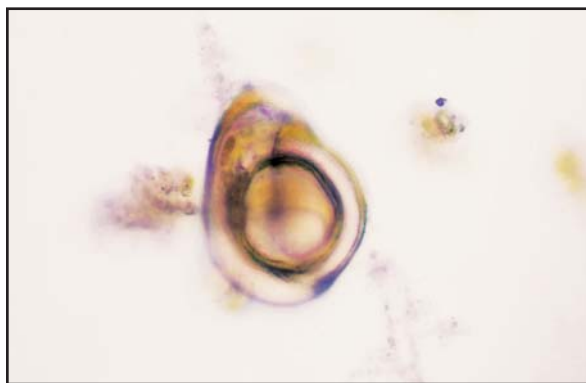
Cornuspira sp.



Cribrononian sp.



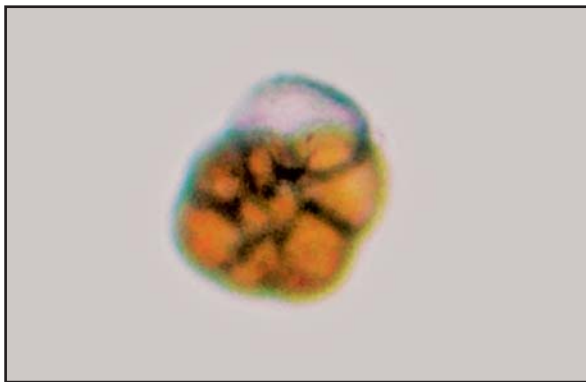
Eggerella bradyi



Fissurina laevigata



Glomospira sp.



Haplophragmoides

PLATE IV

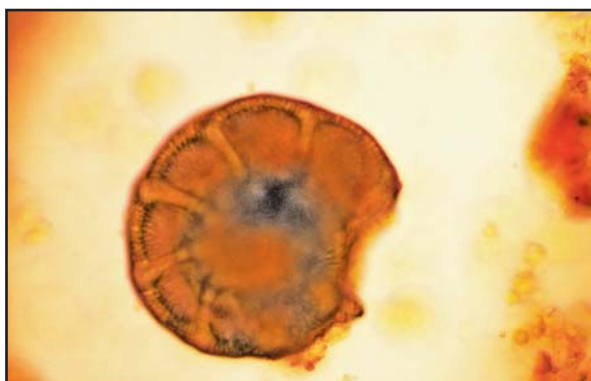
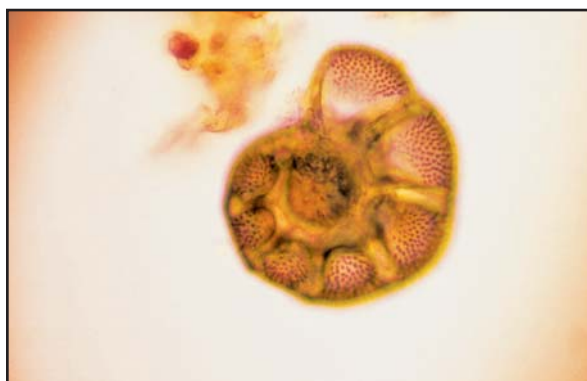
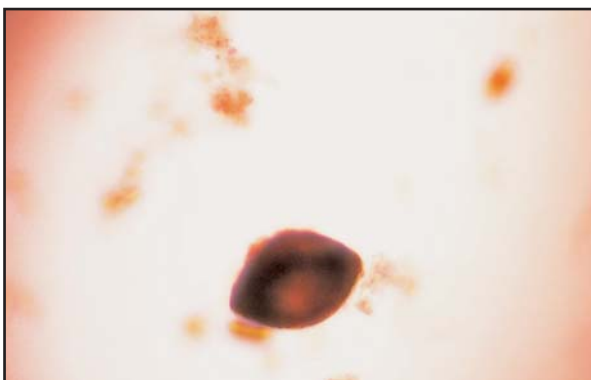
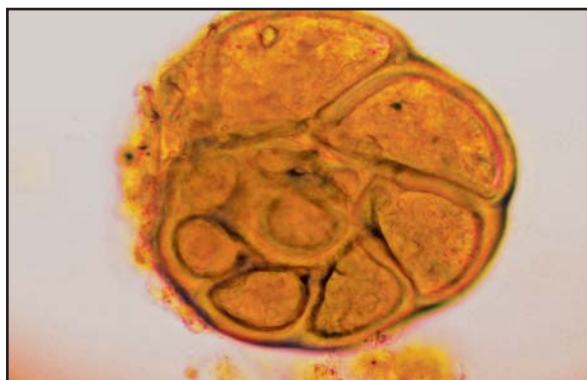
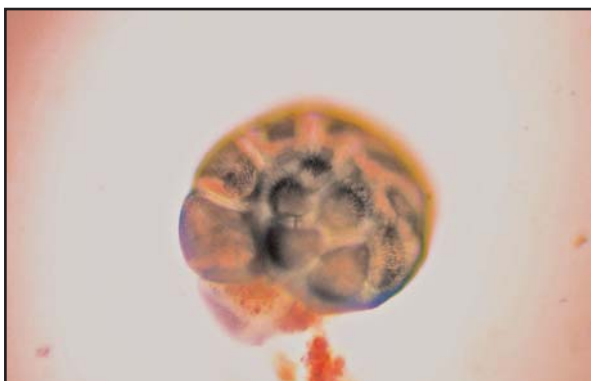
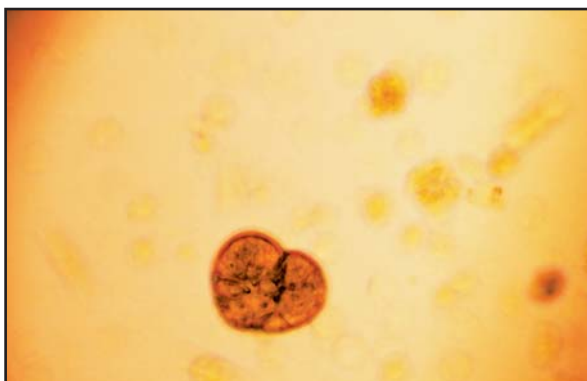
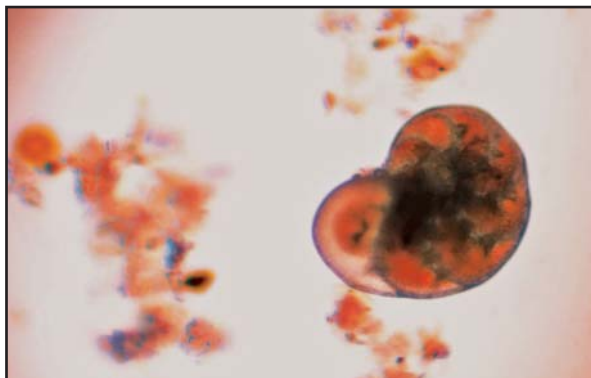
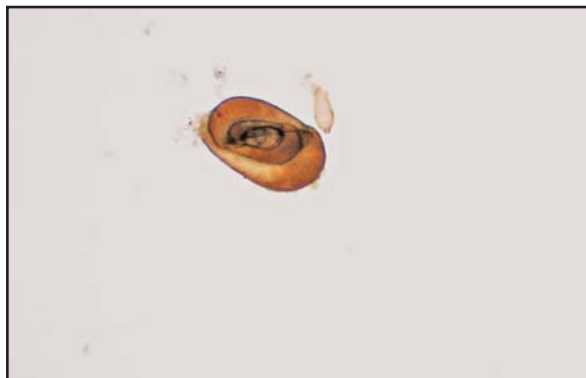
*Hyalinea balthica**Ammonia beccari**Triloculina trigonula**Pararotalia nipponica**Rosalina bradyi**Adelosina laevigata**Ammonia beccari**Miliolinella circularis*

PLATE V



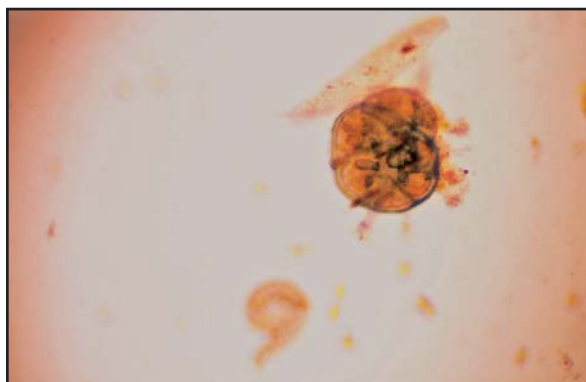
Operculina Sp.



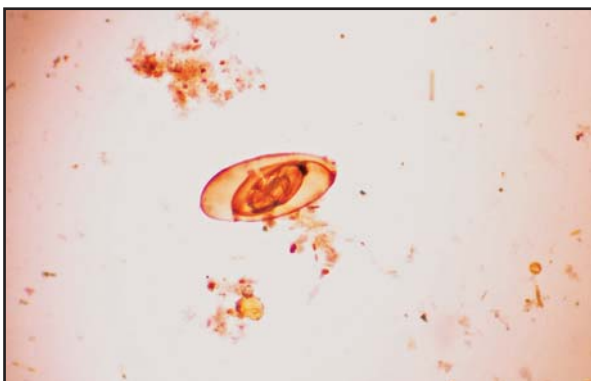
Quinqueloculina seminulum



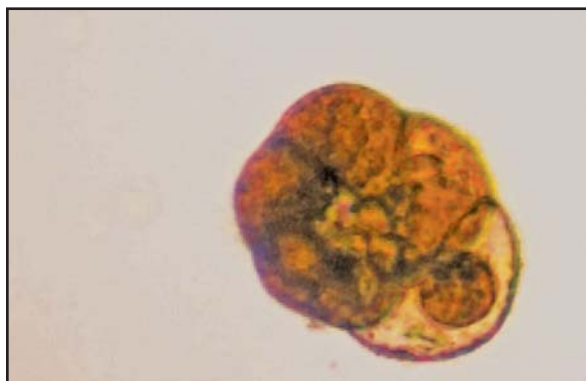
Quinqueloculina laevigata



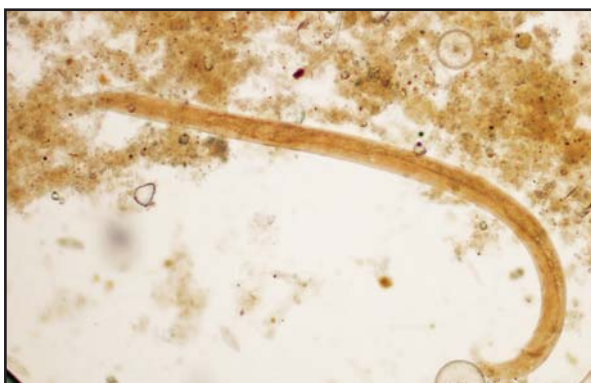
Rosalina sp.



Textularia sp.



Trochammina inflata

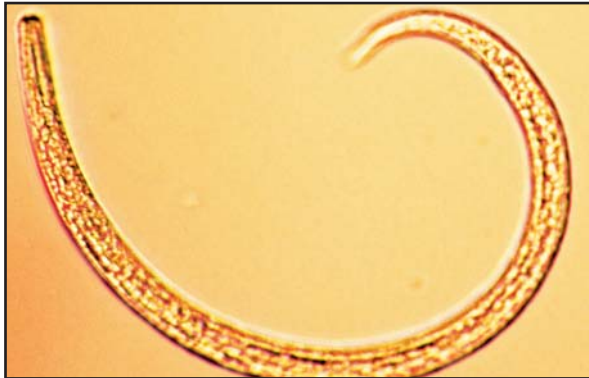


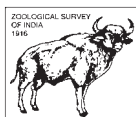
Anticoma acuminata



Camacolaimus barbatus

PLATE VI

*Chromadora macrolaimus**Chromadora* sp.*Desmodora (Desmodora) sanguinea**Paracanthonchus* sp.*Paracomesoma* sp.



ON AN ACCOUNT OF PENTATOMOIDEA (HETEROPTERA: HEMIPTERA) FROM CHHATTISGARH, INDIA

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INTRODUCTION

The pentatomids are commonly known as “shield bugs” or “stink bugs” as their bodies are usually covered by a shield shaped scutellum covering more than half of the abdomen, tibia with weak or no spine, 5 segmented antennae which gives its family name and most of them emit an unpleasant odour, offensive in nature, produced by a pair of glands in the thorax and is released through openings in the metathorax. Although majority of these bugs are plant sucking, the members belonging to the family Asopinae are wholly or partially predaceous. Pentatomoidea is one of the largest superfamilies of Heteroptera comprising of 1301 genera and 7182 species distributed in sixteen families all over the world (Henry, 2009). Of these, family Pentatomidae alone represents 896 genera and 4722 species distributed in eight subfamilies (Pentatominae, Asopinae, Podopinae, Edessinae, Phyllocephalinae, Discocephalinae, Cyrtocorinae and Serbaninae).

A little over 590 species of the Pentatomoidea are known to occur in India through the publication of Distant (1902, 1907, 1918), Ahmad and Afzal (1989), Azim and Nayyar (2011) and Durai (1987). The eight species of Pentatomidae marked with (*) are reported through publication of Biswas and Ghosh (1995) and Chandra and Kushwaha (2012) from Chhattisgarh. The present paper deals with 38 species under 27 genera belonging to 5 families of the superfamily Pentatomoidea studied from Chhattisgarh. Of these, 30 species under 24 genera are reported for the first time from this state. The classification is followed after the Rider (2012).

SYSTEMATIC ACCOUNT

Family I PENTATOMIDAE

Subfamily PENTATOMINAE

Tribe ANTESTINI

Genus 1. *Antestia* Stal, 1864

1. *Antestia anchora* (Thunberg)

*2. *Antestia cruciata* (Fabricius)

Genus 2. *Plautia* Stal, 1867

*3. *Plautia crossota* (Fabricius)

Tribe AGONOSCELIDINI

Genus 3. *Agonoscelis* Spin, 1837

4. *Agonoscelis nubilis* (Fabricius)

Tribe CARPOCORINI

Genus 4. *Gulielmus* Distant, 1901

5. *Gulielmus laterarius* Distant

Tribe EYSARCORINI

Genus 5. *Adria* Stal, 1876

6. *Adria parvula* Dallas

Genus 6. *Carbula* Stal, 1864

7. *Carbula insocia* Walker

8. *Carbula aspavia* Distant

9. *Carbula scutellata* Distant

Genus 7. *Eysarcoris* Hahn, 1834

*10. *Eysarcoris guttiger* (Thunberg)

11. *Eysarcoris montivagus* Distant

12. *Eysarcoris ventralis* (Walker)

Tribe HALYINI

Genus 8. *Halys* Fabricius, 1803*13. *Halys dentatus* FabriciusGenus 9. *Erthesina* Spin., 183714. *Erthesina fullo* Thunberg

Tribe MENIDINI

Genus 10. *Apines* Dall. 185115. *Apines concinna* Dall.Genus 11. *Menida* Motsch., 186116. *Menida formosa* (Westwood)17. *Menida apicalis* (Dallas)

Tribe NEZARINI

Genus 12. *Acrosternum* Fieber, 186018. *Acrosternum graminea* KirkaldyGenus 13. *Nezara* Amy. & Serv. 1843*19. *Nezara viridula* (Linnaeus)

Tribe PENTATOMINI

Genus 14. *Placosternum* Amy & Serv., 184320. *Placosternum dama* (Fabricius)

Tribe PIEZODORINI

Genus 15. *Piezodorus* Fieber, 186121. *Piezodorus hybneri* Gmelin, 1790

Tribe SCIOCORINI

Genus 16. *Menedemus* Distant, 189922. *Menedemus hieroglyphicus* DistantGenus 17. *Sciocoris* Fallen, 182923. *Sciocoris indicus* Dallas

Tribe SEPHELINI

Genus 18. *Niphe* Stal, 186724. *Niphe subferruginea* (Westwood)

Tribe STRACHIINI

Genus 19. *Bagrada* Stal, 1862*25. *Bagrada hiliaris* Burmeister, 1835

Subfamily ASOPINAE

Genus 20. *Amyotea* Ellenr., 186226. *Amyotea malabarica* (Fabricius)Genus 21. *Andrallus* Ellenr. 186227. *Andrallus spinidens* (Fabricius.)Genus 22. *Eocanthecona* Amy. & Serv. 184328. *Eocanthecona furcellata* (Wolff.)

Family II CYDNIDAE

Genus 23. *Adrisa* Amyt & Serv., 184329. *Adrisa magna* (Uhler.)Genus 24. *Macroscytus* Fieber, 186130. *Macroscytus brunneus* (Fabricius)31. *Macroscytus foveolus* (Dallas)

Family III DINIDORIDAE

Genus 25. *Coridius* Illiger 1807*32. *Coridius brunneus* (Thunberg)33. *Coridius ianus* Lis34. *Coridius obscurus* (Fabricius)

Family IV SCUTELLERIDAE

Genus 26. *Chrysocoris* Hahn, 184335. *Chrysocoris perpureus* (Westwood)36. *Chrysocoris stollii* (Wolff.)

Family V TESSARATOMIDAE

Genus 27. *Tessaratomya* Lep. & Serv., 1825*37. *Tessaratomya javanica* (Thunberg)38. *Tessaratomya papillosa* (Drury)

Superfamily PENTATOMOIDEA

Key to the families of the Superfamily Pentatomoidea

1. Primary and subcostal veins of the wings remote, including a central broad area; humus present 2
- Primary and subcostal veins of the wings usually conterminal and diverging at apex, somewhat parallel: humus usually absent..... 3
2. Scutellum covering the whole of the hemelytra, excepting the extreme base of outer margin SCUTELLERIDAE
- Scutellum of moderate size, corium always exposed, basal ventral segment almost completely covered by the metasternum; scutellum variable in size and shape CYDNIDAE

3. Spiracle of basal ventral segment hidden by posterior margin of metasternum 4
- Spiracle of basal ventral segment not hidden by metasternum TESSARATOMIDAE
- 4 Scutellum extending to about or beyond middle of the abdomen, rarely shorter, if shorter the apex narrowed and only slightly produced behind the frena, membrane moderate or small.....PENTATOMIDAE
- Scutellum never extending beyond middle of the abdomen, its apex broad, membrane very large DINIDORIDAE

Family I PENTATOMIDAE

Key to the subfamilies of the family Pentatomidae

1. Rostrum slender; basal joint not incrassated, nor inserted at labrum..... PENTATOMINAE
- Rostrum robust; basal joint incrassated, inserted at labrum ASOPINAE

Subfamily PENTATOMINAE

Tribe ANTESTINI

Key to the genera of the tribe Antestini

1. Anterior and anterior lateral margin of pronotum elevated and callous.....*Antestia*
- Anterior lateral margin of pronotum entire, not collously elevated*Plautia*

Genus 1. *Antestia* Stal, 1864

1864. *Antestia* Stal, *Hem. Afr.* 1: 200.

Key to the species of the genus *Antestia*

1. Pronotum with six black spots, one transverse black spots on each side of anterior margin and four discal spots; corium with three discal black spots.; antennae black.....*anchora*
- Pronotum with ten black spots four on anterior margin and six across disk ; corium with discal black spots and a costal black streak ; Antennae greenish or ochraceous*cruciata*

1. *Antestia anchora* (Thunberg, 1783) (Fig.1)

1783. *Cimex anchora* Thunb., *Nov. Inc. Sp.*, 2: 47

1902. *Antestia anchora*: Distant, *Fauna Brit. India, Rhynchota*, 1: 183.

Material examined: 1ex., Bar Forest, Dist. Raipur, 25.ix.2011, coll. Sunil and party.

Diagnostic character: Body yellow orange; head beneath and legs orange-yellow; apex of rostrum black; antennae black, first and second joints and base of third joint rufous; head with the basal margin, a lineate spot before each eye; pronotum with the anterior, anterior lateral, and central basal margins, and two lateral discal luteous, a transverse black spot on each side of anterior margin and four discal spots of the same colour; corium with three discal black spots; counexivum luteous with black spots. *Length:* 10-12 m.m.

Distribution: India: Chhattisgarh (Raipur Dist.), Meghalaya, Nagaland, Sikkim, *Elsewhere:* Java, Myanmar, Sumatra.

2. *Antestia cruciata* (Fabricius, 1775)* (Fig.2)

1775. *Cimex cruciata* Fabr., *Syst. Ent.*; 714.

1902. *Antestia cruciata*: Distant, *Fauna Brit. India, Rhynchota*, 1: 185.

Material examined: 2 exs., Barnawapara, Dist. Raipur, 9.vii. 2011, 11.vii. 2011, coll. Sunil and party. 1ex., Gurgaon, Dist. Raipur, 23.vii. 2011, coll. Sunil and party.

Diagnostic character: Body orange yellow with black spots; head with two central lines and a spot before each eye black; antennae greenish or yellowish brown; pronotum with ten black spots, four on anterior margin, and six across disk; Maximum width of Pronotum 2.26 X as long as maximum width of head, and 2.71 X as long as length of pronotum, scutellum with four black spots; corium with three discal black spots and a costal black streak, Length of scutellum 1.47X as long as maximum width of head, Maximum width of Pronotum 1.53 X as long as length of scutellum; membrane dark smoky brown; body beneath and legs pale greenish yellow; sternum and abdomen with two sub-lateral series of black spots. *Length:* 7-9 m.m.

Distribution: India: Chhattisgarh (Raipur), Maharashtra, Sikkim, Tamil Nadu, West Bengal. *Elsewhere:* Sri Lanka

Genus 2. **Plautia** Stal, 18671867. *Plautia*, Stal, *Ofv. Vet.-Ak. Forh.*,: 514.3. **Plautia crossota** (Fabricius, 1787)*
(Fig. 3)1787. *Cimex fimbriata* Fabr., *Mant. Ins.*, 2: 295.1902. *Plautia fimbriata*: Distant, *Fauna Brit. India, Rhynchota*, 1: 181.2002. *Plautia crossota*: Rider *et al.*, *ZOOSYST ROSSICA*, 2: 144.

Material examined: 1ex., Chipili Camp, Dist. Kabirdham, 29.viii.2011. Coll. Sunil and party; 1 ex., Barnawapara, Dist. Raipur, 18.vii.2011, Coll. Sunil and party; 1 ex., Barnawapara, Raipur Dist., 9.ix.2011. Coll. Sunil and party; 1 ex., Amajheria, Dist. serguja, 9.xi.2011, Coll. Raha and party; 1 ex., Hardinala, Dist., Raipur, 8.xi.2011. coll. anil and party.

Diagnostic character: Head, pronotum, and scutellum pale olivaceous-green; Maximum width of Pronotum 2.3 X as long as maximum width of head, 2.86 X as long as length of pronotum, 1.52 X as long as length of scutellum, Length of scutellum 1.51 X as long as maximum width of head, corium purplish red, membrane fuliginous, darker at base; abdomen above red; body beneath and legs pale greenish; abdomen with the central disk greenish-ochraceous, and with lateral marginal black; rostrum greenish-ochraceous with the apex piceous; antennae greenish-ochraceous, with the apices of the fourth and fifth joints infuscated; pronotum and scutellum are finely and somewhat sparingly punctate, the corium more thickly punctate. *Length:* 10-11 mm.

Distribution: India: Chhattisgarh (Kabirdham, Raipur), Sikkim, Himachal Pradesh, Maharashtra, West Bengal. *Elsewhere:* Sri Lanka, Myanmar, Bhama, Teinzo, Karennee, Malay Peninsula and Malayan Archipelago, Madagascar.

Tribe AGONOSCELIDINI

Genus 3. **Agonoscelis** Spin., 18371837. *Agonoscelis* Spin., *Ess.*,: 327.4. **Agonoscelis nubilis** (Fabricius, 1775)
(Fig. 4)1775. *Cimex nubila* Fabr., *Syst. Ent.*,: 712.1851. *Agonoscelis nubila*: Dall., *List. Hem.*, 1: 179.1902. *Agonoscelis nubila*: Distant, *Fauna Brit. India, Rhynchota*, 1: 189.2002. *Agonoscelis nubilis*: Rider *et al.*, Rider *et al.*, *Zoosyst Rossica*, 2: 136.

Material examined: 7exs., Hardi Nala, Dist. Raipur, 8.xi.2011, coll. Anil and party.; 1 ex., Barnawapara, Dist. Raipur, 27.vii.2011, Sunil and party Coll.

Diagnostic character: Body yellowish brown, thickly covered with black punctures, lateral and anterior margins and a central fascia to pronotum, posterior central fascia, apex of scutellum and basal lateral margin of corium smooth orange yellow; connexivum orange yellow with minute black spots at the apices of the incisures; lateral margins of sternum and abdomen orange yellow. Maximum width of Pronotum 2.4 X as long as maximum width of head, and 2.45 X as long as length of pronotum, Length of scutellum 1.97X as long as maximum width of head, Maximum width of Pronotum 1.22 X as long as length of scutellum. *Length:* 10-11 m.m.

Distribution: India: Chhattisgarh (Raipur), Jammu & Kashmir, Karnataka, Maharashtra, Meghalaya, Nagaland, Tamil Nadu, Uttar Pradesh, West Bengal; *Elsewhere:* China, Japan, Malayan Peninsula, Myanmar, Pakistan, Sri Lanka.

Tribe CARPOCORINI

Genus 4. **Gulielmus** Dist., 19011901. *Gulielmus* Dist., *Entomologist.*,: 347.5. **Gulielmus laterarius** Distant, 1901
(Fig. 5)1901. *Gulielmus laterarius* Distant, *Entomologist.*,: 347.1904. *Gulielmus laterarius*: Distant, *Fauna Brit. India, Rhynchota*, 1: 137.

Material examined: 2 exs., Ramgarh, Dist. Korea, 3.viii.2011, Coll. Angshuman and party; 1ex., Dongpahari, Dist. Raipur, 16.vii.2011; coll. Sunil and party; 1ex., Bar village, Dist. Raipur, 14.vii.2011; coll. Sunil and party; 1ex., Dondnala, Dist. Raipur, 10.vii.2011; coll. Sunil and party.

Diagnostic character: Body yellowish brown and thickly punctate; Maximum width of Pronotum 1.93 X as long as maximum width of head, 2.38 X as long as length of pronotum,

1.24 X as long as length of scutellum, Length of scutellum 1.55 X as long as maximum width of head, corium tinged with carmine red; extreme margin of head and a small spot at apex of the scutellum black; two small obscure fuscous spots on anterior area of pronotum; membrane pale greyish; a longitudinal black punctuate fascia on each lateral area of abdomen; body beneath yellowish brown. *Length*: 9-10 m.m.

Distribution: India: Chhattisgarh (Korea and Raipur), Maharashtra, Uttar Pradesh.

Tribe EYSARCORINI

Key to the genera of the Tribe Eysarcorini

1. Head more or less acuminate, antennae 5-jointed, alike in both sexes *Adria*
- Head broad, not acuminate..... 2
- 2 Scutellum little narrowed on posterior half, almost as long as corium *Eysarcocoris*
- Scutellum distinctly apically narrowed and shorter than corium..... *Carbula*.

Genus 5. *Adria* Stal, 1876

1876. *Adria* Stal, *En. Hem.*, 5: 58.

6. *Adria parvula* Dallas, 1851 (Fig.6)

1851. *Pentatoma parvula* Dallas, *List. Hem.*, 1: 248.

1902. *Adria parvula* : Distant, *Fauna Brit. India, Rhynchota*, 1: 139.

Material examined: 1ex, Barnawapara, Dist. Raipur, 5.vii.2011, coll. Sunil Kumar and party; 1ex, Barnawapara, Dist. Raipur, 11.viii.2011, coll. Anil Kumar and party; 1ex, Dong nala, Dist. Raipur, 16.vii.2011, coll. Sunil Kumar and party; 1 ex. Notadol Forest, Dist. Korea, 4.viii.2011, coll. Angshuman and party; 1ex, Latadadar, Dist. Raipur, 27.ix.2011, coll. Sunil Kumar and party; 1ex, Barnawapara, Dist. Raipur, 11.ix.2011, coll. Sunil Kumar and party; 1ex, Barnawapara, Dist. Raipur, 19.vii.2011, coll. Sunil Kumar and party; 1ex, Durg camp, Dist. Durg, 24.viii.2011, coll. Sunil Kumar and party; 1ex, Sankara R.H., Dist. Dhamtari, 13.x.2011, coll. Sunil Kumar and party; 1ex, Nakati pond, Dist. Raipur, 13.vii.2011, coll. Sunil Kumar and party.

Diagnostic character: Body brown, somewhat thickly and coarsely punctuate; scutellum with a

spot near each basal angle, and a small darker spot at apex; body beneath more darkly punctuate on the lateral areas; antennae with the fourth and fifth joints dark gray. Maximum width of Pronotum 2X as long as maximum width of head, and 2.29 X as long as length of pronotum, Length of scutellum 1.46X as long as maximum width of head, Maximum width of Pronotum 1.35 X as long as length of scutellum. *Length*: 9-10 m.m.

Distribution: India: Chhattisgarh (Dhamtari, Durg, Korea, Raipur), Jharkhand, Maharashtra, West Bengal. *Elsewhere*: Myanmar.

Genus 6. *Carbula* Stal, 1864

1864. *Carbula* Stal, *Hem. Afr.*, 1: 140.

Key to the species of the genus *Carbula*

1. Lateral angles of pronotum sub-prominent, rounded, scutellum punctuate not transeversly wrinkled *insocia*
- Lateral angles of pronotum strongly spinously produced 2
2. Scutellum with a small spot near each basal angle and the apical margin ochraceous *aspavia*
- Scutellum with a large spot at each basal angle and the apex impunctate..... *scutellata*

7. *Carbula insocia* (Walker, 1807) (Fig. 7)

1808. *Eysarcocoris insocia* Walker, *Cat. Het.*, 3: 556.

1902. *Carbula insocia* Distant, *Fauna Brit. India, Rhynchota*, 1: 173.

Material examined: 1ex., Ghui Range, Dist. Surguja, 12.xi. 2011, coll. Raha and party. 1ex., Dong nala, Dist. Raipur, 16.x. 2011, coll. Raha and party. 1ex., Dong Pahari, Dist. Raipur, 12xi. 2011, coll. Raha and party.

Diagnostic character: Brownish pale brown, thickly, and darkly punctate; a small yellow brown and smooth spot at each basal angle of the scutellum; antennae, anterior lateral margins of the pronotum, basal lateral margins of the corium, connexivum, body beneath, and legs, light brown; rostrum reaching posterior coxae, its apex black; connexivum spotted with black; body beneath blackly punctuate; abdomen with a more or less

continuous broad black fascia which narrows posteriorly; lateral margins of abdomen with a series of small black spots at apices of incisures. *Length*: 8 m.m.

Distribution: India: Chhattisgarh (Raipur, Surguja), Karnataka, Maharashtra, North West Himalayas.

8. *Carbula aspavia* Distant, 1907
(Fig. 8)

1907. *Carbula aspavia* Distant, *Fauna Brit. India*, Rhynchota, 4: 440.

Material examined: 1ex., Chipili Camp, Dist. Kabirdham, 25.viii.2011. Coll. Sunil and party.

Diagnostic character: Body dark brown, coarsely punctuate, head black with reddish tinge centrally longitudinally ridge; pronotum with lateral angles strongly produced, black robust, their apices acute, slightly up-tern; scutellum transversely wrinkled, coarsely punctuate, small spot near each basal angles and the apical margin light brown, abdomen above black. *Length*: 9 m.m.

Distribution: India: Chhattisgarh (Kabirdham), Uttarakhand.

9. *Carbula scutellata* Distant

1887. *Carbula scutellata* Distant, *Tr. E.S.*, 347.

1902. *Carbula scutellata* Distant, *Fauna Brit. India*, Rhynchota, 1: 172.

2002. 1909. *Plautia crossota*: Rider *et al.*, *ZOOSYST ROSSICA*, 2: 138.

Material examined: 1ex., Manparat, Dist. Surguja, 22xi.2011, coll. Raha and party.

Diagnostic character: Body brownish yellow, brownly punctuate, lateral pronotal angles produced into long acute black spines, scutellum brownish yellow, darkly punctuate, thickest at lateral margins, a large spot at each basal angle of scutellum and apex impunctate, body beneath with scattered black punctures on disk and femora, the margins and under surface of pronotal angles black. Maximum width of Pronotum 3.58X as long as maximum width of head, and 3.34X as long as length of pronotum, 2X as long as scutellum. Length of scutellum 1.79X as long as maximum width of head. *Length*: 8 m.m.

Distribution: India: Chhattisgarh (Surguja), Maharashtra, Meghalaya; *Elsewhere*: Myanmar.

Genus 7. *Eysarcoris* Hahn, 1834

1834. *Eysarcoris* Hahn, *Wanz.*, 11: 66.

Key to the species of the genus *Eysarcoris*

1. Ventral disc of the abdomen completely black..... 2
- Ventral disc with its central angulated fascia black; apical joint of antennae brownish yellow; lateral angles of pronotum acutely prominent..... *montivagus*
2. Pronotum with its anterior area without any spot; apical joint of antennae shiningly black; lateral angles of pronotum obtusely prominent..... *guttiger*
- Pronotum with its anterior area with two large brassy black spots, pronotal angles normal..
..... *ventralis*

10. *Eysarcoris guttiger* (Thunberg, 1783)*
(Fig. 9)

1783. *Cimex guttiger* Thunb., *Nov. Ins. Sp.*, 2: 32.

1902. *Eusarcocoris guttiger*: Distant, *Fauna Brit. India*, Rhynchota, 1: 165

1999. *Eysarcocoris guttiger*: Chakraborty & Ghosh, *Fauna of Meghalaya: State Fauna Series* 4: 402.

2002. *Eysarcoris guttiger*: Rider *et al.*, *Zoosyst Rossica*, 2: 144.

Material examined: 1ex., Hardinala, Dist. Raipur, 8.xi.2011, coll. Anil and party.

Diagnostic character: Body clay in color, thickly punctured with bronzy black, mainly confluent on head, anterior area of pronotum, and lateral angles of pronotum, lateral angles of the pronotum obtusely prominent; a large spot near each basal angle and apical margin of scutellum smooth and clay colour; body beneath and legs brown and blackly punctuate. *Length*: 5.25-5.50 m.m.

Distribution: India: Chhattisgarh (Raipur), Maharashtra, Nagaland, Sikkim, Uttar Pradesh West Bengal; *Elsewhere*: China, Japan, Myanmar, Sri Lanka.

11. ***Eysarcoris montivagus*** (Distant, 1902)
(Fig. 10)

1902. *Eysarcoris montivagus* Distant, *Fauna Brit. India, Rhynchota*, 1: 166.

1999. *Eysarcoris montivagus*: Chakraborty & Ghosh, *Fauna of Meghalaya: State Fauna Series No. 4*: 402.

2002. *Eysarcoris guttiger*: Rider *et al.*, *Zoosyst Rossica*, 2: 144.

Material examined: 1ex., Ghui, Dist. Surguja, 12.xi.2011, Coll. Raha & party; 1ex., Dardipathar, Dist. Raipur, 12.viii.2011, Coll. Anil & party.

Diagnostic character: Differs from *guttiger* by less produced pronotal angles; the narrower and more laterally sinuate scutellum; the abdomen beneath with a central brassy black angulate fascia; the lateral margin of scutellum brassy black. Maximum width of Pronotum 2.47 X as long as maximum width of head, 1.17 X as long as maximum width of head, 2.11 X as long as length of scutellum, Length of scutellum 1.17 X as long as maximum width of head. *Length:* 5-5.5 m.m.

Distribution: India: Chhattisgarh (Surguja, Raipur), Assam, Meghalaya, Nagaland, Sikkim, Uttar Pradesh.

12. ***Eysarcoris ventralis*** (Westwood, 1837)
(Fig. 11)

1837. *Pentatoma ventralis* Westwood, *In Hope Cat.*, 1: 36.

1902. *Eysarcoris ventralis*: Distant, *Fauna Brit. India, Rhynchota*, 1: 167.

1999. *Eysarcoris ventralis*: Chakraborty & Ghosh, *Fauna of Meghalaya: State Fauna Series No 4*: 402.

2002. *Eysarcoris guttiger*: Rider *et al.*, *Zoosyst Rossica*, 2: 144.

Material examined: 1ex., Mendra beat, Dist. Surguja, 19.xi.2011, Coll. Raha and party; 1ex., Barnawapara, Dist. Raipur, 5.vii.2011, Coll. Sunil and party; 1ex., Barnawapara, Dist. Raipur, 10.xi.2011, Coll. Sunil and party; 1ex., Hardinala, Dist. Raipur, 8.xi.2011, Coll. Anil and party; 1ex. Hardipatha, Dist. Korea, 12.viii.2011, Coll. Anil and party; 1ex., Daldhawa Beat, Dist. Surguja, 14.xi.2011, Coll. Raha and party; 1ex. Banjarahill, Dist. Kabirdham, 25.xi.2011, Coll. Anil and party.

Diagnostic character: Body brownish yellow thickly punctuate; anterior area of pronotum clay colour with two large transverse brassy black spots;

head brassy black lateral margin of pronotum and a large rounded spot near each basal angle of scutellum, smooth and clay colour, Maximum width of Pronotum 2 X as long as maximum width of head, 1.29 X as long as maximum width of head, 1.55 X as long as length of scutellum, Length of scutellum 1.29 X as long as maximum width of head; central disk of abdomen brassy black; body beneath, legs and antennae yellowish brown. *Length:* 5.5-6.5 m.m.

Distribution: India: Chhattisgarh (Kabirdham, Korea, Raipur and Surguja), Jaharkhand, Karnataka, Maharashtra, Uttar Pradesh, West Bengal. *Elsewhere:* Myanmar.

Tribe HALYINI

Key to the genera of the Tribe Halyini

1. Posterior tibiae simple sometimes dilated, head longer than pronotum..... *Halys*
- Anterior and posterior tibiae dilated
..... *Erthesina*

Genus 8. ***Halys*** Fabr., 1803

1803. *Halys* Fabr., *Syst. Rhyng.*, : 180.

13. ***Halys dentatus*** (Fabricius, 1775)*
(Fig. 12)

1775. *Cimex dentatus* Fabr., *Syst. Ent.*, : 702.

1902. *Halys dentatus*: Distant, *Fauna Brit. India, Rhynchota*, 1: 119.

Material examined: 1ex., Devpur, Dist. Raipur, 1.viii.2011, Sunil and party Coll.; 1ex., Barnawapara, Dist. Raipur, 6.ix.2011, Sunil and party Coll.; 1ex, Sankara R.H. Dist. Dhamtari, 27.xi.2011, Sunil & Party Coll.

Diagnostic character: Body dull brown, darkly punct ate, pronotum with obscure oblique fasciae, scutellum with small basal and central discal and two marginal spots before apex, corium with discal patches, black; membrane grayish brown; body beneath and legs yellowish brown; head beneath and abdomen thickly punctuate; rostrum extending as long as 5th abdominal segment. *Length:* 17-23 m.m.

Distribution: India: Chhattisgarh (Dhamtari, Raipur), Assam, Andaman & Nicobar Islands, Andhra Pradesh, Kerala, Meghalaya, Sikkim, Uttar

Pradesh, West Bengal; *Elsewhere*: Bangladesh, China, Japan, Sri Lanka.

Genus 9. ***Erthesina*** Spin., 1837

1837. *Erthesina* Spin., Ess.,: 291.

14. ***Erthesina fullo*** (Thunberg, 1783)
(Fig. 13)

1783. *Cimex fullo* Thunberg, Nov. Ins. Spec, 2: 42.

1904. *Erthesina fullo*: Distant, Fauna Brit. India, Rhynchota, 1: 117.

Material examined: 1ex. Kudmuran R.H. Dist. Korba, 27.xi.2011, Raha and party coll., 1ex., Stapoamber, Dist. Raipur, 7.viii. 2011, Sunil and party coll., 1ex., Devpur, Raipur, 1.viii. 2011, Sunil and party coll.; 1ex., Luha beat, Dist. Jagdalpur, 4.xi. 2011, Gupta and party coll.

Diagnostic character: Head black thickly punctuate, a central longitudinal line, lateral margins, inner margins of eyes and ocelli yellowish brown; pronotum and scutellum black thickly punctuate; corium purplish brown connexivum alternately clay colour and yellowish brown; four longitudinal fasciae to head beneath, sternal and abdominal incisures, marginal spots and sub apical spots to the abdomen black. *Length*: 20 to 25 m.m.

Distribution: India: Chhattisgarh (Korba and Raipur), Assam, Andhra Pradesh, Andaman & Nicobar Islands, Kerala, Meghalaya, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal. *Elsewhere*: China, Japan.

Tribe MENIDINI

Key to the genera of the Tribe Menidini.

1. Body ovulate, more or less convex above ...
..... *Apines*
- Body more or less flattened, abdomen always distinctly spined at base..... *Menida*

Genus 10. ***Apines*** Dall., 1851

1851. *Apines* Dall., List. Hem., 1: 232.

15. ***Apines concinna*** Dall., 1851
(Fig. 15)

1851. *Apines concinna* Dall. List. Hem., 1: 232.

1902. *Apines concinna*: Distant, Fauna Brit. India, Rhynchota, 1: 186.

Material examined: 1ex., Orissa road, Dist.

Jagdalpur, 18.vii.2011, coll. Rajendra Gupta and party.

Diagnostic character: Body shiny black, thickly punctuate, body beneath black; pronotum with a central elongate light yellow brown spot; antenna; black, with the second joint bright red brown, Maximum width of pronotum 3.26 X as long as maximum width of head, and 2.62 X as long as length of pronotum, Maximum width of Pronotum 1.78 X as long as length of scutellum; scutellum with three basal spots, a transverse arcuate spot, sometimes linearly extending posteriorly and the apex light yellow brown, Length of scutellum 1.82 as long as maximum width of head; corium with the basal lateral margin and a transverse fasciate spot on apical area light yellow brown; a few elongated lateral marginal abdominal spots, coxae, bases of femora, and the tibiae, creamy white; bases and apices of tibiae more or less black. *Length*: 6.5 m.m.

Distribution: India: Chhattisgarh (Jagdalpur), Maharashtra, Uttarakhand.

Genus 11. ***Menida*** Motsch., 1861

1861. *Menida* Motsch, Et. Ent., 10: 23

Key to the species of the genus Menida

1. Head with three pale brownish yellow lines and a spot of same colour before the eyes, scutellum with a large spot at each basal angle and large anchor shaped yellowish brown apical spot..... *formosa*
- Head with six black punctured lines, scutellum with a small orange spot in each basal angle, a large round black spot in the middle and a black spot on each lateral margin near apex *apicalis*

16. ***Menida formosa*** (Westwood, 1837)
(Fig. 16)

1837. *Pentatoma formosa* Westwood, in Hope Cat., 1: 34.

1902. *Menida formosa*: Distant, Fauna Brit. India, Rhynchota, 1: 226.

Material examined: 1ex., Sarodadadar, Dist. Kabirdham, 27.viii.2011, coll. Sunil and party, 1ex., Sankara R.H., Dist. Dhamtari, 12.x.2011, coll. Sunil and party,

Diagnostic character: Body Shiny dark bright

red brown, thickly punctate; head with three pale light brown lines and a small spot of the same colour before the eyes, antennae light brown, apex of third joint, and fourth and fifth joints excluding bases, fuscous; Maximum width of Pronotum 2.19 X as long as maximum width of head, 2.73 X as long as length of pronotum, 1.56 X as long as length of scutellum, scutellum with a large spot at each basal angle, sometimes connected at basal margin, and a large anchor-shaped apical spot, sometimes connected with the basal spots, light brown, Length of scutellum 1.48 X as long as maximum width of head; corium with the basal lateral margin and a discal spot light brown; membrane colourless; body beneath and legs light brown; the whole disk of sternum; ventral spine long and slender, just passing the intermediate coxae. *Length*: 6.5 m.m.

Distribution: India: Chhattisgarh (Dhamtari, Kabirdham), Maharashtra, Uttarakhand.

17. *Menida apicalis* (Dallas, 1837)
(Fig. 17)

1837. *Rhaphigaster apicalis* Dallas, *List. Hem.*: 285.

1902. *Menida apicalis*: Distant, *Fauna Brit. India, Rhynchota*, 1: 228.

Material examined: 1ex., Sarodadadar, Dist. Kabirdham, 27.viii.2011, coll. Sunil and party, 1ex., Sankara R.H., Dist.Dhamtari, 12.x.2011, coll. Sunil and party,

Diagnostic character: Body pale greyish olive; head with six black punctured lines on the anterior portion, Antennae with the three basal joints brownish yellow; fourth and fifth black. Pronotum thickly punctured with black, the anterior and lateral margins with a narrow whitish edge, Maximum width of Pronotum 2.18 X as long as maximum width of head, 2.52 X as long as length of pronotum, 2.11 X as long as length of scutellum. Scutellum thickly punctured with black, with a small orange spot in each basal angle, a large round black spot in the middle of the base, and a black spot on each lateral margin near the apex, Length of scutellum 1.39 X as long as maximum width of head. Legs brownish yellow, thickly punctured with black; tarsi with the apical joint brown. Rostrum brownish yellow with the tip black. *Length*: 9 m.m.

Distribution: India: Chhattisgarh (Dhamtari, Kabirdham), North India.

Tribe NEZARINI

Key to the genera of the Tribe Nezarini

1. Antennae with the 2nd segment longer than 3rd, metathoracic scent gland peritreme short and wide*Nezara*
- Antennae with 2nd segment shorter than the 3rd, metathoracic scent gland peritreme long and acuminate.....*Acrosternum*

Genus 12. ***Acrosternum*** Fieber, 1860

1860. *Acrosternum* Fieber, *Eur. Hem.*: 79.

18. *Acrosternum graminea* (Dist.)

1787. *Cimex graminea*: Fabricius, *Mant. Ins.* 2: 295.

1904. *Nezara graminea*: Distant, *Fauna Brit. India*, 1: 221.

1909. *Acrosternum graminea*: Kirkaldy, *Cat. Hem.*, 1: 115.

Material examined: 1ex., Budhadev colony, Dist. Jagdalpur, 16.xi.2011, coll. Gupta and party; 1ex., Bakavand, Dist. Jagdalpur, 16.xi.2011, coll. Gupta and party.

Diagnostic characters: Body above green or yellowish-green, thickly punctate; Maximum width of Pronotum 2.22 X as long as maximum width of head, 2.8 X as long as length of pronotum, 1.48 X as long as length of scutellum, apex of scutellum with two small sub-callous whitish spots, body beneath and legs pale greenish, legs more or less streaked and suffused with yellowish-green, Length of scutellum 1.49 as long as maximum width of head, disk of abdomen brownish yellow; antennae pale fuscous, bases of first, second, and third joints more or less distinctly pale greenish. *Length*: 7-9 m.m.

Distribution: India: Chhattisgarh (Jagdalpur), Tamil Nadu, West Bengal, *Elsewhere*: Sri Lanka.

Genus 13. ***Nezara*** Amy. & Serv., 1843

1843. *Nezara* Amy & Serv., *Hem.*: 143.

19. *Nezara viridula* (Linnaeus, 1758)*
(Fig. 19)

1758. *Cimex viridula* Linn., *Syst. Ent. Nat.* ed 10: 444.

1902. *Nezara viridula*: Distant, *Fauna Brit. India*, 1: 220.

Material examined: 1ex., Chipli Camp, Dist. Kabirdham, 20.xi.2011. Coll. Anil and party;

7exs., Barnawapara, Dist. Raipur, 6.vii.2011, 10.vii.2011, 13.vii.2011, 18.vii.2011. 1.viii. 2011, coll. Sunil and party; 1ex., Kund pani, Dist. Kabirdham, 21.xi.2011. coll. Anil and party; 1ex., Pipar tala forest, Dist. Kabirdham, 17.xi. 2011, coll. Sunil and party; 1ex., Thalara Forest, Dist. Kabirdham, 23.xi.2011. coll. Anil and party; 1ex., Dongpahari, Dist. Raipur, 4.viii. 2011, coll. Sunil and party; 1ex., Hardinala, Dist. Raipur, 4.viii. 2011, coll. Sunil and party; 1ex., Achanik Pur, Dist. Raipur, 9.viii. 2011, coll. Sunil and party; 1ex., Gabod, Dist. Raipur, 8.x. 2011, coll. Sunil and party; 1ex., K.riv.P., Dist. Jagdalpur, 27.vii. 2011, coll. Gupta and party; 1ex., Makdi ring, Dist. Jagdalpur, 8.xi. 2011, coll. Renu and party; 1ex., Karampani, Dist. Surguja, 15.xi. 2011, coll. Raha and party; 1ex., Ghuirng, Dist. Surguja, 21.xi. 2011, coll. Raha and party.

Diagnostic character: Body pale to dark green, thickly punctuate; extremities of segmental angles of abdomen black; antennae green, apices of the 3rd, 4th and 5th joints purplish brown. Maximum width of Pronotum 2.4 X as long as maximum width of head, 2.72 X as long as length of pronotum, 1.44 X as long as length of scutellum, Length of scutellum 1.66 X as long as maximum width of head. *Length:* 12-16 m.m.

Distribution: India: Chhattisgarh (Jagdalpur, Kabirdham, Raipur, Surguja), Throughout whole of British India; *Elsewhere:* Australasian, Ethiopian, Nearctic, Neotropical, Palearctic.

Tribe PENTATOMINI

Genus 14. **Placosternum** Amy & Serv., 1843

1843. *Placosternum* Amy & Serv., *Hem.*,: 174.

20. **Placosternum dama** (Fabricius, 1794) (Fig. 20)

1794. *Cimex dama* Fabr., *Ent. Syst.*, 4: 92.

1902. *Placosternum dama* Distant, *Fauna Brit. India, Rhynchota*, 1: 211.

Material examined: 1ex., Bar forest, Dist. Raipur, 6.8.2011, coll. Sunil and party; 1ex., Barnawapara, Dist. Raipur, 31.2.2011, coll. Sunil and party; 1ex., Kudmurah R.H., Dist. Korba, 27.xi.2011, Coll. Raha and party.

Diagnostic character: Body elongate and the much less produced pronotal angles, which are

sinuate near the anterior angle and then lobately rounded posteriorly; the lateral margins, are simply crenulate; the antennal joints are piceous. *Length:* 18-20 m.m.

Distribution: India: Chhattisgarh (Korba and Raipur), Assam, Kerala, Tamil Nadu.

Tribe PIEZODORINI

Genus 15. **Piezodorus** Fieber, 1861

1861. *Piezodorus* Fieb, *Eur. Hem.*,: 78 & 329.

21. **Piezodorus hybneri** (Gmelin), 1790 (Fig. 21)

1790. *Cimex hybneri* Gmelin, *Linn. Syst.Nat.*, 1(4): 1517-2224.

2002. *Piezodorus hybneri*: Rider *et.al.* *Zoosyst Rossica*, 2: 144.

Material examined: 1ex., Janakpur, Dist. Korba, 14.8.2011, Coll. Angshuman and party; 1ex., Bakabandh, Dist. Jagdalpur, 22.xi.2011, Coll. R.P.Gupta and party; 1ex., Anjani beat, Dist. Surguja, 10.xi.2011, Coll. Raha and party; 1ex., Barnawapara, Dist. Raipur, 24.ix.2011, coll. Sunil and party; 2exs., Hardipathar Dist. Raipur, 5.xi.2011, coll. Sunil and party; 1ex., Devgaon forest, Dist. Raipur, 12.ix.2011, coll. Sunil and party; 1ex., Latadar, Dist. Raipur, 9.xi.2011, coll. Sunil and party; 1ex., Hardinala, Dist. Raipur, 8.xi.2011, coll. Anil and party; 1ex., Barnawapara, Dist. Raipur, 6.x.2011, coll. Sunil and party; 1ex., Barnawapara, Dist. Raipur, 11.xi.2011, coll. Sunil and party; 13exs., Kundpani, Dist. Kabirdham, 21.xi.2011, coll. Anil and party; 11exs., Pipartala forest, Dist. Kabirdham, 17.xi.2011, coll. Sunil and party; 2exs., Sital pani Forest, Dist. Kabirdham, 19.xi.2011, coll. Anil and party; 5exs., Banjari, Dist. Kabirdham, 25.xi.2011, coll. Anil and party; 14exs., Loop Forest, Dist. Kabirdham, 25.xi.2011, coll. Anil and party; 1ex., Chipli Forest, Dist. Kabirdham, 14.xi.2011, coll. Anil and party; 13exs., Thalara forest, Dist. Kabirdham, 23.xi.2011, coll. Anil and party; 1ex., Kharapani Forest, Dist. Kabirdham, 16.xi.2011, coll. Sunil and party; 1ex., Boudha Forest, Dist. Kabirdham, 24.xi.2011, coll. Anil and party; 2 exs., Kudadhura Forest, Dist. Kabirdham, 15.4.xi.2011, coll. Sunil and party.

Diagnostic character: Body pale greenish,

thickly punctuate; pronotum with a purplish fascia between the angles, Maximum width of Pronotum 2.19 X as long as maximum width of head, Pronotum 2.67 X as long as length of pronotum, 1.35 X as long as length of scutellum; Length of scutellum 1.62 X as long as maximum width of head, clavus with a small black apical spot; basal lateral margin of corium and connexivum pale purplish or reddish; body beneath and legs pale clay colour. *Length*: 8-10 m.m.

Distribution: India: (Jagdalpur, Korba, Raipur, Surguja), Assam, Maharashtra, Sikkim, Uttar Pradesh, West Bengal. *Elsewhere*: Australasia, Japan, Malay peninsula, Myanmar, Sri Lanka.

Tribe SCIOCORINI

Genus 16. *Menedemus* Distant, 1899

1899. *Menedemus* Distant, *A.M.N.H.* (7)4: 430

22. *Menedemus hieroglyphicus* Distant, 1899 (Fig. 22)

1899. *Menedemus hieroglyphicus* Distant, *A.M.N.H.* (7)4: 430.

1902. *Menedemus hieroglyphicus*: Distant, *Fauna Brit. India, Rhynchota*, 1: 127

2011. *Menedemus hieroglyphicus*: Azim, *Halteres*, 3: 2.

Material examined: 1ex., Khar Village, Dist. Surguja, 10.xi.2011, coll. Raha and party.

Diagnostic characters: Body brown, thickly and darkly punctate; head with three discal levigate, linear, light brown fasciae; pronotum with five similar fasciae, and between the two outermost on each side a short basal fascia, and the lateral margins light brown, Maximum width of Pronotum 1.77 X as long as maximum width of head, 2.17 X as long as length of pronotum, 1.32 X as long as length of scutellum; scutellum with an elongate spot near each basal angle, the lateral and apical margins, a central longitudinal fascia, and a transverse central sinuate fascia crossing disk smooth, light brown, Length of scutellum 1.33 X as long as maximum width of head; membrane piceous; connexivum alternately ochraceous and black; body beneath black with reddish tinge; abdomen with the posterior segmental margins, and a series of marginal spots light brown; antennae dull dark brownish, first and third and fourth and fifth joints sub-equal in length. *Length*: 7-8 m.m.

Distribution: India: Chhattisgarh (Surguja), Maharashtra.

Genus 17. *Sciocoris* Fallen, 1829

1829. *Sciocoris* Fallen, *Hem. Suec.*, 20.

23. *Sciocoris indicus* Dallas, 1851 (Fig. 23)

1851. *Sciocoris indicus* Dallas. *List. Hem.*, 1: 132.

2011. *Sciocoris indicus*: Azim, *Halteres*, 3: 2.

Material examined: 1ex., Khar Village, Dist. Surguja, 10.xi.2011, coll. Raha and party.

Diagnostic characters: Body light brown, thickly, coarsely, darkly punctate; antennae with the 1st and 2nd joints light brown, the remainder black with reddish tinge; pronotum with a central smooth line extending through the scutellum, Maximum width of Pronotum 1.78 X as long as maximum width of head, 2.56 X as long as length of pronotum, 1.39 X as long as length of scutellum; apex of scutellum pale greyish, Length of scutellum 1.27 X as long as maximum width of head; connexivum light brown, spotted with reddish black; membrane fuliginous, hyaline; sternum with a narrow pale fascia on each lateral area; abdomen with the disk reddish black, gradually narrowing towards apex, where it contains a central pale line, and with a sub-apical black spot. *Length*: 5.5-6 m.m.

Distribution: India: Chhattisgarh (Surguja), Kerala.

Tribe SEPHELINI

Genus 18. *Niphe* Stal, 1867

1867. *Niphe* Stal, *Ofv. Vet. – Ak. Forh.*, 516.

24. *Niphe subferruginea* (Westwood, 1837) (Fig. 24)

1837. *Pentatoma subferruginea* Westwood, *In Hope Cat.* 1: 35.

1902. *Niphe subferruginea*: Distant, *Fauna Brit. India, Rhynchota*, 1: 151.

Material examined: 1ex., Chipli R.H., Dist. Kabirdham, 28.vii.2011. Coll. Sunil and party; 1ex., Chipli Camp, Dist. Kabirdham, 25.vii.2011. Coll. Sunil and party; 8exs., Barnawapara, Dist. Raipur, 2.viii.2011, Sunil and party Coll. 3exs., Barnawapara, Dist. Raipur, 6.ix.2011, Sunil and party Coll. 2exs., Barnawapara, Dist.

Raipur, 27.vii.2011, Sunil and party Coll. 1ex., Barnawapara, Dist. Raipur, 24.ix.2011, Sunil and party Coll. 10exs., Barnawapara, Dist. Raipur, 4.ix.2011, Sunil and party Coll. 5 exs., Barnawapara, Dist. Raipur, 4.viii.2011, Sunil and party Coll. 1ex., Barnawapara, Dist. Raipur, 27.vii.2011, Sunil and party Coll. 1ex., Barnawapara, Dist. Raipur, 27.vii.2011, Sunil and party Coll. 5exs., Barnawapara, Dist. Raipur, 3.viii.2011, Sunil and party Coll. 3exs., Barnawapara, Dist. Raipur, 16.viii.2011, Sunil and party Coll. 1ex., Latadar, Dist. Raipur, 23.ix.2011, Sunil and party Coll. 1ex., Ahanakpur, Dist. Raipur, 9.viii.2011, Sunil and party Coll. 1ex., Dongpahari, Dist. Raipur, 4.viii.2011, Sunil and party Coll.

Diagnostic character: Body reddish brown, thickly and darkly punctate; lateral margins of the pronotum, basal lateral margins of corium, apex of scutellum, connexivum, body beneath, and legs brown; Maximum width of Pronotum 2.33 X as long as maximum width of head, 2.75 X as long as length of pronotum, 1.33 X as long as length of scutellum, Length of scutellum 1.75 X as long as maximum width of head, antennae with the apex of the third and apical halves of fourth and fifth joints black; sternum coarsely but palely punctate and with about two small black spots on the lateral areas of each segment; lateral areas of abdomen with scattered small spots and the stigmata black. *Length:* 12-14 m.m.

Distribution: India: Chhattisgarh (Kabirdham and Raipur), Kerala, Maharashtra, Meghalaya. *Elsewhere:* Myanmar.

Tribe STRACHIINI

Genus 19: *Bagrada* Stal, 1862

1862. *Bagrada* Stal, *Stett. Ent. Ziet.*, 23: 105.

25. *Bagrada hilaris* Burmister, 1935* (Fig. 25)

1935. *Bagrada hilaris* Burmister, *Hand de Ent.*, 2:

2002. *Bagrada hilaris*: Rider, *Zoosyst. Rossica*, 2: 137.

Material examined: 1ex., Akaltara, Dist. Riapur, 17.vii.2011, Coll. Sunil and party.

Diagnostic character: Body black; anterior and lateral margins and a central fascia to pronotum, a spot near each basal angle and a spot on each

margin before apex of scutellum, a marginal fascia to corium becoming sub marginal a little beyond base and terminating in a rounded discal spot before apex yellowish brown, connexivum yellowish brown spotted with black; streaks to head, lateral marginal spots to sternum and abdomen and segmental spots, black. *Length:* 5-7 m.m.

Distribution: India: Chhattisgarh (Raipur), Uttarakhand, Uttar Pradesh, Maharashtra, Manipur, West Bengal; *Elsewhere:* Sri Lanka.

Subfamily ASOPINAE

Key to the genera of the Subfamily Asopininae

1. Anterior femora with a prominent spine, lateral pronotum margin crenulated or dentate.....
.....*Eocanthecona*
- Anterior femora unarmed 2
2. lateral pronotal angles more or less produced, head longer than broad*Andrallus*
- lateral pronotal angles rounded, not produced, 2nd joint of antennae more than twice as long as 3rd *Amyotea*

Genus 20. *Amyotea* Ellenreider, 1862

1862. *Amyotea* Ellenreider, *Nat. Tijds. Nederlandsche Indie*. 24: 137.

26. *Amyotea malabarica* (Fabricius, 1775) (Fig. 26)

1775. *Cimex malabarica* Fabricius, *Syst. Ent. Sis. insect*: 718.

1977. *Amyotea malabarica*: Hsiao et al., *Academia Sinica*: 88.

Material examined: 1ex., Hardinala, Dist. Raipur, 8.xi.2011, coll. Anil and party.

Diagnostic character: Body pale reddish, above thickly and very finely punctuate, beneath yellow brown; antennae, eyes, basal spot to head, two spots to pronotum, a large spot near each basal angle of scutellum, and membrane black; head beneath, lateral margins of sternum and abdomen, rostrum, coxae, and femora pale reddish; tibiae, tarsi, and anterior margins of sternal and abdominal segments black or bluish-black. *Length:* 12-14 m.m.

Distribution: India: Chhattisgarh (Raipur),

Assam, Karnataka, Maharashtra, West Bengal, Elsewhere: Borneo, Java, Sumatra, Myanmar, Philippines.

Genus 21. ***Andrallus*** Bergroth, 1905

1905. *Andrallus* Bergroth, *Ann. Soc. Ent. Belg.*, **49**: 370.

27. ***Andrallus spinidens*** (Fabricius, 1787)
(Fig. 27)

1787. *Cimex spinidens* Fabr., *Mant. Ins.*, **2**: 285.

1902. *Audentia spinidens*: Distant, *Fauna Brit India, Rhynchota*, **1**: 253.

1905. *Andrallus spinidens*: Bergroth, *Ann. Soc. Ent. Belg.*, **49**: 370.

Material examined: 1ex., Barnawapara, Dist. Raipur, 7.vii.2011, coll. Sunil and party; 1ex., Bakabandh, Dist. Jagdalpur, 22.xi.2011, coll. Gupta and party.

Diagnostic character: Body pale brownish to yellowish brown; head with blackish punctate fascia on each side of the central lobe; pronotum with pale central smooth line extending between the pronotal angles which are black and emarginated with the posterior spine being very small. **Length:** 13-16 m.m.

Distribution: India: Chhattisgarh (Jagdalpur, Raipur), Assam, Jharkhand, Karnataka, Meghalaya, Sikkim, Uttar Pradesh, West Bengal. Elsewhere: Africa, Fiji Island, Malayan archipelago, Mexico, Tahiti Island.

Genus 22: ***Eocnthecona*** Bergroth, 1915

1915. *Eocnthecona* Bergroth, *Ann. Mag. Nat. Hist.* **8(15)**: 481.

28. ***Eocnthecona furcellata*** (Wolff, 1801)
(Fig. 28)

1801. *Cimex furcellata* Wolff., *IC.*,: 182.

1902. *Canthecona furcellata*: Distant, *Fauna Brit. India, Rhynchota*, **1**: 248.

1994. *Eocnthecona furcellata*: Thomas, *Insect Mundi*, **8(3-4)**: 176.

Material examined: 1ex., Loop forest, Dist. Kavidham, 20.xi.2011, Anil and party; 1ex., Hardi Pather, Dist. Raipur, 5.xi.2011, coll. Sunil and party; 1ex., Kontarali baeat, dist. Sarguja, 19.xi.2011., coll. Raha and party; 1ex., Karmpani, dist. Sarguja, 15.xi.2011., coll. Raha and party.

Diagnostic character: Body yellowish brown, thickly punctate with bronzy punctures; head with a central fascia; pronotum with broken transverse fascia on anterior area with the lateral angle bronzy black, pronotal margin anteriorly finely dentate and apices of the pronotal angles bifid; connexivum punctate with sub quadrate bronzy black spots; scutellum bronzy black at base with a smooth spot at each basal angle. **Length:** 15-16m.m.

Distribution: India: Chhattisgarh (Kabirdham, Raipur and Surguja), Jharkhand, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal; Elsewhere: Japan, Myanmar, Sri Lanka.

Family II CYDNIDAE

Key to the genera of the Family Cydnidae

1. Antennae four jointed; Posterior femora not spined.....*Adrisa*
- Antennae five jointed; Posterior femora generally spined.....*Macroscytus*

Genus 23. ***Adrisa*** Amyt & Serv., 1843

1843. *Adrisa*, Amt. & Serv., *Hem.*, : 89.

29. ***Adrisa magna*** (Uhler, 1843)
(Fig. 29)

1830. *Acatalectus magna* Uhler., *Proc. Ac. X. S. Phil.*, : 222

1902. *Adrisa magna*: Distant, *Fauna Brit. India, Rhynchota*, **1**:89.

Material examined: 1ex., Barnawapara, Raipur Dist., 15.vii.2011, Sunil and party.

Diagnostic characters: Body black, punctured; head rounded in front, the lateral margins wrinkled, strongly punctate, and very finely and obscurely meeting in front of the median lobe; pronotum sub-quadrate, the anterior angles rounded, the pronotal disk punctured excepting a smooth space on the anterior area; scutellum wrinkled and punctate, with a more or less distinct central carinate line; corium thickly punctate; membrane smoky brown. **Length:** 13-19 m.m.

Distribution: India: Chhattisgarh (Raipur), Nagaland; Elsewhere: Hong Kong, Myanmar

Genus 24. ***Macroscytus*** Fieber, 1861

1861. *Macroscytus*, Fieber, *Eur. Hem.*,: 83, 362.

Key to species of the genus *Macroscytus*

1. Body deep brown, pronotum convex in front, transversely flattened without any impression, head rounded, tarsi yellow, membrane hyaline.....*brunneus*
- Body pitchy brown, pronotum and scutellum at apex deeply foveate, ocelli very large and red, tarsi ochraceous, membrane brownish and semitransparent.....*foveolus*

30. *Macroscytus brunneus* (Fabricius, 1803)
(Fig. 30)

1803. *Cydus brunneus*, Fabr., *Syst. Rhyng.*: 18.

1902. *Macroscytus brunneus*: Distant, *Fauna Brit. India, Rhynchota*, 1: 95.

Material examined: 1ex., Barnawapara, Raipur Dist., 9.vii.2011, Sunil and party; 1ex., Barnawapara, Raipur Dist., 14.viii.2011, Sunil and party.

Diagnostic characters: Body oval, deep brown; corium glossy; rostrum, base of antennae, and the tarsi light brown. Head rounded in front, central lobe as long as the lateral lobes, with 5-6 hairs along the margin; first and second joints of the antennae light brown, the third shorter than the second; pronotum convex in front, transversely flattened, without an impression; finely punctured on the disk; corium almost flat, finely punctate; membrane hyaline, veins infuscated; tarsi yellow, all the femora spinose beneath, posterior femora with two stout spines at apex. *Length* : 8 m.m.

Distribution: India: Chhattisgarh (Raipur), All over India, *Elsewhere:* Africa, China, Myanmar, Sri Lanka and Europe.

31. *Macroscytus foveolus* (Dallas, 1851)
(Fig. 31)

1851. *Aethys foveolus* Dall., *List. Hem.*, 1: 113.

1902. *Macroscytus foveolus*: Distant, *Fauna Brit. India, Rhynchota*, 1: 97.

Material examined: 1ex., Bridulaw colony, Jagdalpur Dist. 16.vii.2011, 1ex., Barnawapara, Raipur Dist., 15.viii.2011, Sunil and party.

Diagnostic characters: Body pitchy brown, head relatively small, with the anterior margin rounded, Ocelli very large, red. Antennae rusty red brown, dusky towards the base. Thorax pitchy-

brown, with the posterior margin chestnut; anterior margin with a faint, finely punctured, transverse fovea; Scutellum pitchy-brown at the base, chestnut-brown towards the apex and strongly but sparingly punctured; the tip with a distinct fovea; membrane brownish, semitransparent. Abdomen beneath pitchy, very smooth and shiny; the sides thickly and finely punctured. Anterior legs pitchy-red with the coxae reddish; all the tarsi rusty red brown. Rostrum pitchy-red, with the apex pitchy. *Length*: 8.5-11 m.m.

Distribution: India: Chhattisgarh (Jagdalpur and Raipur), North India, Sikkim.

Family III DINIDORIDAE

Genus 25. *Coridius* Illiger, 1807

1807. *Coridius* Illiger, *Fauna Etrusca.*, 2: 361.

Key to the species of the genus *Coridius*

1. Antennae black, body beneath and legs black.....*ianus*
- Antennae fuscous, body beneath and legs more or less infuscated..... 2
2. Abdomen above red, third joint of antennae longer than the second.....*brunneus*
- Abdomen above black, third joint of antennae never longer than second.....*obscurus*

32. *Coridius brunneus* (Thunberg, 1783)*
(Fig. 32)

1783. *Cimex brunneus* Thunberg, *Nov. Ins. Sp.*, 2: 45.

1902. *Aspongopus brunneus*: Distant, *Fauna Brit. India, Rhynchota*, 1: 281

1992. *Coridius brunneus*: Lis., *Ann. Upper Silesian Mus. Ent.*, 3: 38(R).

Material examined: 1ex., Baranwapara, Dist. Raipur, 10.vii.2011, coll. Sunil and party; 1ex., Kontarali beat, Dist. Surguja, 19.xi.2011, coll. Raha and party; 1ex., Makdirno, Dist. Jagdalpur, 10. ix.2011, coll. R.P. Gupta and party; 1ex., Jamunapani F, Dist. Kabirdham, 22.xi.2011, coll. Anil and party; 1ex., Sitalpani F, Dist. Kabirdham, 19.xi.2011, coll. Anil and party;

Diagnostic characters: Body yellowish brown, beneath and legs more or less smoky gray brown with blackish tinge; antennae dark brown near to black, apical joint brownish yellow, sometimes

with its apex narrowly black; abdomen above red; third joint of the antennae a little longer than the second, shorter than the fourth or fifth joints. *Length*: 17-20 m.m.

Distribution: India: Chhattisgarh (Jagdalpur, Kabirdham, Raipur, Surguja), Assam, Jharkhand, Maharashtra, Meghalaya, Nagaland, West Bengal. *Elsewhere*: Myanmar

33. *Coridius ianus* (Fabricius, 1775)
(Fig. 33)

1775. *Cimex ianus* Fabr., *Syst. Ent.*, 714.

1902. *Aspongopus janus*: Distant, *Fauna Brit. India, Rhynchota*, 1: 281.

1992. *Coridius ianus*: Lis., *Ann. Upper Silesian Mus. Ent.*, 3: 38(R).

Material examined: 1ex., Barnawapara, Dist. Raipur, 7.vii.2011, coll. Sunil and party, 1ex., Guragaon, Dist. Raipur, 23.vii.2011, coll. Sunil and party.

Diagnostic character: Body yellowish brown or blood reddish; antennae, head, subanterior transverse fascia to pronotum, basal half of scutellum black or greenish black; antennae with the 3rd joint a little longer than first, shorter than remaining joints. *Length*: 16 to 20 m.m.

Distribution: India: Chhattisgarh (Raipur), Karnataka, Kerala, Maharashtra, Meghalaya, Tamil Nadu, Uttarakhand, West Bengal. *Elsewhere*: Myanmar, Sri Lanka.

34. *Coridius obscurus* (Fabricius, 1794)
(Fig. 34)

1794. *Cimex obscurus* Fabr., *Ent. Syst.*, 4: 107.

1902. *Aspongopus obscurus*: Distant, *Fauna Brit. India, Rhynchota*, 1: 281

1992. *Coridius obscurus*: Lis., *Ann. Upper Silesian Mus. Ent.*, 3: 38(R).

Material examined: 1ex., Barnawapara, Dist. Raipur, 10.vii.2011, coll. Sunil and party.

Diagnostic characters: This species is very similar to *C. brunneus*, in general body colour and size, but differ for *C. brunneus* by having the abdomen above black, and the second and third joints of the antennae sub-equal in length, not third joint longer than second. *Length*: 17-20 m.m.

Distribution: India: Chhattisgarh (Raipur), Assam, Karnataka, Maharashtra, West Bengal.

Family IV SCUTELLERIDAE

Genus 26. *Chrysocoris* Hahn, 1843

1843. *Chrysocoris*, Hahn, *Wanz. Ins.*, 38.

Key to the species of the genus *Chrysocoris*

1. Pronotum with five spots on, two anterior and three on posterior disk, seven spots on scutellum, six arranged in pairs and one elongate spot on anterior disk..... *perpureus*
- Pronotum with eight spots, three near anterior margin, three larger on posterior disk, and one on each lateral angle *stollii*

35. *Chrysocoris perpureus* (Westwood, 1837)
(Fig. 35)

1837. *Callidea purpureus*, Westw. in *Hope Cat.*, 1: 15

1902. *Chrysocoris perpureus*: Distant, *Fauna Brit. India, Rhynchota*, 1: 58.

Material examined: 1ex., Bakavand, Dist. Jagdalpur, 16.xi.2011, coll. Gupta and party; 1ex., Balamdehi riv., Dist. Raipur, 1.x.2011, coll. Sunil and party;

Diagnostic characters: Above bluish or purplish-green; five spots on pronotum, two anterior and three on posterior disk, seven spots on scutellum, six arranged in pairs and one on anterior disk; antenna black; Body beneath, base of first joint of antennae, and femora ochraceous, lateral margins of the abdomen purplish; head beneath, marginal spots on sternal segments, stigmatal spots, apices of femora, the tibiae and tarsi, and third and fourth joints of rostrum bluish-black; a central spot to sternum, and sometimes one at base and apex of abdomen, piceous. *Length*: 15-17 m.m.

Distribution: India: Chhattisgarh (Jagdalpur and Raipur), Andhra Pradesh, Himachal Pradesh, Karnataka, Maharashtra, Tamil Nadu,

36. *Chrysocoris stollii* (Wolff., 1801)
(Fig. 36)

1801. *Cimex stollii* Wolff., *IC.*, 2: 48, 45.

1902. *Chrysocoris stollii*: Distant, *Fauna Brit. India, Rhynchota*, 1: 58

Material examined: 5exs., Rampur, dist. Durg, 24.viii.2011, Sunil and party; 8exs., Bhilai, dist.

Durg, 21.viii.2011, 19.viii.2011, Sunil and party; 1ex., Balamdehi riv., Dist. Raipur, 1.x.2011, coll. Sunil and party; 1ex., Bakavand, Dist. Jagdalpur, 16.xi.2011, coll. Gupta and party; 4exs., Saja, Dist. Durg, 23.viii.2011. coll. Sunil and party.

Diagnostic characters: Body above bluish or purplish green; pronotum with eight spots, three near anterior margin, three larger and basal on posterior margin and on each lateral angles; scutellum with 7 spots, six of which arrange in pairs and a central one large sub-ovate. *Length:* 13-14.5 m.m.

Distribution: India: Chhattisgarh (Durg, Jagdalpur and Raipur), Andaman & Nicobar islands, Assam, Delhi, Meghalaya, Nagaland, Sikkim, West Bengal. *Elsewhere:* China, Pakistan, Myanmar.

Family V TESSARATOMIDAE

Genus 27. *Tessaratoma* Lep. & Serv., 1825

Key to species of the genus *Tessaratoma*

1. Male with the anal appendage is truncate at its apex.....*javanica*
- Male with the anal appendage is sinuate at the apex, the apical angles acute
.....*papillosa*

37. *Tessaratoma javanica* (Thunberg, 1783)* (Fig. 37)

1783. *Cimex javanica* Thunb., *Nov. Ins. Spec.*, 2: 45.

1902. *Tessaratoma javanica*: Distant, *Fauna Brit. India, Rhynchota*, 1: 259.

Material examined: 23exs., Kartala Rest House, Dist. Korba. 5.vi.2012, Coll. Kailash Chandra and party.

Diagnostic characters: Body yellowish brown; antennae black, apical joint brownish-yellowish brown; margins of head and pronotum very narrowly black; pronotum with the lateral margins moderately amplified and reflexed, apex of scutellum more or less dull black; body beneath generally covered with a white powdery substance; legs and tarsi dark bright red brown; body above

very finely and obscurely punctuate. *Length:* 25-31 m.m.

Distribution: India: Chhattisgarh (Korba), Andhra Pradesh, Assam, Maharashtra, Sikkim. *Elsewhere:* Myanmar.

38. *Tessaratoma papillosa* (Drury, 1770) (Fig. 38)

1770. *Cimex papillosa* Drury, *Ill* 1: 96.

1902. *Tessaratoma papillosa*: Distant, *Fauna Brit. India, Rhynchota*, 1: 259.

Material examined: 1ex., Ramgarh, Korea Dist., 3.viii.2011, coll. Angshuman and party; 1ex., Raipur, Raipur Dist., Teak plantation, 3.viii.2011, coll. Anil and party.

Diagnostic characters: This species is alike to *T. javanica*, in general body colours, but it can easily be separated from *T. javanica* by having narrower and more elongated body; the antennae are altogether black. Male with the anal appendage sinuate at the apex, the apical angles acute. *Length:* 25-28 m.m.

Distribution: India: Chhattisgarh (Korea and Raipur), Assam, Tamil Nadu, West Bengal. *Elsewhere:* China

SUMMARY

This paper deals with 38 species of Pentatomid bugs belonging to 27 genera under 5 families from the state of Chhattisgarh. Of these 30 species belonging to 24 genera constitute new record from this state. The diagnostic character of each species, keys to various taxa, distributions of each species in various districts of Chhattisgarh, other states and countries have been incorporated. The study is based on the collections made by different survey parties in recent years.

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PLATE I



Figs. 1. *Antestia anchora* (Thunb.)



Figs. 2. *Antestia cruciata* (Fabr.)



Figs. 3. *Plautia crossota* Krik



Figs. 4. *Agonoscelis nubilus* (Fabr.)



Figs. 5. *Gulielmus laterarius* Distant



Figs. 6. *Adria parvula* Dallas



Figs. 7. *Carbula insocia* Walker



Figs. 8. *Carbula aspavia* Distant



Figs. 9. *Carbula scutellata* Dist.

PLATE II

Figs. 10. *Eysarcoris guttiger* (Thunb.)Figs. 11. *Eysarcoris montivagus* Dist.Figs. 12. *Eysarcoris ventralis* (Walker)Figs. 13. *Halys dentatus* Fabr.Figs. 14. *Erthesina fullo* Thunb.Figs. 15. *Apines concinna* Dall.Figs. 16. *Menida formosa* (Westw.)Figs. 17. *Menida apicalis* (Dall.)Figs. 18. *Acostermum grami* Dist.

PLATE III



Figs. 19. *Nezara viridula* (Linn.)



Figs. 20. *Placosternum dama* (Fabr.)



Figs. 21. *Piezodorus rubrofasciatus* (Fabr.)



Figs. 22. *Menedemus hieroglyphicus* Dist.



Figs. 23. *Sciocoris indicus* Dall.



Figs. 24. *Niphe subferruginea* (Westw.)



Figs. 25. *Bagrada hilaris* (Burmeister)



Figs. 26. *Amyotea malabaricus* (Fabr.)

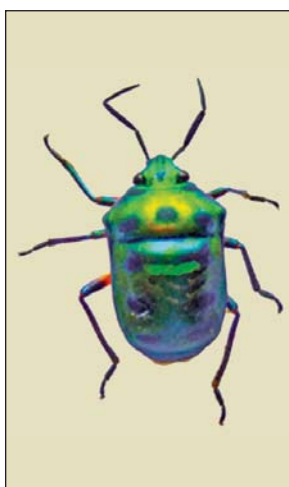


Figs. 27. *Andrallus spinidens* (Fabr.)



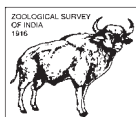
Figs. 28. *Eocanthecona furcellata* (Wolff)

PLATE IV

Figs. 29. *Adrisa magna* (Uhler)Figs. 30. *Macroscyrtus brunneus* (Fabr.)Figs. 31. *Macroscyrtus foveolus* (Dall.)Figs. 32. *Coridius brunneus* (Thunb.)Figs. 33. *Coridius ianus* (Fabr.)Figs. 34. *Coridius obscurus* (Fabr.)Figs. 35. *Chrysocoris perpureus* (Westw.)Figs. 36. *Chrysocoris stollii* (Wolff)Figs. 37. *Tessaratomya javanica* (Thunb.)Figs. 38. *Tessaratomya papillosa* (Drury)

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NEW RECORDS AND UPDATED LIST OF BUTTERFLIES (LEPIDOPTERA: RHOPALOCERA) FROM CHHATTISGARH, CENTRAL INDIA

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INTRODUCTION

India falls mainly under the Oriental Region and partly under the Palaearctic Region. It has one of the richest and diverse butterfly faunas with 1,641 species representing more or less 9.50% of the total butterfly species of the world (Varshney 2006). Approximately 10.58% of the butterfly diversity found in India has so far been documented from Central Indian landscape i.e. Madhya Pradesh and Chhattisgarh (Chandra *et al.*, 2007).

Several studies on the butterfly fauna of central India have been done, mostly by Forsayeth (1884), Swinhoe (1886), De Nicéville (1890), Betham (1890, 1891) and Witt (1909). Subsequently, Evans (1932), Talbot (1939, 1947) and Winter-Blyth (1957) made significant contributions. Later, several workers studied butterflies from some districts and conservation areas of Madhya Pradesh and Chhattisgarh (Singh 1977; Gupta & Shukla 1987; Chaudhury 1995; Chandra *et al.*, 2000a, b & 2002; Singh & Chandra 2002; Siddiqui & Singh 2004; Chandra 2006). Chandra *et al.* (2007) provided a checklist of 174 species/subspecies from Central India, of which 153 and 113 butterfly species from Madhya Pradesh and Chhattisgarh, respectively. Two more butterflies were also added to the above mentioned checklist of Chhattisgarh (Sharma & Chandra, 2009). Since most of the faunal inventories pertaining to Chhattisgarh also included those from Madhya Pradesh, the present study was undertaken to comprehensively document the butterfly fauna from areas exclusively under Chhattisgarh.

MATERIALS AND METHODS

Study area

Chhattisgarh is a newly formed state of India, established by the bifurcation of seven districts of Madhya Pradesh on 1st November, 2000. At present, the state consists of twenty seven districts. The state Chhattisgarh extends between 17°46' - 24°8' N latitude and 80°15' - 84°24' E longitude in the central Indian landscape having a total area of 1,35,194 sq. km. About 44% of the total land mass is covered by forests and a major part (35736.289 sq. km.) is outside Protected Areas.

Biogeographically, the state belongs to the Deccan Plateau and includes three provinces: 6D - Chota Nagpur Plateau, 6C - Eastern Highland and 6E - Central Highland, respectively (Rodgers *et al.* 2002). The state harbours several forest types such as dry-deciduous, moist-deciduous, grassland, bamboo patch and small semi-evergreen. Due to such varied forest types and significant altitudinal gradients the state bears a considerable part of the country's rich and unique biological diversity.

Methods

The present study is based on the field surveys conducted by Zoological Survey of India in 10 districts of Chhattisgarh. Only representative specimens were collected from different parts of the state. Data collection was done from July 2011 to September 2012. Generally, field work was conducted twice during daytime i.e. from morning 9 am to 12 pm and from 3 pm to 5:30 pm (from 8

am to 11 am and from 4:30 pm to 6:30 pm during summer months). Specimens were identified referring Evans (1932), Talbot (1939 & 1947), Winter-Blyth (1957), Kunte (2000) & Kehimkar (2008). Photographs taken during the field work helped in the identification of specimens which could not be collected. Survey site co-ordinates were recorded using GPS (Garmin Oregon 550), and the map of the sites surveyed prepared using Quantum GIS version 1.7.1 (Fig. 1).

The classification scheme followed here is based on Ackery (1984). The details of specimens studied, registration numbers and distribution of newly recorded species from the state are provided. In case of species having only photographic evidence, the date and sites of encounter along with their distribution are provided. Identified specimens were deposited in National Zoological Collection, Zoological Survey of India, Kolkata.

Abbreviations used: KVNP-Kanger Valley National Park; GGNP-Guru Ghasidas National Park; BWS-Badalkhol Wildlife Sanctuary; JDP- Jagdalpur Range; CAMPA- Compensatory Afforestation Managemnet Planning and Authority.

RESULTS

In the present study, 22 species were added to the previous list of 115 butterflies compiled from previously published accounts on the butterflies of Chhattisgarh. Thus, updated to a total of 137 species of butterflies belonging to 88 genera and 5 families from the state. The annotated checklist of 137 species with their updated district-wise distribution in Chhattisgarh and their status based on the Indian Wildlife (Protection) Act, 1972 (when applicable) are provided in Table 1. The new records include 11 species belonging to Lycaenidae followed by 6 species from Hesperidae, 4 from Nymphalidae and 1 from Papilionidae. Moreover, the study revealed 13 butterfly species newly recorded in the Central Indian landscape and thus resulting in significant range extensions.

Family PAPILIONIDAE

Subfamily PAPILIONINAE

1. *Graphium doson* (Felder & Felder, 1864)

Common Jay (Fig. 2A & B)

Material studied: India, Chhattisgarh, Bastar, Jagdalpur, JDP, 29.viii.2011 (1 ex.), Reg. No. CAMPA CG/104, coll. R. P. Gupta and party.

Distribution: India: Arunachal Pradesh, Chhattisgarh (Bastar), Odisha, South India up to Maharashtra, Uttaranchal and West Bengal. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

Family NYMPHALIDAE

Subfamily DANAINAE

2. *Tirumala septentrionis* (Butler, 1874)

Dark Blue Tiger (Fig. 2C & D)

Material studied: India, Chhattisgarh, Bastar Dist., KVNP, (1 ex.), 27.vii.2011, Reg. No. CAMPA CG/112., Jagdalpur Dist., Darbha, (2 exs.), 14.viii.2011, Reg. No. CAMPA CG/113, Coll. R. P. Gupta and party.

Distribution: India: Chhattisgarh (Bastar), Himachal Pradesh eastwards up to Arunachal Pradesh, Odisha, and Peninsular India up to Southern Maharashtra. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

3. *Parantica aglea* (Stoll, 1782): Glassy Tiger (Fig. 2E & F)

Material studied: India, Chhattisgarh, Bastar, KVNP, West Mawlipadar, 28.vii.2011 (1 ex.), Reg. No. CAMPA CG/111, coll. R. P. Gupta and party.

Distribution: India: Chhattisgarh (Bastar) and throughout India. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

Subfamily BIBLIDINAE

4. *Ariadne ariadne* (Linnaeus, 1763)

Angled Castor

Material studied: India, Chhattisgarh, Bastar, Jagdalpur, Orissa Road, 18.vii.2011 (2 exs.), Reg. No. CAMPA CG/186, coll. R. P. Gupta and party.

Distribution: India: Chhattisgarh (Bastar) and throughout India except arid North and Northwest. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

Subfamily CYRESTINAE

5. *Cyrestis thyodamas* Boisduval, 1846
Common Map (Fig. 3A)

Photograph was taken on 28th May, 2012 at BWS, Jashpur district.

Distribution: India: Chhattisgarh (Jashpur), Jammu and Kashmir to Arunachal Pradesh and South India. *Elsewhere:* Afghanistan, Bangladesh, Bhutan, Myanmar, Nepal and Pakistan.

Family LYCAENIDAE

Subfamily THECLINAE

6. *Deudorix isocrates* (Fabricius, 1793):
Guava Blue

Material studied: India, Chhattisgarh, Bastar, Jagdalpur, Chitrakote, 25.viii.2011 (1 ex.), Reg. No. CAMPA CG/190, coll. R. P. Gupta and party.

Distribution: India: Chhattisgarh (Bastar), Madhya Pradesh, almost throughout India except desert regions. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

7. *Amblypodia anita* Hewitson, 1862
Leaf Blue

Material studied: India, Chhattisgarh, Bastar, KVN, West Mawlipadar, 28.vii.2011 (1 ex.), Reg. No. CAMPA CG/192, coll. R. P. Gupta and party.

Distribution: India: Chhattisgarh (Bastar), Jharkhand, Madhya Pradesh, North-east India, Odisha, Peninsular India up to Central India and West Bengal. *Elsewhere:* Bangladesh, Myanmar and Sri Lanka.

8. *Rapala pheretima* (Hewitson, 1863)
Copper Flash (Fig. 3B)

Photograph was taken on 25th May 2012 at BWS, Jashpur District.

Distribution: India: Chhattisgarh (Jashpur), North East, Odisha, Sikkim to Arunachal Pradesh and West Bengal. *Elsewhere:* Bangladesh, Bhutan, Myanmar and Nepal.

9. *Zesius chrysomallus* Hübner, 1821
Redspot (Fig. 3D)

Photograph was taken on 3rd June 2012 at Lemru Range of Korba Forest Division.

Distribution: India: Chhattisgarh (Korba), Jharkhand, Odisha, Peninsular India up to Maharashtra and West Bengal.

Subfamily POLYOMMATINAE

10. *Catochrysops panormus* (Felder, 1860)
Silver Forget-Me-Not (Fig. 3C)

Photograph was taken on 23rd September 2012 at Lalpur Range of Kabirdham District.

Distribution: India: Assam to Arunachal Pradesh and Chhattisgarh (Kabirdham). *Elsewhere:* Bangladesh Myanmar Sri Lanka.

11. *Anthene emolus* (Godart, 1824)
Common Ciliate Blue (Fig. 3E)

Photograph was taken on 3rd June 2012 at Lemru Range of Korba District.

Distribution: India: Chhattisgarh (Korba), Sikkim, South India up to Maharashtra and West Bengal. *Elsewhere:* Bangladesh, Bhutan, Myanmar and Nepal.

12. *Chilades trochylus* (Freyer, 1845)
Grass Jewel

Sighted in Ghui Range of East Surguja Forest Division on 11th November 2011 and Lalpur Range of Kawardha Forest Division on 23rd September 2012.

Distribution: India: Chhattisgarh (Kabirdham, Surguja), Madhya Pradesh. *Elsewhere:* Myanmar, Pakistan and Sri Lanka.

13. *Acytolepis puspa* (Horsfield, 1828)
Common Hedge Blue

Material studied: India, Chhattisgarh, Bastar, Jagdalpur, JDP, 29.viii.2011 (1 ex.), Reg. No.

CAMPA CG/193, Machkote Range, 05.ix.2011 (1 ex.), Reg. No. CAMPA CG/194, coll. R. P. Gupta and party.

Distribution: India: Chhattisgarh (Bastar), Madhya Pradesh, Jharkhand, Jammu & Kashmir to Arunachal Pradesh and Peninsular India up to Gujarat. *Elsewhere:* Afghanistan, Bangladesh, Myanmar, Pakistan and Sri Lanka.

14. ***Petrelaea dana*** (De Nicéville, 1884)
Dingy Lineblue (Fig. 3F)

Sighted at GGNP, Koriya district on 17th August 2011 and in Lalpur Range of Kawardha Forest Division on 23rd September 2012.

Distribution: India: Andaman Islands, Chhattisgarh (Kabirdham, Koriya), South India up to Jharkhand and Uttaranchal to Arunachal Pradesh. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

15. ***Prosotus dubiosa indica*** (Evans, 1925)
Tailles Lineblue (Fig. 3G)

Material studied: Bastar, KVNP, 30.vii.2011 (1 ex.), Reg. No. CAMPA CG/195, coll. R. P. Gupta and party.

Distribution: India: Chhattisgarh (Bastar, Durg) and throughout India except arid and semi-arid regions. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal, Pakistan and Sri Lanka.

16. ***Cupido lacturnus*** (Godart, 1824)
Indian Cupid

Photograph was taken on 28th May 2012 at BWS, Jashpur District.

Distribution: India: Chhattisgarh (Jashpur), Madhya Pradesh, almost throughout India. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

Family HESPERIIDAE

Subfamily PYRGINAE

17. ***Tagiades japetus*** (Stoll, 1781)
Common Snow Flat

Material studied: India, Chhattisgarh, Bastar,

Jagdarpur, JDP, 20.viii.2011 (1 ex.), Reg. No. CAMPA CG/199, coll. R. P. Gupta and Party.

Distribution: India: Chhattisgarh (Bastar), Madhya Pradesh, North-east India, South India up to Gujarat, Uttaranchal to Arunachal Pradesh and West Bengal. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

18. ***Celaenorrhinus ambareesa*** (Moore, 1866)
Malabar spotted Flat

Photograph was taken on 7th June 2012 at Rengakhar Range of Kawardha Forest Division

Distribution: India: Chhattisgarh (Kabirdham), South India upto Madhya Pradesh and West Bengal.

19. ***Coladenia indrani*** (Moore, 1866)
Tricoloured Pied Flat

Material studied: Surguja, GGNP, Moharli Range, 16.viii.2011 (1 ex.), Reg. No. CAMPA CG/201, coll. Angshuman Raha and party.

Distribution: India: Chhattisgarh (Surguja), Himachal Pradesh, Madhya Pradesh, North-east India, South India up to Maharashtra and West Bengal. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

Subfamily HESPERIIDAE

20. ***Notocrypta curvifascia*** (Felder & Felder, 1862): Restricted Demon (Fig. 2G & H)

Material studied: India, Chhattisgarh, Bastar, Jagdarpur, JDP, 20.viii.2011 (1 ex.), Reg. No. CAMPA CG/196, 29.viii.2011 (1 ex.), Reg. No. CAMPA CG/197, Machkote Range, 05.ix.2011 (1 ex.), Reg. No. CAMPA CG/198, coll. R. P. Gupta and party.

Distribution: India: Arunachal Pradesh, Chhattisgarh (Bastar), Himachal Pradesh, North-east India and Western Ghats south of Goa. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

21. ***Telicota colon*** (Fabricius, 1775)
Pale Palm Dart (Fig. 2H)

Photograph was taken on 14th September

2012 at Ambikapur Forest Division in Surguja District.

Distribution: India: Chhattisgarh (Surguja) and throughout India. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal, Pakistan and Sri Lanka.

22. ***Borbo cinnara*** (Wallace, 1866): Rice Swift

Material studied: India, Chhattisgarh, Bastar, Jagdalpur, Lamani Eco Park, 22.vii.2011 (1 ex.), Reg. No. CAMPA CG/200, coll. R. P. Gupta and party.

Distribution: India: Chhattisgarh (Bastar), Madhya Pradesh and throughout India. *Elsewhere:* Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka.

occur in Western Ghats south to Goa preferring evergreen, semi-evergreen and moist deciduous forests. The present record extends its distribution northwards to Goa and in central Indian landscape. Moreover, the study confirms occurrence of four species in Central India i.e. Dark Blue Tiger, Common Map, Common Ciliate Blue and Redspot which were so far, known from South India up to Maharashtra. Because of its location and forest types, Chhattisgarh is expected to harbour a rich and unique butterfly diversity which could be more than twice the number of what is known today. It is expected that many more species will be added to the list as a result of future exploration within the state.

DISCUSSION

The Central India Landscape possesses a rich faunal diversity which includes mostly an admixture of faunas found in northern and southern part of the country. As a part of central India, Chhattisgarh's fauna is also influenced strongly by both northern and southern elements. The study reflects significant southward range extension to central India of two species namely, *Catochrysops panormus* (Felder) and *Rapala pheretima* (Hewitson) which were hitherto known from North-east India. In south India, Restricted Demon (*Notocrypta curvifascia*) was known to

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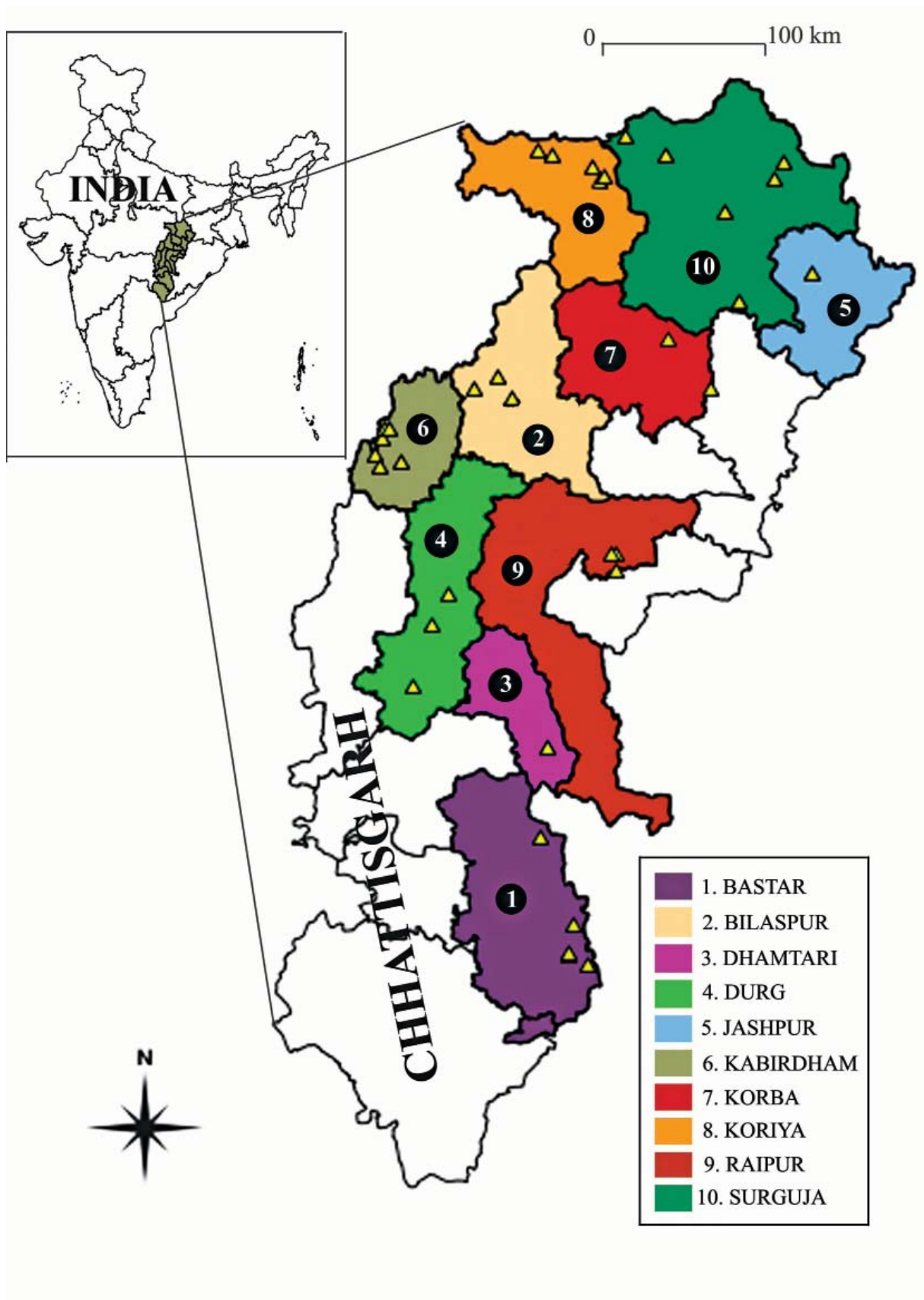


Fig. 1. Map showing collection localities (yellow triangle) in ten districts of Chhattisgarh.

PLATE I

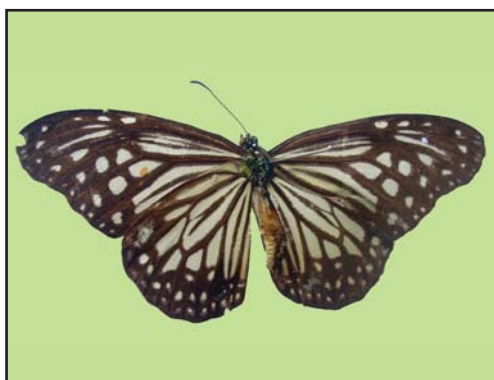
2A. *Graphium doson* - UP2B. *Graphium doson* - UN2C. *Tirumala septentrionis* - UP2D. *Tirumala septentrionis* - UN2E. *Parantica aglea* - UP2F. *Parantica aglea* - UN2G. *Notocrypta curvifascia* - UP2H. *Notocrypta curvifascia* - UN

PLATE II



3A. *Cyrestis thyodamas*



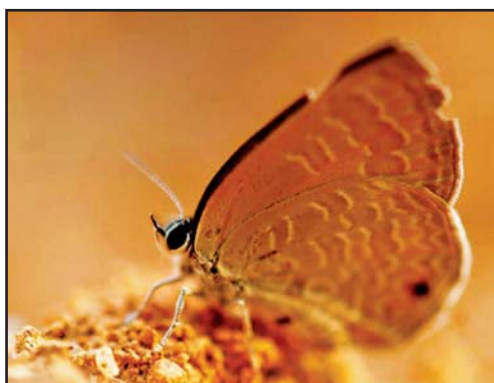
3B. *Rapala pheretima*



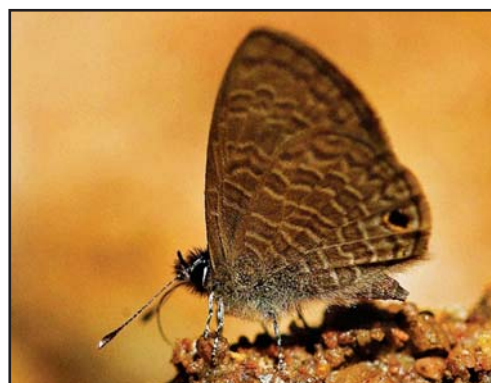
3C. *Catochrysops panormus*



3D. *Zesius chrysomallus*



3E. *Anthene emolus*



3F. *Petrelaca dana*



3G. *Prosotus dubiosa indica*



3H. *Telicota colon*

Table 1. District-wise distribution of butterflies recorded from Chhattisgarh, India, with Indian Wildlife Protection Act, 1972 Schedule status (WPA-Wildlife Protection Act; Sch.- Schedule; NRCI-New record to Central India; NRC-New record to Chhattisgarh).

S. No.	Scientific Name	Common Name	Distribution in Chhattisgarh	WPA Status	Remark
A. Super Family PAPILIONOIDEA					
I. Family PAPILIONIDAE					
Subfamily Papilioninae					
1	<i>Papilio demoleus</i> Linnaeus	Lime Butterfly	Bastar, Dantewara, Kanker, Koriya, Raigarh, Raipur, Surguja		
2	<i>Papilio crino</i> Fabricius	Common Banded Peacock	Bastar, Kabirdham, Koriya		
3	<i>Papilio polymnestor</i> Cramer	Blue Mormon	Bastar, Dantewara, Kabirdham, Surguja, Raipur		
4	<i>Papilio polytes</i> Linnaeus	Common Mormon	Bastar, Dantewara, Durg, Kabirdham, Korla, Surguja, Raipur		
5	<i>Papilio clytia</i> Linnaeus	Common Mime	Bastar, Bilaspur, Jashpur, Koriya	Sch. I	
6	<i>Graphium nomius</i> (Esper)	Spot Swordtail	Bastar, Korba, Jashpur, Koriya		
7	<i>Graphium agamemnon</i> (Linnaeus)	Tailed Jay	Bastar		
8	<i>Graphium doson</i> (Felder & Felder)	Common Jay	Bastar		NRCI
9	<i>Pachliopta aristolochiae</i> (Fabricius)	Common Rose	Bastar, Kabirdham, Raipur		
10	<i>Pachliopta hector</i> (Linnaeus)	Crimson Rose	Bastar	Sch. I	
II. Family PIERIDAE					
Subfamily Coliadinae					
11	<i>Catopsilia pomona</i> (Fabricius)	Common Emigrant	Bastar, Bilaspur, Durg, Jashpur, Kanker, Kabirdham, Korba, Raigarh, Raipur, Surguja		

Table 1. *contd.*

S. No.	Scientific Name	Common Name	Distribution in Chhattisgarh	WPA Status	Remark
12	<i>Catopsilia pyranthe</i> (Linnaeus)	Mottled Emigrant	Bastar, Bilaspur, Durg, Kabirdham, Kanker, Korla, Raigarh, Raipur, Surguja		
13	<i>Eurema laeta</i> (Boisduval)	Spotless Grass Yellow	Bastar, Bilaspur, Dantewara, Kanker		
14	<i>Eurema brigitta</i> (Cramer)	Small Grass Yellow	Bastar, Dantewara, Kanker		
15	<i>Eurema hecabe</i> (Linnaeus)	Common Grass Yellow	Bastar, Dantewara, Durg, Raipur, Raigarh, Jashpur, Kabirdham, Kanker, Surguja		
Subfamily Pierinae					
16	<i>Pieris canidia</i> (Linnaeus)	Indian Cabbage White	Bastar		
17	<i>Belenois aurota</i> (Fabricius)	Pioneer	Bilaspur, Surguja		
18	<i>Cepora nerissa</i> (Fabricius)	Common Gull	Bastar, Dantewara, Kanker, Raipur, Surguja	Sch. II	
19	<i>Delias eucharis</i> (Drury)	Common Jezebel	Bastar, Dantewara, Koriya, Raigarh, Raipur, Surguja		
20	<i>Delias hyparete</i> (Linnaeus)	Painted Jezebel	Bastar, Dantewara		
21	<i>Appias lyncida</i> (Cramer)	Chocolate Albatross	Bastar, Dantewara		
22	<i>Leptosia nina</i> (Fabricius)	Psyche	Bastar		
23	<i>Colotis eucharis</i> (Fabricius)	Plain Orange Tip	Bastar		
24	<i>Colotis fausta</i> (Olivier)	Large Salmon Arab	Bastar		
25	<i>Pareronia hippia</i> (Fabricius)	Common Wanderer	Bastar, Dantewara, Kabirdham, Kanker, Jashpur, Raipur		
III. Family NYMPHALIDAE					
Subfamily Euploeinae					
26	<i>Euploea core</i> (Cramer)	Common Indian Crow	Bastar, Bilaspur, Dantewara, Durg, Jashpur, Kabirdham, Raigarh, Raipur		

Table 1. contd.

S. No.	Scientific Name	Common Name	Distribution in Chhattisgarh	WPA Status	Remark
27	<i>Euploea mulciber</i> (Cramer)	Striped Blue Crow	Bastar	Sch. IV	
Subfamily Danainae					
28	<i>Danaus genutia</i> (Cramer)	Common Tiger	Bastar, Bilaspur, Kabirdham, Korba, Koriya, Raigarh, Raipur, Surguja		
29	<i>Danaus chrysippus</i> (Linnaeus)	Plain Tiger	Bastar, Bilaspur, Korba, Koriya, Durg, Dantewara, Jashpur, Raigarh, Surguja, Raipur		
30	<i>Tirumala limniace</i> (Cramer)	Blue Tiger	Bastar, Dantewara Raigarh, Raipur, Surguja		
31	<i>Tirumala septentrionis</i> (Butler)	Dark Blue Tiger	Bastar		NRCI
32	<i>Parantica aglea</i> (Stoll)	Glassy Tiger	Bastar		NRCI
Subfamily Satyrinae					
33	<i>Mycalesis mineus</i> (Linnaeus)	Dark Branded Bush Brown	Bilaspur, Kabirdham		
34	<i>Mycalesis lepcha</i> (Moore)	Lepcha Bush Brown	Bilaspur	Sch. II	
35	<i>Mycalesis perseus</i> (Fabricius)	Common Bush Brown	Bastar, Dantewara, Kabirdham, Kanker, Raipur, Surguja		
36	<i>Mycalesis visala</i> Moore	Long brand-Bush Brown	Bastar, Dantewara, Kanker		
37	<i>Melanitis leda</i> (Linnaeus)	Common Evening Brown	Bastar, Bilaspur, Dantewara, Kanker, Koriya, Raipur, Surguja		
38	<i>Melanitis zitenius</i> (Herbst)	Great Evening Brown	Bastar, Dantewara		
39	<i>Elymnias hypermnestra</i> (Linnaeus)	Common Palmfly	Bastar, Dantewara		
40	<i>Lethe rohria</i> (Fabricius)	Common Tree Brown	Bastar, Kabirdham		

Table 1. *contd.*

S. No.	Scientific Name	Common Name	Distribution in Chhattisgarh	WPA Status	Remark
41	<i>Lethe europa</i> (Fabricius)	Bamboo Tree Brown	Bastar, Raipur	Sch. I	
42	<i>Lethe drypetis</i> (Hewitson)	Tamil Tree Brown	Bastar, Bilaspur		
43	<i>Orsotriaena medus</i> (Fabricius)	Nigger	Bastar, Dantewara		
44	<i>Ypthima huebneri</i> Kirby	Common Fourring	Bastar, Dantewara, Surguja, Raipur,		
45	<i>Ypthima ceylonica</i> Hewitson	White or Ceylon Fourring	Bastar, Dantewara		
Subfamily Biblidinae					
46	<i>Ariadne merione</i> (Cramer)	Common Castor	Bastar, Raigarh		
47	<i>Ariadne ariadne</i> (Linnaeus)	Angled Castor	Bastar		NRCI
Subfamily Heliconinae					
48	<i>Argyreus hyperbius</i> (Linnaeus)	Indian Fritillary	Bastar, Dantewara, Kanker		
49	<i>Phalanta phalantha</i> (Drury)	Common Leopard	Bastar, Bilaspur, Dantewara, Kabirdham, Kanker, Koriya, Raipur		
50	<i>Phalanta alcippe</i> (Stoll)	Small Leopard	Bastar, Dantewara		
51	<i>Acraea violae</i> (Fabricius)	Tawny Coster	Bastar, Bilaspur, Dantewara, Koriya, Raipur		
Subfamily Nymphalinae					
52	<i>Vanessa cardui</i> (Linnaeus)	Painted Lady	Bastar, Bilaspur Koriya		
53	<i>Junonia iphita</i> (Cramer)	Chocolate Pansy	Bastar, Kabirdham, Bilaspur, Dantewara, Kanker, Surguja, Koriya, Raipur		
54	<i>Junonia atlites</i> (Linnaeus)	Grey Pansy	Bastar, Kabirdham, Korba, Koriya, Bilaspur, Dantewara, Kanker, Raigarh, Raipur		
55	<i>Junonia almana</i> (Linnaeus)	Peacock Pansy	Bastar, Bilaspur, Dantewara, Kabirdham, Kanker, Koriya, Surguja, Raipur		

Table 1. contd.

S. No.	Scientific Name	Common Name	Distribution in Chhattisgarh	WPA Status	Remark
56	<i>Junonia hierta</i> (Fabricius)	Yellow Pansy	Bastar, Bilaspur, Durg, Kabirdham, Korba, Koriya, Surguja		
57	<i>Junonia orithya</i> (Linnaeus)	Blue Pansy	Bastar, Bilaspur, Dantewara, Jashpur, Kbirdham, Kanker, Koriya, Surguja, Raipur		
58	<i>Junonia lemonias</i> (Linnaeus)	Lemon Pansy	Bastar, Bilaspur, Dantewara, Kabirdham, Kanker, Koriya, Raipur		
59	<i>Kallima inachus</i> (Boisduval)	Orange Oakleaf	Bastar, Kabirdham		
60	<i>Hypolimnas bolina</i> (Linnaeus)	Great Eggfly	Bastar, Bilaspur, Durg, Kabirdham, Korba, Raipur, Surguja		
61	<i>Hypolimnas misippus</i> (Linnaeus)	Danaid Eggfly	Bastar, Bilaspur, Dantewara, Jashpur, Raigarh, Surguja, Dantewara	Sch. I	
Subfamily Limenitidinae					
62	<i>Neptis hylas</i> (Linnaeus)	Common Sailer	Bastar, Bilaspur, Dantewara, Kanker		
63	<i>Neptis jumbah</i> Moore	Chestnut-streaked Sailer	Bastar, Bilaspur	Sch. I	
64	<i>Phaedyma columella</i> (Cramer)	Short Banded Sailer	Bilaspur, Koriya		
65	<i>Pantoporia hordonia</i> (Stoll)	Common Lascar	Bastar, Dantewara		
66	<i>Athyma nefte</i> (Cramer)	Colour Sergeant	Bastar, Jashpur, Koriya		
67	<i>Athyma ranga</i> Moore	Blackvein Sergeant	Bastar, Dantewara	Sch. II	
68	<i>Athyma selenophora</i> (Kollar)	Staff Sergeant	Bastar, Bilaspur, Dantewara, Kabirdham, Jashpur		

Table 1. *contd.*

S. No.	Scientific Name	Common Name	Distribution in Chhattisgarh	WPA Status	Remark
69	<i>Athyma perius</i> (Linnaeus)	Common Sergeant	Bastar, Bilaspur, Dantewara, Kabirdham, Koriya		
70	<i>Moduza procris</i> (Cramer)	Commander	Bastar, Bilaspur, Kabirdham, Jashpur, Raipur		
71	<i>Tanaecia lepidea</i> (Butler)	Grey Count	Bastar, Bilaspur, Dantewara, Korba, Koriya, Jashpur, Surguja		
72	<i>Euthalia nais</i> (Forster)	Baronet	Bastar, Dantewara, Korba, Surguja, Koriya		
73	<i>Euthalia aconthea</i> (Cramer)	Common Baron	Bastar, Surguja, Kabirdham		
74	<i>Euthalia lubentina</i> (Cramer)	Gaudy Baron	Bastar, Jashpur	Sch. IV	
Subfamily Charaxinae					
75	<i>Polyura athamas</i> (Drury)	Common Nawab	Bastar		
76	<i>Charaxes bernardus</i> (Fabricius)	Tawny Rajah	Bastar		
77	<i>Charaxes solon</i> (Fabricius)	Black Rajah	Bastar, Bilaspur		
Subfamily Cyrestinae					
78	<i>Cyrestis thyodamas</i> Boisduval	Common Map	Jashpur		NRCI
IV. Family LYCAENIDAE					
Subfamily Riodininae					
79	<i>Abisara echerius</i> (Stoll)	Plum Judy	Bastar, Dantewara, Surguja, Koriya, Raipur		
Subfamily Curetinae					
80	<i>Curetis bulis</i> (Westwood)	Bright Sunbeam	Bastar		
Subfamily Polyommatainae					
81	<i>Jamides celeno</i> (Cramer)	Common Cerulean	Bastar, Dantewara Jashpur		

Table 1. contd.

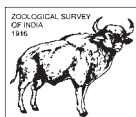
S. No.	Scientific Name	Common Name	Distribution in Chhattisgarh	WPA Status	Remark
82	<i>Jamides alecto</i> (Felder)	Mettalic Cerulean	Bastar		
83	<i>Catochrysops strabo</i> (Fabricius)	Forget-Me-Not	Bastar, Bilaspur, Dantewara, Kabirdham, Korba		
84	<i>Catochrysops panormus</i> (Felder)	Silver Forget-Me-Not	Kabirdham		NRCI
85	<i>Lampides boeticus</i> (Linnaeus)	Pea Blue	Bastar, Bilaspur, Dantewara, Kanker, Bilaspur	Sch. II	
86	<i>Tarucus plinius</i> (Fabricius)	Zebra Blue	Bastar, Dantewara, Kabirdham		
87	<i>Tarucus callinara</i> Butler	Spotted Pierrot	Bastar, Dantewara	Sch. II	
88	<i>Tarucus theophrastus</i> (Fabricius)	Pointed Pierrot	Bastar		
89	<i>Tarucus nara</i> (Kollar)	Striped Pierrot	Bastar, Bilaspur, Raipur		
90	<i>Anthene emolus</i> (Godart)	Common Ciliate Blue	Korba		NRCI
91	<i>Freyeria trochylus</i> (Freyer)	Grass Jewel	Surguja, Kabirdham		NRC
92	<i>Caleta caleta</i> (Hewitson)	Angled Pierrot	Bastar, Dantewara		
93	<i>Castalius rosimon</i> (Fabricius)	Common Pierrot	Bastar, Bilaspur, Dantewara, Kanker, Surguja		
94	<i>Zizeeria knysna</i> (Trimen)	Dark Grass Blue	Bastar, Dantewara, Kanker, Raipur, Surguja		
95	<i>Zizeeria otis</i> (Fabricius)	Lesser Grass Blue	Bastar, Dantewara, Kanker		
96	<i>Pseudozizeeria maha</i> (Kollar)	Pale Grass Blue	Dantewara		
97	<i>Zizula hylax</i> (Fabricius)	Tiny Grass Blue	Bastar, Dantewara, Kanker, Jashpur		
98	<i>Pithecops corvus</i> Fruhstorfer	Forest Quaker	Bastar		
99	<i>Euchrysops cnejus</i> (Fabricius)	Gram Blue	Bastar, Dantewara, Kanker, Surguja	Sch. II	

Table 1. *contd.*

S. No.	Scientific Name	Common Name	Distribution in Chhattisgarh	WPA Status	Remark
100	<i>Acytolepis puspa</i> (Horsfield)	Common Hedge Blue	Bastar	Sch. I	NRC
101	<i>Petrelaea dana</i> (De Nicéville)	Dingy Lineblue	Koriya, Kabirdham		NRCI
102	<i>Prosotas dubiosa</i> (Semper)	Tailless Lineblue	Bastar, Durg		NRCI
103	<i>Chilades pandava</i> (Horsfield)	Plains Cupid	Bastar, Kabirdham, Jashpur, Koriya		
104	<i>Chilades parrhasius</i> (Fabricius)	Indian Cupid	Jashpur		NRC
Subfamily Theclinae					
105	<i>Spindasis vulcanus</i> (Fabricius)	Common Silverline	Bastar, Korba, Koriya, Surguja		
106	<i>Zesius chrysomallus</i> Hübner	Redspot	Korba		NRCI
107	<i>Deudorix isocrates</i> (Fabricius)	Common Guava Blue	Bastar		NRC
108	<i>Amblypodia anita</i> Hewitson	Leaf Blue	Bastar,		NRC
109	<i>Arhopala amantes</i> (Hewitson)	Large Oakblue	Bastar, Bilaspur, Korba, Jashpur, Koriya		
110	<i>Arhopala atrax</i> (Hewitson)	Indian Oakblue	Bilaspur, Korba, Jashpur, Surguja		
111	<i>Arhopala centaurus</i> (Fabricius)	Western Centaur Oakblue	Bastar		
112	<i>Iraota timoleon</i> (Stoll)	Blue Silver Streak	Bastar		
113	<i>Loxura atymnus</i> (Stoll)	Yamfly	Bastar, Bilaspur, Koriya		
114	<i>Tajuria cippus</i> (Fabricius)	Peacock Royal	Bastar, Bilaspur		
115	<i>Tajuria jehana</i> Moore	Plains Blue Royal	Bastar		
116	<i>Chliaria othona</i> (Hewitson)	Orchid Tit	Bastar, Koriya, Raipur		
117	<i>Rapala iarbus</i> (Fabricius)	Indian Red Flash	Bastar, Bilaspur		
118	<i>Rapala manea</i> (Hewitson)	Slate Flash	Bastar		
119	<i>Rapala pheretima</i> (Hewitson)	Copper Flash	Jashpur		NRCI

Table 1. contd.

S. No.	Scientific Name	Common Name	Distribution in Chhattisgarh	WPA Status	Remark
V. Family HESPERIIDAE					
Subfamily Coeliadinae					
120	<i>Hasora chromus</i> (Cramer)	Common Banded Awl	Bastar, Koriya, Raipur		
121	<i>Badamia exclamationis</i> (Fabricius)	Brown Awl	Bilaspur, Koriya		
Subfamily Pyrginae					
122	<i>Celaenorrhinus leucocera</i> (Kollar)	Common Spotted Flat	Bastar		
123	<i>Celaenorrhinus ambareesa</i> (Moore)	Malabar Spotted Flat	Kabirdham		NRC
124	<i>Tagiades japetus</i> (Stoll)	Common Snow Flat	Bastar		NRC
125	<i>Coladenia indrani</i> (Moore)	Tricolored Pied Flat	Surguja		NRC
126	<i>Caprona ransonnetti</i> (Felder)	Golden Angle	Bilaspur		
127	<i>Spialia galba</i> (Fabricius)	Indian Skipper	Bastar, Bilaspur, Kanker, Surguja		
Subfamily Hesperinae					
128	<i>Udaspes folus</i> (Cramer)	Grass Demon	Bastar, Bilaspur, Jashpur		
129	<i>Notocrypta curvifascia</i> (Felder & Felder)	Restricted Demon	Bastar		NRCI
130	<i>Telicota ancilla</i> (Herrich-Schäffer)	Dark Palm Dart	Bastar		
131	<i>Telicota colon</i> (Fabricius)	Pale Palm Dart	Surguja,		NRCI
132	<i>Pelopidas mathias</i> (Fabricius)	Small Branded Swift	Bastar, Surguja		
133	<i>Caltoris kumara</i> (Moore)	Blank Swift	Bastar, Bilaspur		
134	<i>Suastus gremius</i> (Fabricius)	Indian Palm Bob	Bilaspur, Surguja		
135	<i>Baoris farri</i> (Moore)	Paintbrush Swift	Bilaspur	Sch. IV	
136	<i>Pseudoborbo bevani</i> (Moore)	Bevan's Swift	Bastar		
137	<i>Borbo cinnara</i> (Wallace)	Rice Swift	Bastar		NRC



ON A COLLECTION OF MITES INFESTING HERBS USED AS SPICES AND OIL SEEDS IN INDIA WITH SPECIAL REFERENCE TO WESTERN GHAT AREAS

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INTRODUCTION

Since the ancient time India is famous for having rich collection of plants used as spices and hence India has a good export market of these plants. The states in India, which are known to grow spices in large quantities and contribute a major share in the export market are Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, West Bengal, Sikkim and Madhya Pradesh. Spices like black pepper, cardamom, zinger, garlic, turmeric, chili, cumin, etc. are grown in large quantities in Southern States. Though the insect pests of spice plants have been explored but information on mites infesting spices are not well documented barring some stray reports (Gupta, 1985, 2002, 2003), Gupta (2005), in his book on insects and mites of medicinal plants of India reported some mites on spices plants which are also known to have medicinal values apart from their uses as spices. Since, no consolidated published account dealing with mites infesting spices in India is available, it was thought desirable to explore this fauna from spice growing areas of India like Kerala, Karnataka, Tamil Nadu and Maharashtra during 2007 to 2011 and the present report is based on collection and study of those materials.

A total of 53 species belonging to 27 genera, 13 families under 2 orders are reported herein, of those, 10 are phytophagous belonging to 7 genera

and 3 families and 41 are predatory belonging to 19 genera and 9 families and 1 belong to fungivorous group. Most of the host/habitat records reported here were earlier unknown for the spices dealt with here.

Apart from giving collection records, diagnosis, etc, distribution, pest/predatory importance, wherever observed, have also been discussed. This document forms the first consolidated account on mites infesting spices in India.

MATERIAL AND METHODS

The mite specimens included in this paper were collected from leaves of spice plants of Kohzikode, Wayannad, Munner and Kumily of Kerala State, Madikeri, Mudegere, Chickmagalore, Shimoga and Sirsi of Karnataka State, Chandrapur, Satara, Malvan, Dapoli of Maharashtra State and Sirumalai, Alagumandai of Tamil Nadu State. The infested leaves were examined under a 10x lens in the field itself and the mites were picked up by a fine sable-hair brush moistened with alcohol (75%). The specimens were mounted first in lactic acid for identification and later mounted in Heinze's medium for making permanent slides. All measurements given here are in microns.

The specimens were examined under a research microscope. The entire material is deposited in the National Collection of the Zoological Survey of India.

SYSTEMATIC ACCOUNT

PHYTOPHAGOUS MITES

Order-1 PROSTIGMATA

Family1 TETRANYCHIDAE Donnadieu

1. *Tetranychus ludeni* Zacher

1913 *Tetranychus ludeni* Zacher, Mitt. Kais. Biol. Anst. Land. U.Forstw, **14**: 40.

1959. *Tetranychus ludeni*, Puttarudriah & Channa basavanna, Proc. Ist. All India Congr. Zool. p. 530

1994. *Tetranychus ludeni*, Gupta & Gupta, Mem. zool. Surv. India, **18**(1): 27-28.

Diagnosis: Aedeagal knob very small, no posterior angulation, in female, palpus with terminal sensillum as long as broad, tibia I with 1 sensory and 9 tactile setae, tarsus- I with 1 sensory and 4 tactile setae.

Collection Records: KARNATAKA: Bettadamanne, Mudigere, 5 ♀♀, *Elettaria cardamomum*, 8.12.2008; MAHARASHTRA: Jangao, Chandrapur, 1 ♀, *-Sesamum indicum*, 10.10.2010; Mazra, Chandrapur, 9 ♀♀, 1 ♂, *Glycine max*, 11.10. 2010.

Remarks: This species mostly attacks vegetable crops and is not known to damage on other crops. However, though a good infestation was seen on cardamom but no noticeable damage done by this mite was observed. It is known to occur on over 50 host plants in India, but its occurrence on cardamom is rather an uncommon one.

2. *Tetranychus urticae* Koch

1836. *Tetranychus urticae* Koch, Deu, Crust. Myr. Arach. Fasc., **1**: 10

1994. *Tetranychus urticae*, Gupta & Gupta, Mem. zool. Surv. India, **18** (1): 139-140.

Diagnosis: Greenish yellow/ reddish with 2 large black spots on dorsum, Axis of aedeagal knob parallel with axis of shaft. In female, palpus with terminal sensillum 2 times as long as broad. Tibia I with 1 sensory and 9 tactile setae, tarsus I with 1 sensory and 3 tactile setae.

Collection Records: MAHARASHTRA: Surla, Chandrapur, 3 ♀♀, 2 ♂, *Glycine max*, 10.10.2010.

Remarks: This is a cosmopolitan species and is known to occur on over 200 plants and often the damage caused by this mite becomes very serious. The infestation noticed in the present study was not of any serious nature and damage was insignificant.

3. *Tetranychus* sp.

Collection Records: MAHARASHTRA; Surla, Chandrapur, 2 ♀♀, *Glycine max*, 10.10.2010.

Remarks: Since no male of this species could be collected, the specific identity could not be done.

4. *Schizotetranychus* sp.

Collection Records: MAHARASHTRA; Parsuda, 1 ♀, *Glycine max*, 11.10.2010.

Remarks: For lack of male specimen, the specific identity could not be ascertained.

5. *Eotetranychus* sp.

Collection Records: MAHARASHTRA: Khairgaon, Chandrapur, 1 ♀, *Glycine max*, 11.10.2010.

Remarks: This mite was in badly damaged condition. Further identification was not possible as no male could be collected.

6. *Porcupinychus* sp (?)

Collection Records: TAMIL NADU; Sirumalai, *Elettaria cardamomum*, 10.4.2011.

Remarks: This probably belongs to genus *Porcupinychus*, as appears from the setal pattern. This needs further study as the pertaining literature is unavailable.

Family 2 TENUIPALPIDAE Berlese

7. *Dolichotetranychus floridanus* (Banks)

1900. *Stigmaeus floridanus* Banks, U.S. Dept. Agr. Div. Int. Tech. Ser., **8**: 77.

1938. *Dolichotetranychus floridanus*, Sayed, Bull. Mus. natn. Hist. Nat. Paris, (2)**10**(6): 606.

1985. *Dolichotetranychus floridanus*, Gupta: 133.

Diagnosis: It is bright red, elongated, slender,

hysterosoma with 2 pairs of dorsocentrals, one pair of dorso-sublateral and 5 pairs of dorsolaterals.

Collection Records: Kerala: Keller, 1 ♀, *Elettaria cardamomum*, 25.10.2007.

Remarks: It feeds on tender tissues of host and causes the appearance of reddish spots. Its damage on pineapple is more serious than on Cardamom. Earlier it was known from Karnataka.

8. *Brevipalpus euphorbiae* Mohanasundaram

1982. *Brevipalpus euphorbiae* Mohanasundaram, *Entomon*, 7(4): 427-429.

1985. *Brevipalpus euphorbiae*, Gupta: 127.

Diagnosis: Reddish mite, rostrum extends beyond middle of femur I. Reticulation present on middle of hysterosoma, with 5 pairs of dorsolaterals, 1 pair of humerals and 3 pairs of dorsocentrals.

Collection Records: KARNATAKA: Gajanur Spice Garden, Shimoga. 3 ♀ ♀, *Elettaria cardamomum*, 12.12.2008.

Remarks: This mite caused no noticeable damage on cardamom plant and its occurrence on under surface of leaves was of casual nature.

9. *Brevipalpus* sp.

Collection Records: KARNATAKA: Gajanur Spice Garden, Shimoga 3 ♀ ♀, *Elettaria cardamomum*, 12.12.2008 MAHARASHTRA: Dapoli Krishi Vidyapeeth, 1 ♀, All spice, 19.10.2010.

Remarks: One species of this genus was collected on all spice (*Pimenta dioica*) plant but its specific identity could not be ascertained.

Family 3 ERIOPHYIDAE Nalepa

10. *Aceria* sp.

Collection Records: MAHARASHTRA: Surla, 1 ♀, *Glycine max*, 10.10.2010.

Remarks: Some specimens belonging to *Aceria* could be collected as vagrants on under surface of leaves but their identity could not be ascertained.

PREDATORY MITES

Order-2 MESOSTIGMATA

Family 4 PHYTOSEIIDAE Berlese

11. *Amblyseius herbicolus* (Chant)

1959. *Typhlodromus (Amblyseius) herbicolus*, Chant; *Can. Ent.*, 91: 84-85.

2000. *Amblyseius (Amblyseius) herbicolus*, Gupta; In: *Fauna of Tripura, State Fauna Series*, 7(Part-2), p. 21-22

2003. *Amblyseius (Amblyseius) herbicolus*, Gupta, *Mem. zool. Surv. India*, 20(1): 18-20.

2007. *Amblyseius herbicolus*, Chant & McMurtry, *Illustrated keys and diagnosis for the genera and sub genera of the Phytoseiidae of the world (Acari: Mesostigmata)*, 78.

Diagnosis: It is a whitish mite with 3 pairs of long setae, while the others being small. Measurements of setae J₁-25, J₃-33, s₄-107, Z₅-205, Z₄-125. Others measure between 5-10 microns long. Ventrianal shield pitcher shaped. Macrosetae on legs IV. genu-129, Tibia-90, basitarsus-70.

Collection Records: KERALA: Sugandagiri, Wayanad, 4 ♀ ♀. *Piper betle*, 23.10.2007; 3 ♀ ♀ Karadpara, Munner, *Piper betle*, 26.10.2007; 16 ♀ ♀, 4 ♂, 1 nymph. Keller, Munnar, *Elettaria cardamomum*, 25.10.2007; 9 ♀ ♀, 2 ♂, Thekkdi, Kumily, *Elettaria cardamomum*, 29.11.2008.

KARNATAKA: I.S.R.I. Appangala, 2 ♀ ♀, 1 ♂, *Cinnamomum verum*, 03.12.2008; 4 ♀ ♀, 2 ♂ Handi Estate, *Piper betle*, 09.12.2008; 2 ♀ ♀, 3 ♂ Handi Estate, *Elettaria cardamomum*, 09.12.2008; 1 ♂, Madikeri, Chettali, *Scinams cowa*, 05.12.2008; 3 ♀ ♀, 2 ♂, Sirsi, *Piper betle*, 14.12.2008; Chickmagalore, 3 ♀ ♀, *Piper betle*, 10.12.2008; Sirsi, Sandy's Garden, 3 ♀ ♀, *Elettaria cardamomum*, 14.12.2008. MAHARASHTRA: Chandrapur, Garoli, 1 ♀, *Arachis hypogaea*, 13.10.2010; 1 ♀, Dr. B.S. Kokan Krishi Vidyapeeth, Vengurle *Syzygium aromaticum*(L), 16.10.2010; 3 ♀ ♀, 2 ♂, Agricultural University Campus, Dapoli, *Cinnamomum verum*, 18.10.2010.

TAMIL NADU: Sirumalai, 1 ♀, *Elettaria cardamomum*, 10.04.2011.

Remarks: This species was originally described from Citrusin Floride and later could be collected on several fruit trees from many parts of India (West Bengal, Tripura, Mizoram, Sikkim, Tamil Nadu, Maharashtra, Kerala, Karnataka) and outside Thailand, China, Taiwan, Papua, New Guinea, Australia, Japan, Madagascar, South Africa, Mexico, Brazil. Earlier it was known to feed upon tea purple mite, Citrus scarlet mite, bamboo Spider mite, 2-Spotted spider-mite on vegetables, etc. Presently, it was seen in field in association with *Brevipalpus* sp. on cardamom, but its feeding was not observed. This is otherwise a very common species and could be collected from a large number of plants, in association with Tetranychid and Tenuipalpid mites (Gupta, 2003).

12. *Amblyseius largoensis* (Muma)

1955. *Amblyseiopsis largoensis* Muma, *Ann. Ent. Soc. Am.* **48**: 206.
 1997. *Amblyseius largoensis*, Wei-nan, *Economic Insect Fauna of China: Phytoseidae*, p.39.
 2003. *Amblyseius (Amblyseius) largoensis*, Gupta, *Mem. zool. Surv. India*, **20**(1): 22.
 2007. *Amblyseius largoensis*, Chant & McMurtry, **78**.

Diagnosis: It is very close to *Amblyseius herbicolus* but differs in the shape of spermatheca which is with fundibular cervix in *A. herbicolus* and in case of *A. largoensis* cervix is tubular with parallel sides. The long setae measure, j_1 -35, j_3 -50, s_4 -100, Z_5 -250, Z_4 -100, Macrosetae on leg IV, genu-100, tibia-75, basitarsus-50.

Collection Records: KERALA: Spring Valley, 3 ♀♀, *Elettaria cardamomum*, 28.10.2007; 1 ♀, Chullikode. *Piper betle*, 28.10.2007; 1 ♀, Puliakode, *Piper betle*, 21.10.2007; 4 ♀♀, Kumily, *Piper betle*, 30.11.2008; 3 ♀♀, 1 ♂ Kumily, *Myristica fragrans* Houtt, 30.11.2008. KARNATAKA: 4 ♀♀, Chickmagalore, *Elettaria cardamomum*, 10.12.2008; 6 ♀♀, Sirsi, *Elettaria cardamomum*, 15.12.2008. MAHARASHTRA: 1 ♀, Dr. B.S. Kokan Krishi Vidyapeeth, Vengurle, *Piper betle*, 16.10.2010; 1 ♂, 1 nymph, Kokan Krishi Vidyapeeth, Vengurle, *Vanilla planifolia*,

16.10.2010; 1 ♀, Kokan Krishi Vidyapeeth, Vengurle, *Cinnamomum verum*, 16.10.2010; 1 ♀, Dapoli Krishi Vidyapeeth, *Myristica fragrans* Houtt, 18.10.2010; 1 ♂, 1 nymph, Dapoli Krishi Vidyapeeth, *Vanilla planifolia*, 19.10.2010.

Remarks: This is another very common species and in the present study it could be collected from a wide range of spices plants as given in the collection data. It is also a very good predator, and was seen feeding upon immatures of 2- spotted spider mite, avoiding the adults. Earlier, it was reported from almost throughout India, feeding upon Citrus brown mite, (*Eutetranychus orientalis*), mango spider mite (*Olionychus mangiferus*), Citrus red mite (*Panonychus citri*) and tenuipalpid mite on calotropis (Gupta, 2003). This appears to be a potentially important predatory mite.

13. *Amblyseius indirae* Gupta

1985. *Amblyseius (Amblyseius) indirae* Gupta, *Entomon.*, **10**(3): 209-211.
 1999. *Amblyseius (Amblyseius) indirae* Gupta & Chatterjee, *Sci. & Cult.*, **65**: 161
 2003. *Amblyseius (Amblyseius) indirae* Gupta, *Mem. zool. Surv. India*, **20**(1): 20-22
 2007. *Amblyseius indirae*, Chant & McMurtry, **78**.

Diagnosis: This is a slow moving whitish mite, Setae measure: j_1 -33, j_3 -35, s_4 -105, Z_5 -235, Z_4 -100; other setae minute. Leg IV macrosetae: genu- 115, tibia-100, basitarsus-70, spermatheca with long duct.

Collection Records: MAHARASHTRA; Dapoli Krishi Vidyapeeth, 8 ♀♀, *Myristica fragrans* Houtt, 19.10.2010; 1 ♀, 1 ♂, Dapoli Krishi Vidyapeeth, *Piper betle*, 19.10.2010; 1 ♀, Dapoli Krishi Vidyapeeth, *Cinnamomum verum*, 19.10.2010.

Remarks: This is rather an uncommon species and could be collected from Cinnamon and *Piper betle*, It was described from Karnataka it is being reported here for the first time on this host. Economic importance of this species is unknown.

14. *Amblyseius neorykei* Gupta

1977. *Amblyseius neorykei* Gupta, *Ent.mon. Mag.*, **112**: 56.

1996. *Amblyseius (Amblyseius) neorykei*, Chatterjee & Gupta, *J. Beng. nat. Hist. Soc.*, (NS) **15**(2): 25.

2007. *Amblyseius neorykei*, Chant & McMurtry, p. 80.

Diagnosis: Dorsal shield with long setae measure j_1 -30, j_3 -45, s_4 -95, Z_5 -135, Z_4 -85. Leg IV macrosetae: genu-70, tibia-50, basitarsus-72.

Collection Records: KERALA: Poovachuli 2 ♀ ♀, *Myristica fragrans*, 22.10.2007.

Remarks: This species was earlier known from West Bengal, Arunachal Pradesh and Sikkim and is reported here for the first time from Kerala. The economic importance of this species is unknown.

15. *Amblyseius muraleedharani* Gupta

1986. *Amblyseius (Amblyseius) muraleedharani* Gupta, *Fauna of India: Phytoseiidae*: 57-59.

1987. *Amblyseius (Amblyseius) muraleedharani* Gupta, *Rec. zool. Surv. India, Occ. Pap.*, **95**: 13-14

2003. *Amblyseius (Amblyseius) muraleedharani* Gupta, *Mem. zool. Surv. India*, **20**(1): 25

2007. *Amblyseius muraleedharani* Gupta, Chant & McMurtry : 80.

Collection Records: TAMILNADU: Sirumalai, 2 ♀ ♀, 1 protonymph, *Piper betle* 10.04.2011.

Remarks: This species appears to be very close to *Amblyseius muraleedharani*, but slightly differs in setal length of the dorsal shield which may be treated as variation. No predator importance was observed.

16. *Amblyseius shoreae* Gupta

1977. *Amblyseius shoreae* Gupta, *Ent. Mon. Mag.*, **112**: 57.

1986. *Amblyseius (Amblyseius) shoreae*, Gupta, *Fauna of India: Phytoseiidae*, p. 65-67.

2003. *Amblyseius (Amblyseius) shoreae*, Gupta, *Mem. Zool. Surv. India*, **20**(1): 28.

2007. *Amblyseius shoreae*, Chant & McMurtry: 81.

Diagnosis: The long setae on dorsal shield measure j_1 -27, j_3 -50, s_4 -60, Z_5 -95, Z_4 -60. Macrosetae on leg IV: genu-70, tibia-45, basitarsus-55.

Collection Records: KARNATAKA:

Bettadamanne, 1 ♀, *Pimenta dioica* (L) Merr. 08.12.2008.

Remarks: This species was described from West Bengal, and so far not known from outside West Bengal. So, Karnataka, where from this species was collected in the present study, forms new record. The economic importance of this species is unknown. The Allspices wherefrom it was collected also forms new habitat record.

17. *Amblyseius channabasavannai*

Gupta & Daniel

1978. *Amblyseius channabasavanni* Gupta & Daniel., *Oriental Ins.*, **12**: 328-330.

1995. *Amblyseius (Amblyseius) channabasavannai* Gupta, In: *Fauna of Meghalaya, State fauna Series*, **4** (Part 2):

2003. *Amblyseius (Amblyseius) channabasavannai*, Gupta, *Mem. zool. Surv. India*, **20**(1): 15

2007. *Amblyseius channabasavannai*, Chant & McMurtry: 78.

Diagnosis: This is a fast moving white mite, the long setae on dorsal shield measure j_1 -26, j_3 -40, s_4 -80, Z_5 -250, Z_4 -110. Spermatheca with long cervix and thick major duct. Leg IV macrosetae, genu-90, tibia-65, basitarsus-55.

Collection Records: MAHARASHTRA: Dapoli Krishi Vidyapeeth, 2 ♀ ♀, 1 ♂, 2 nymph, *Piper betle*, 19.10.2010.

Remarks: From India it was known from both Eastern States (West Bengal, Meghalaya, Arunachal Pradesh, Sikkim) as well as from southern states (Tamil Nadu, Kerala). This is widely available in southern states and appears to be a promising predator upon spider mites as it was seen feeding upon immatures of *Tetranychus* sp.

18. *Amblyseius mcmurtryi* Muma

1967. *Amblyseius mcmurtryi* Muma, *Fla. Ent.*, **50**: 270.

1999. *Amblyseius (Amblyseius) mcmurtryi*, Gupta & Chatterjee, *Sci & Cult.*, **65**: 162.

2003. *Amblyseius (Amblyseius) mcmurtryi*, Gupta, *Mem. zool. Surv. India*, **20**(1): 23.

2007. *Amblyseius mcmurtryi*, Chant & McMurtry: 80.

Diagnosis: The dorsal shield with long setae measure j_1 -25, j_3 -35, s_4 -60, Z_5 -140, Z_4 -60. Spermatheca short with tubular cervix. Macrosetae on leg IV: genu-50, tibia 40, basitarsus-45

Collection Records: Kerala: Sugandagiri hill, 1 ♀, *Elettaria cardamomum*, 23.10.2007.

Remarks: Earlier, in India, it was reported from Assam, Meghalaya, Lakshadwip and therefore Kerala forms a new record.

19. *Amblyseius paraaerialis* Muma.

1967. *Amblyseius paraaerialis* Muma, *Fla. Ent.*, **50**: 270-271.

1995. *Amblyseius (Amblyseius) paraaerialis*, Gupta, In: *Fauna of Meghalaya, State Fauna Series*, **4**(Part 2): 31.

2003. *Amblyseius (Amblyseius) paraaerialis* Gupta, *Mem. zool. Surv. India* **20**(1): 27.

2007. *Amblyseius paraaerialis*, Chant & McMurtry: 80.

Diagnosis: Dorsal shield with long setae measure j_1 -27, j_3 -50, s_4 -72, Z_5 -161, Z_4 -90. Macrosetae on leg IV, genu-70, tibia-45, basitarsus-55. Spermatheca characteristically with looped elongated cervix.

Collection Records: KERALA: Spring Valley, Kumily 1 ♀, *Elettaria cardamomum*, 28.10.2007.

Remarks: Earlier it was known from Assam, Arunachal Pradesh, Meghalaya, Sikkim, Kerala. The Cardamom forms new habitat record. No predatory importance was observed in the field.

20. *Euseius coccineae* (Gupta)

1975. *Amblyseius coccineae* Gupta, In. *J. Acarol.*, **1**: 30.

2000. *Amblyseius(Euseius)coccineae* Gupta, In: *Fauna of Tripura, State Fauna Series*, **7**(Part-2): 23.

2003. *Amblyseius (Euseius) coccineae* Gupta, *Mem. zool. Surv. India*, **20**(1):35.

2007. *Euseius coccineae*, Chant & McMurtry: 120.

Diagnosis: Measurements of setae on dorsal shield - J_1 -25, j_4 - j_5 -15 each, J_2 -15, J_5 -6, j_3 -30, z_2 -20, z_4 -20, s_4 -35, Z_1 -12, S_2 -20, S_4 -22, S_5 -24, Z_5 -60, Z_4 -13, z_5 -9, Spermatheca bell shaped. Macrosetae on leg IV genu- 45, tibia-35, basitarsus-50.

Collection Records: KARNATAKA; I.S.R.I.,

Appangala, Madikeri, 1 ♀, *Cinnamomum verum*, 03.12.2008.

Remarks: This is a widely distributed species in India but was not known from Karnataka wherefrom the present specimens were collected. *Cinnamomum* also forms a new habitat record. Though earlier report indicated its feeding on eggs of *Oligonychus mangiferus* and found associated with *Tetranychus urticae* but no feeding on spider mites in the field was observed during the present study.

21. *Euseius alstoniae* (Gupta)

1975. *Amblyseius alstoniae* Gupta, *Internat. J. Acarol.*, **1**(2): 31-32.

2000. *Amblyseiu(Euseius) alstoniae* , Gupta, In: *Fauna of Tripura, State Fauna Series*, **7**(Part 2) : 22.

2003. *Amblyseiu(Euseius) alstoniae*, Gupta, *Mem. zool. Surv. India*, **20**(1): 32.

2007. *Amblyseiu(Euseius) alstoniae*, Chant & McMurtry: 120.

Diagnosis: Measurements of setae j_1 -25, j_4 -10, j_5 -10, j_6 -25, J_2 -30, J_5 -6, j_3 -28, z_2 -25, z_4 -30, s_4 -50, Z_1 -20, S_2 -26, S_4 -20, S_5 -30, Z_5 -55 (serrate), Z_4 -30, spermatheca with narrow elongated cervix and buldging vesicle. Macrosetae on leg IV, genu-50, tibia-35, basitarsus-70.

Collection Records: MAHARASHTRA: Chandrapur, Mazra, 3 ♀ ♀, *Gossypium herbaceum*, 11.10.2010; 1 ♀, Chandrapur, Mazra, *Glycine max*, 11.10.2010.

Remarks: Though this is a widely distributed species and has been recorded from different states of India on diverse plants, mostly fruit trees and vegetables, but its record from Maharashtra was unknown. It is a good predator but in the present study its predatory behaviour was not seen in the field.

22. *Scapulaseius eucalypticus* (Gupta)

1978. *Typhlodromalus eucalypticus* Gupta, *Oriental Ins.*, **12**: 330-331.

1987. *Amblyseius(Typhlodromalus) eucalypticus*, Gupta, *Rec. zool Surv. India, Occ. Paper*, **95**: 53.

2003. *Amblyseius(Typhlodromalus) eucalypticus*, Gupta, *Mem. zool. Surv. India*, **20**(1): 66-67.

2007. *Scapulaseius eucalypticus*, Chant & McMurtry: 67.

Diagnosis: Measurements of setae j_1 -24, j_3 -20, s_4 -28, Z_5 -65, Z_4 -25, the other dorsal setae small. Spermatheca with narrow funnel shaped cervix. Macrosetae on leg IV genu-60, basitarsus-60.

Collection Records: KERALA: Tushergiri, 1 ♀., *Piper betle*, 18.10.2007.

Remarks: Its earlier record was from Karnataka and the present record from Kerala forms new distributional record. No economic importance of this species is known.

23. *Euseius ovalis* (Evans)

1953. *Typhlodromus ovalis* Evans, *Ann. Mag. Nat. Hist.*, **6**: 458-461.

1994. *Amblyseius (Euseius) ovalis*, Gupta, In: *Contributions to Acarological Researches in India*, p. 442.

2000. *Amblyseius (Euseius) ovalis*, Gupta, *Mem. zool. Surv. India*, **20**(1): 42.

2007. *Euseius ovalis*, Chant & McMurtry: 121.

Diagnosis: Dorsal shield with all the setae small or minute, excepting J_1 and Z_5 Which are 30 and 50 respectively, Macrosetae on leg IV genu-35, tibia-30, basitarsus-50, Spermatheca bellshaped.

Collection Records: TAMILNADU: Alagumadi, 3 ♀ ♀. *Piper betle*, 12.04.2011.

Remarks: This is a widely distributed species and a good predator of spider mites (*Oligonychus coffeae*, *Tetranychus neocaledonicus*) (Gupta, 2003). In the present investigation no such predatory behavior was noticed.

24. *Euseius rhododendronis* (Gupta)

1970. *Amblyseius rhododendronis*, Gupta, *Oriental Ins.* **4**: 187-188.

2000. *Amblyseius (Eusius) rhododendronis*, Gupta, In : *Fauna of Tripura, State Fauna Ser.*, **7**(Part-2) : 24.

2003. *Amblyseius rhododendronis*, Gupta, *Mem. zool. Surv. India*, **20**(1): 44.

2007. *Euseius rhododendronis*, Chant & McMurtry: 123.

Diagnosis: Measurements of setae of dorsal shield: j_1 -27, j_4 , j_5 -8 each, J_6 , J_2 -10 each, j_3 -18, z_2 , z_4 -12 each, s_4 -25, Z_1 -8, S_2 -12, Z_5 -55, Z_4 -10. Macrosetae on leg IV-genu-40, tibia-30, basitarsus-40.

Collection Records: TAMILNADU: Sirumalai, 5 ♀ ♀., *Elettaria cardamomum*, 10.04.2011.

Remarks: The occurrence of this species is rather rare and in the present study it was collected on *Elettaria cardamomum*, which forms a new habitat record.

25. *Euseius* sp. nov. (?)

Collection Records: KARNATAKA: Sirsi, 1 ♂, *Myristica fragrans* Houtt, 14.12.2008; TAMIL NADU: Sirumalai, 3 ♀ ♀, 9 ♂ ♂, *Elettaria cardamomum*, 10.04.2011.

Remarks: Some unidentified species of *Euseius* were recorded from Nutmeg, Cardamom, which do not tally with any of the known described species and hence appear to be undescribed ones. Further investigation to ascertain their novelty is on and final decision will be taken later.

26. *Neoseiulus cynodonae* (Gupta)

1977. *Amblyseius cynodonae*, Gupta, *Oriental. Ins.*, **11**: 626-627.

1987. *Amblyseius (Neoseiulus) cynodonae* Gupta, *Rec. zool. Surv. India, Occ. pap.*, **95**: 36.

2003. *Amblyseius (Neoseiulus) cynodonae* Gupta, *Mem. zool. Surv. India*, **20**(1): 51.

2007. *Neoseiulus cynodonae*, Chant & McMurtry: 29.

Diagnosis: Measurements of setae on dorsal shield: j_1 -17, j_4 - J_5 -5 each, J_2 -10, j_3 -12, z_2 , z_4 -10 each, s_4 -25, Z_1 -10, S_2 -16, S_4 -12, S_5 -10, Z_5 -67, Z_4 -36. Spermatheca with funnel shaped tubular cervix. Leg IV macrosetae, genu-40, tibia-18, basitarsus-55.

Collection Records: KERALA: Pozhuthana, 1 ♀, *Piper betle*, 23.10.2007.

Remarks: Earlier it was known from Andaman-Nicobar Islands and its present report from Kerala forms new distributional record.

27. *Typhlodromips syzygii* (Gupta)

1975. *Amblyseius syzygii* Gupta, *Interna. J. acarol.*, **1**(2): 44-45.

2003. *Amblyseius (Typhlodromips) syzygii* Gupta, *Mem. zool. Surv. India*, **20**(1): 82.

2007. *Typhlodromips syzygii*, Chant & McMurtry, **63**.

Diagnosis: This is whitish brown mite, with dorsal shield reticulated, Measurements of setae. j_1 -16, j_4 - j_6 , J_2 -6-8 each long, j_3 -15, Z_2 - Z_4 -10 each, s_4 -22, Z_1 -15, S_2 , S_4 , 10-12, S_5 10-12, S_5 - Z_5 65(serrate), Z_4 -35. Spermathica with long duct and cup shaped cervix. Macrosetae on leg IV: genu- 45, tibia-30, basitarsus-45.

Collection Records: KARNATAKA: Chickmagalore, 3 ♀ ♀, *Elettaria cardamomum*, 10.12.2008.

Remarks: This species was earlier known from West Bengal, Tripura, Orissa, Meghalaya, Bihar, Sikkim, Mizoram, Uttar Pradesh and the present report from Karnataka forms the new record. *Elettaria cardamomum*, also forms new habitat record. Outside India, it has been reported from Thailand. This is also a good predator and found associated with *Dolichotetranychus floridanus* infesting the same host.

28. *Typhlodromus himalayensis* Gupta

1981. *Typhlodromus himalayensis* Gupta, *Indian J. Acar.*, 5(1-2): 32-33.

1999. *Typhlodromus (Amblydromella) himalayensis* Gupta & Chatterjee, *Sci. & cult.*, 65: 162.

2003 *Typhlodromus (Amblydromella) himalayensis* Gupta, *Mem. zool. Surv. India* 20(1): 123.

2007. *Typhlodromus (Anthosius) himalayensis* Chant & McMurtry: 155.

Diagnosis: Measurements of setae j_1 -12, j_4 -10, j_5 -12, j_6 -16, J_2 -16, J_5 -8, Z_5 -8, J_3 -14, z_2 -18, z_3 -16, z_4 -16, s_4 -20, s_6 -24, S_2 , S_4 -24 each, S_5 -17, Z_5 -40 (serrate, knobbed), Z_4 -24. Macroseta on leg IV-basitarsus-36.

Collection Records: KERALA: Karadipara, 1 ♀, *Piper beetle*, 26.10.2007; 1 ♀, Sugandagiri, *Elettaria cardamomum*, 23.10.2007.

Remarks: This was earlier known from Himachal Pradesh, Uttar Pradesh, Jammu & Kashmir, Lakshadwip and the present one forms new report from Kerala with new habitat record.

29. *Typhlodromus* sp.

Collection Record: Maharashtra : Chandrapur, Jalgaon, 1 ♀ *Sesamum indicum*, 10.10.2010.

Remarks: An undetermined species of *Typhlodromus* was recorded from Jalgaon Chandrapur in Maharashtra. The specific identity could not be ascertained as the specimen was in damaged condition.

Family 5 ASCIDAE Voigts & Oudemans

30. *Asca* sp.

Collection Records: Kerala: Sugandagiri, 1 ♀, *Piper beetle*, 23.10.2007.

Remarks: One undetermined species of *Asca* was collected from the host as mentioned in collection records but its specific identity could not be ascertained due to lack of literature.

ORDER 3 PROSTIGAMATA

Family 6 ANYSTIDAE Oudemans

31. *Anystis baccarum* (Linn.)

1758. *Acarus baccarum* (Linn.), *Systema Naturae* 10th ed., 106.

2002. *Anystis baccarum*, Gupta, *Mem. zool. Surv. India*, 19(2): 18-19.

Diagnosis: Propodosomal shield rounded anteriorly, indented posteriorly opisthosoma with 8 pairs of setae, anogenital region with many short serrate setae. Palp tibia with 3 claws.

Collection Records: KERALA: Kumely 1 ♀, *Syzygium aromaticum* (L.), 28.10.2007.

Remarks: This is a good predatory species and is known earlier from India from Jammu & Kashmir, Punjab, feeding on tetranychids. This is the first record of this species from Kerala while *Syzygium aromaticum* forms new habitat record.

Family 7 BDELLIDAE Grandjean

32. *Bdellodes* sp. nr. *angustifolius* (Gupta)

1991. *Bdella angustifolius* Gupta, *Rec. zool. Surv. India*, 88 : 201.

2002. *Bdellodes angustifolius* Gupta, *Mem. zool. Serv. India*, 19(2): 31-32.

Collection Records: MAHARASHTRA: Lasorne, Satara, 1 ♀, Sunflower, 14.10.2010; 1 ♀, Dr. B.S. Kokan Krishi Vidyapeeth, Vengurle, *Pimenta dioica* (L.), 16.10.2010.

Remarks: This species is very close to *Bdellodes angustifolius* (Gupta) but differs in hypostomal striation pattern and chaetotaxy of dorsum. The members of this family are known to be good predators but in the present case, no predation was observed. Although the present specimen has been tentatively identified as near to *Bdella angustifolius* but there are some differences which are evaluated and final discussion regarding its identity will be taken later.

33. *Bdellodes* sp.

Collection Records: KERALA: Puliakode, Dist. Malapuram, 1 ♀, *Piper betle*, 21.10.2007; 1 ♀, Karadipara, Munnar, *Piper betle*, 26.10.2007.

Remarks: This species of *Bdellodes* could not be identified upto species level for want of literature. However, it does not tally with any of the known species of this genus from India.

34. *Bdella* sp.

Collection Records: KERALA: Keller, 1 ♂, *Elettaria cardamomum*, (L.), 25.10.2007.

Remarks: This genus is known from India only by 2 species one from Maldah and the other from Arunachal Pradesh. However, this is different from both the species. Final specific identification is kept pending till further literature are available.

35. *Bdella* sp. nr. *maldahensis* Gupta

1992. *Bdella maldahensis*, Gupta, In: *Fauna of West Bengal, State Fauna Ser.*, 3(Part 3): 12.

1999. *Bdella maldahensis*, Gupta, *Sci. & Cult.*, **65**: 161.

2003. *Bdella maldahensis*, Gupta, *Mem. zool. Surv. India*, **20**(1): 27.

Collection Records: TAMILNADU: Sirumalai, 1 ♀, *Piper betle*, 10.04.2011.

Family 8 CHEYLETIDAE

36. *Eucheyletia* sp.

Collection Records: KARNATAKA: Chickmagalore, 1 ♀, *Elettaria cardamomum*, 10.12.2008.

Remarks: This species is different from the only known species of this genus from India, i.e. *Eucheyletia reticulate* Cunliffe by the number

and shape of idiosomal setae and number of teeth on outer and inner combs. Till availability of additional material, the final decision on its identity is kept in abeyance.

Family 9 CUNAXIDAE Thor

37. *Dactyloscirus* sp. nov.

Collection Records: MAHARASHTRA: Dr. B.S. Kokan Krishi Vidyapeeth, Vengurle, 1 ♀, *Cinnamomum verum*, 16.10.2010; KARNATAKA: Bettadamann, Mudigere, 1 ♀, *Elettaria cardamomum*, 8.13.2008.

Remarks: This genus is known from India only by 2 species, viz., *Dactyloscirus machairodus* (Oudemans) and *Dactyloscirus bengalensis* Gupta. However, it differs from both in setation pattern of palp femur, as well as in setation of hysterosomal region. The decision regarding its novelty is kept pending till availability of further material.

38. *Cunaxoides* sp.

Collection Records: TAMIL NADU: Sirumalai, 1 ♀, *Piper betle*, 10.4.2011.

Remarks: This specimen of *Cunaxoides* was damaged while mounting. Therefore, its identity could not be ascertained.

Family 10 ERYTHRAEIDAE Robineau-Desvoidy

39. *Leptus* sp. nr. *indicus* Khot

1964. *Leptus indicus* Khot, *Acarologia*, **6**: 682.

2002. *Leptus indicus*, Gupta *Mem. zool. Serv. India*, **19**(2): 89.

Collection Records: MAHARASHTRA: Lasurne, Satara, 2 ♀ ♀, *Glycine max*, 14.10.2010; KARNATAKA: Sirsi 1 ♀, *Piper betle*, 14.12.2008.

Remarks: This genus is known from India by only 4 species viz., *Leptus samsungensis*, Gupta, *Leptus poonaensis* Khot, *Leptus giganticus* Khot and *Leptus indicus* Khot. However, this is close to only *Leptus indicus* from which it differs in setation of dorsum. The specific identity has been kept pending till further material becomes available.

Family 11 STIGMAEIDAE Oudemans.

40. *Agistemus obscura*, Gupta.

1991. *Agistemus obscura* Gupta, *Rec. zool. Surv. India*, **88**: 210-211.
1997. *Agistemus obscura*, Gupta & Chatterjee, *Sci. & Cul.*, **65**(5-6): 161.
2002. *Agistemus obscura*, Gupta, *Mem. zool. India*, **19**(2): 108.

Diagnosis: Setae on propodosoma ae/ae-ae = 1.6, be/be-be-1.1, ce/ce-ce-o.4, all setae on medium shield barbed. A-50, b-60, la-64, lm-65, c-65.

Collection Records: KERALA, Spring Valley 1 ♀, *Cinnamomum verum*, 28.10.2007.

Remarks: Earlier this was known from Manipur and hence, Kerala forms new distributional record and *Cinnamomum* forms the new habitat record.

41. *Agistemus heterophylla* Gupta

1991. *Agistemus heterophylla* Gupta, *Rec. zool. Surv. India*, **88**: 211-214.
1996. *Agistemus heterophylla*, Chatterjee & Gupta, *J. Beng. nat. Hist. Soc.*, (NS), **15**(2): 27.
2002. *Agistemus heterophylla* Gupta, *Mem. zool. Surv. India*, **19**(2): 104.

Diagnosis: Measurements of setae: ae-40, be-79, ce-58, ae/ae-ae-1.2, be/be-be-1.2. Palp tarsus as long as palptibial claw. a-58, la-70, b-55, lm-65, c-65.

Collection Records: TAMIL NADU, Sirumalai 1 ♀, *Elettaria cardamomum*, 10.04.2011.

Remarks: This was earlier known from Arunachal Pradesh and West Bengal. Its present record on Cardamom from Tamil Nadu forms new habitat and distributional records, respectively.

42. *Agistemus aramatai* Gupta

1991. *Agistemus aramatai* Gupta, *Rec. zool. Surv. India*, **88**: 210.
2002. *Agistemus aramatai*, Gupta, *Mem. zool. Surv. India*, **19**(2): 99.

Diagnosis: Propodosomal setae ae-50, be-48, ce-50, ae/ae-ae-3.1, ae-be-26, be-ce-40, a-50, b-35, c-50, la-55, lm-34, a/a-a-1.5.

Collection Records: TAMIL NADU, Sirumalai 1 ♀, *Piper betle*, 10.04.2011.

Remarks: This species was earlier known from Arunachal Pradesh, Assam, Mizoram, Lakshadwip. Hence, Tamil Nadu forms new distributional record.

43. *Agistemus industani* Gonzalez. Rodriguez

1965. *Agistemus industani*, Gonzalez. Rodriguez, *Univ. Calif. Pub. Ent.*, **41**: 40.
1999. *Agistemus industani*, Dhooria, *J. Acar*, **14**: 88-89.
2002. *Agistemus industani*, Gupta, *Mem. zool. Surv. India*, **19**(2): 104-105.

Diagnosis: Measurements of setae ae-56, ae-ae-26, ae/ae-ae-2.1, be-70, be-ce-70, a-b-65, c-68, la-68, lm-67, e-38.

Collection Records: MAHARASHTRA, Pursuda, 1 ♂, *Curcuma longa* L., 11.10.2010.

Remarks: This species was previously known from Arunachal Pradesh, Mizoram, Nagaland, Tamil Nadu, Uttar Pradesh, Punjab, Tamil Nadu, Karnataka. Hence its present record from Maharashtra forms new distributional record as well as the plant, *Curcuma longa*, on which it was recorded forms new habitat record.

44. *Agistemus fleschneri* Summers

1960. *Agistemus fleschneri* Summers, *Proc. ent. Soc. Wash.*, **62**: 237-240.
2000. *Agistemus fleschneri*, Gupta, In: *Fauna of Tripura, State Fauna Ser.*, **7**(Part 2): 18.
2002. *Agistemus fleschneri*, Gupta, *Mem. zool. Surv. India*, **79**(2): 101-102.

Diagnosis: Measurements of setae ae-44, ae/ae-ae-2.5, be-69, be/be-be-2.00, ce-60, ce-ce-60, a-50, b-46, c-52, la-47, lm-50.

Collection Records: TAMIL NADU: Allagumadai, 1 ♀, *Piper betel*, 12.04.2011.

Remarks: It is widely distributed in India like Arunachal Pradesh, Assam, Meghalaya, Manipur, Sikkim, Tripura, West Bengal, Delhi, Haryana, Punjab, Andaman & Nicobar Islands. However, its report from Tamil Nadu on *Piper betle* forms new distributional and habitat records.

45. *Ledermuelleria* sp.

Collection Records: KARNATAKA: Chickmagalore, 1 ♀, *Elettaria cardamomum*, 10.12.2008.

Remarks: One species of this genus could be collected but its placement to species level could not be done for the damaged condition of the specimen.

Family 12 TYDEIDAE Kramer

46. *Promnematus fleschneri* Baker

1968. *Promnematus fleschneri* Baker, *Ann. Ent. Soc. Amer.*, **61**(5): 1092-1093.

2000. *Promnematus fleschneri*, Gupta, In: *Fauna of Tripura, State Fauna Ser.*, 7(Part 2): 18-19.

2002. *Promnematus fleschneri*, Gupta, *Mem. zool. Surv. India*, **19**(2): 126.

Diagnosis: Propodosomal striation longitudinal with minute lobes. Setae D_1 - D_3 , L_1 subequal in length, tibia I shorter than tarsus I, solenidion on tarsus I extends beyond the tip of segment.

Collection Records: KERALA: Spice Research Institute, Peruvannamuzhi, 1 ♀, *Myristica fragrans* Hoult, 17.10.2007.

Remarks: This is a widely distributed species and is known from West Bengal, Tripura, Sikkim, Bihar, Delhi, Punjab, Uttar Pradesh, Andaman-Nicobar Islands, Kerala forms new distributional record. It has been reported to be feeding upon *Tetranychus neocaledonicus* and *Oligonychus mangiferus* (Gupta, 2002) but such feeding behaviour could not be seen in the field.

47. *Pronematus elongatus* Baker

1968. *Pronematus elongatus* Baker, *Ann. Ent. Soc. Amer.*, **61**: 1093-1094

1993. *Pronematus elongatus*, Rather, *J. Acerol.*, **15**: 20.

2002. *Pronematus elongatus*, Gupta, *Mem. zool. Surv. India*, **19**(2): 124.

Diagnosis: Propdosoma with fine longitudinal station. Hysterosoma with transverse stration, over dorsocentral area, except V-like between D_1 - D_3 Tarsus I longer than tibia I, solenideon on tarsus I short and rounded.

Collection.Records: KERALA: Balusseri, 1 ♀, *Piper betle*, 17.10.2007.

Remarks: Earlier it was known only from Jammu & Kashmir. So Kerala forms new distributional record.

48. *Pronematus* sp.

Collection Records: KARNATAKA: Chickmagalore, 1 ♀, *Piper betle*, 10.12.2008.

Remarks: One undetermined species of *Pronematus* was collected which did not tally with any of the known species of this genus from India. However, for lack of some recent literature further identification was not possible.

49. *Parapronematus ferox* Gupta

1991. *Parapronematus ferox* Gupta, *Rec. zool. Surv. India*, **88**: 231.

2002. *Parapronematus ferox*, Gupta, *Mem. zool. Surv. India*, **19**(2): 123.

Diagnosis: Forked seta 1.5 times as long as width of segment, solenideon on tarsus I present on middle of segment, setae measure P_1 -25, S-31, D_3 -22, D_4 -31.

Collection Records: MAHARASHTRA: Dr. B.S.Kokan Krishi Vidyapeeth, Vengurle, 1 ♀, *Piper betle*, 16.10.2010.

Remarks: It was described from West Bengal and its present record on Cardamom from Kerala forms new distributional and habitat records.

50. *Parapronematus* sp.

Collection Records: KARNATAKA: Sirsi, 1 ♀, *Elettaria cardamomum*, 15.12.2008. This species could not be identified beyond generic level for want of literature.

51. *Tydeus* spp.

Collection Records: KERALA: Keller, 1 ♀, *Syzygium aromaticum* (L), 25.10.2007; *Cinnamomum verum*; 1 ♀, 1 ♂, 25.10.2007. KARNATAKA: Sirsi, 5 ♀, *Elettaria cardamomum*, 14.12.2008. Donigal, Bettadamanne, 1 ♀, *Cinnamomum verum*; 08.12.2008; Chickmagalore, 2 ♀, *Vanilla panifolia*, 10.12.2008, Chettali, Madikeri, 1 ♀, *Garcinea* sp., 05.12.2008.

Remarks: Some specimens of this genus were collected but could not be placed to any of the known species due to difference in striation pattern on dorsum and dorsal chaetotaxy. Most likely one or two might be new species.

FUNGUS FEEDING MITES

Family 13 EUPODIDAE Koch.

52. *Eupodes sigmoidensis* Strandtmann & Goff.1978. *Eupodes sigmoidensis* Strandtmann & Goff. *Pacific Insects*, **19**(2): 91.

Collection Records: KERALA: Tushargiri, 1 ♀, *Piper beetle*, 28.10.2007; KARNATAKA: 1 ♀, Indian Institute of Spice Research, Appangala, *Myristica fragrans*, 4.12.2008; TAMIL NADU: Sirumalai, 1 ♀, *Piper beetle*, 10.4.2011; Sirumalai, 1 ♀, *Elettaria cardamomum*, 10.4.2011.

Remarks: Earlier records of this species are from West Bengal, Mizoram, Sikkim and Lakshadwip from India. The present one forms new distributional record. It is known to be associated with fungus and phytophagous mites but its relation with the latter is not known with certainty.

53. *Eupodes* sp.

Collection Records: KERALA: Tushargiri, 1 ♀, *Curcuma longa* L., 18.10.2007; Sugandagiri, 1 ♀, *Piper beetle*, 23.10.2007; 2 ♀ ♀, Spring valley, *Piper beetle*, 28.10.2007

Remarks: Another species of this genus was collected which was different from the earlier

one but because of its fragile nature, the correct identification remained doubtful.

SUMMARY

The present paper documents a total of 53 species belonging to 27 genera under 13 families and 2 orders, of those 10 belong to phytophagous group, 41 to predatory group and one to fungal feeding group. All the species are listed giving relevant references, diagnosis, collection records and biological observations made in the field. This forms a first consolidated account of mites infesting plants used as spices in India.

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REPORT OF LITCHI STINK BUG, *TESSARATOMA JAVANICA* (HEMIPTERA: TESSARATOMIDAE) ON MAHUA TREE IN CHHATTISGARH

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INTRODUCTION

Mahua (*Maduca indica*) is one of the most important forest trees widely distributed in India, belonging to family Sapotaceae. It is a tropical tree found largely in Central and North Indian plains forests. It is fast growing tree attains about 20 meters in height, possesses evergreen or semi-evergreen foliage. The tree is considered as boon for the tribals and forest dwellers in Central India.

The Litchi stink bug, *Tessaratomia javanica* (Thunberg) is relatively large sized bug characterized by the proportionately small head, short labium and large sternal plate between the middle and hind coxae. In India, it is considered to be a minor pest of litchi and has also been reported a pest of apple, pear and mulberry plant (*Morus alba*) (Sunil and Chandrashekar, 2013), whereas in southern part of India it is very common on *Michelia champaca*. Recently, an outbreak of Litchi stink bug was recorded during February–April, 2011 from the Chotanagpur plateau of Jharkhand, India (Chaudhary *et al.*, 2013).

This bug usually appears on litchi from the last week of April and disappears from the orchard after the last week of August and undergoes hibernation in adult stages (Kumar *et al.* 2008). The nymphs and adults of the bug suck the sap of the flowering and fruiting shoots, flowers and

young fruits causing flowers and fruits to fall, the necrosis of young twigs, the blackening of fruit to drying of shoot tips. Present study includes the report of new host plant of litchi stink bug from Chhattisgarh and also provides additional diagnostic and morphometric characters by taking measurements of different body parts and their ratios, means and Standard Deviation has also been calculated (Table-1)

MATERIALS AND METHODS

While undertaking the entomological survey of Korba district, 22 specimens (8 ♂♂ and 14 ♀♀), were collected by the second author from the bark of Mahua tree near Kartala Rest House, (22°16'405", 82°51'10.6"; 343 m.), Korba district, Chhattisgarh, which were also observed from other localities in Korba district. The dead nymphs were observed in many numbers on the trunk of Mahua tree and many adults were found on the ground below the tree. Collected bugs were studied in details and photographs and measurements of different body parts were taken with the help of stereoscopic microscope (Leica M 205A).

RESULTS

The size of the litchi bug is 25 to 31 mm. length and breadth 15 to 16 mm. The body colour is ochraceous to pale olivaceous brown and the underside of the body is covered with a white

Table 1. Means and standard deviations of different body parts and their ratios in the male and female of adult *Tessaratomia javanica* (Thunberg).

Parts of body	MALE			FEMALE		Mean+SD
	MIN (m.m.)	MAX (m.m.)	Mean+SD	MIN (m.m.)	MAX (m.m.)	
Length of head (HL)	2.14	2.83	2.517±0.240	2.60	2.75	2.638±0.049
Max. width of head across eyes (HW)	3.64	3.95	3.818±0.102	3.80	4.03	3.881±0.077
Length of Pronotum (PL)	7.98	8.77	8.562±0.300	8.36	9.99	9.058±0.507
Max. width of pronotum (PW)	11.87	13.57	12.876±0.580	13.35	14.67	13.935±0.479
Length of fore femur (FF)	4.00	4.20	4.088±0.098	3.81	5.48	4.389±0.610
Length of mid femur (MF)	4.81	5.41	5.076±0.214	5.07	6.02	5.423±0.271
Length of hind femur (HF)	5.89	6.64	6.201±0.294	5.59	7.03	6.605±0.466
Length of 2 nd joint of antennae (A2)	2.18	2.53	2.305±0.116	1.91	2.65	2.361±0.244
Length of 3 rd joint of antennae (A3)	2.10	2.43	2.242±0.103	2.16	2.43	2.246±0.117
Length of 4 th joint of antennae (A4)	2.69	3.08	2.861±0.181	2.81	2.87	2.848±0.031
Ratios						
Length of head / Max. width of head across eyes (HL/HW)	0.556	0.724	0.659±0.057	0.648	0.716	0.680±0.022
Length of Pronotum / Max. width of head across eyes (PL/HW)	2.097	2.409	2.244±0.104	2.194	2.479	2.333±0.098
Max. width of pronotum / Max. width of head across eyes (PW/HW)	3.149	3.569	3.373±0.127	3.397	3.782	3.591±0.116
Max. width of pronotum / Length of pronotum (PW/PL)	1.393	1.631	1.505±0.077	1.396	1.637	1.542±0.081
Length of hind femur / Length of mid femur (HF/MF)	1.163	1.260	1.222±0.030	1.103	1.292	1.218±0.068
Length of hind femur/ Length of fore femur (HF/FF)	1.402	1.660	1.518±0.097	1.246	1.693	1.522±0.166
Length of hind femur/ Max. width of head across eyes (HF/HW)	1.506	1.775	1.626±0.099	1.467	1.789	1.701±0.104
Length of 2 nd joint of antennae/ Length of 3 rd joint of antennae (A2/A3)	0.961	1.076	1.029±0.037	0.876	1.227	1.052±0.109
Length of 2 nd joint of antennae/ Length of 4 th joint of antennae (A2/A4)	0.711	0.881	0.808±0.058	0.666	0.943	0.829±0.087

powdery substance. The antennae brown, apical joint generally, brownish ochraceous; margins of head and pronotum very narrowly piceous; body above very finely and obscurely punctate. Head triangular from anterior view, wider than long, length 0.66 X to its width; antennae 4 jointed, 1st joint smallest, 2nd joint little longer than 3rd joints and 4th longest; antennal formula, $1 < 3 < 2 < 4$; rostrum relatively shorter, just passing anterior coxae; Pronotum slightly convex, slightly extended over, wider than long, maximum width of pronotum 1.5 X to its length. Femurs provided with pairs of apical spurs, hind femora more than one and a half times as long as fore femora, tibiae and tarsal segments, in all three legs are provided with spines arranged in row, basal joints of tarsi longer than rest of the tarsal joints; Scutellum more or less triangular, narrow at apex; corium finely punctuated, Abdomen ovate, wider than the maximum width of head in middle, about 1.19 X to hind femora and rounded apically.

The species is widely distributed all over India including Chhattisgarh, Assam, Andhra

Pradesh, Bihar, Delhi, Gujarat, Haryana, Madhya Pradesh, Punjab, Rajasthan, Maharashtra, Sikkim, Uttar Pradesh and elsewhere in Bangladesh, Myanmar, Central Africa, Indo-China, Java, Indonesia, Malaysia, Laos, Lesser Sunda Is., Malay Peninsula, Pakistan, Philippines, Sri Lanka, Sumatra, Thailand, Vietnam.

Litchi stink bug, *Tessaratoma javanica* (Thunberg) has recorded for the first time on the bark of Mahua tree (*Maduca indica*) near Kartala in Korba district of Chhattisgarh. Hundreds of specimens were found on the ground below Mahua tree and various localities and nymph were attached to the bark of the tree and the hatched eggs were also found on the bark.

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PLATE I

Tessaratoma javanica (Thunberg)



A. dorsal view male



B. dorsal view female



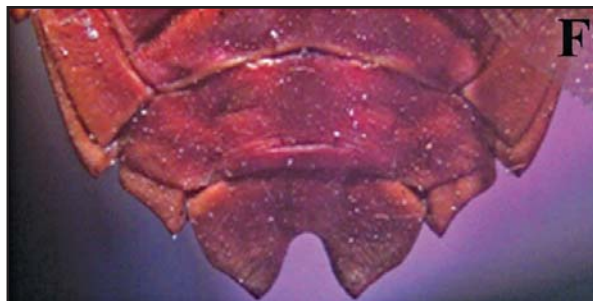
C. head and antennae



D. legs



E. male external genitalia (dorsal view)

PLATE II*Tessaratoma javanica* (Thunberg)

F. Female external genitalia (dorsal view)



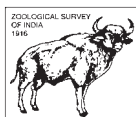
G. Hatched eggs



H. Nymph



I. Dead nymphs and adults laying near Mohua tree



DIVERSITY AND DISTRIBUTION OF SEA ANEMONES IN INDIA WITH SPECIAL REFERENCE TO ANDAMAN AND NICOBAR ISLANDS

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INTRODUCTION

Sea anemones are brightly coloured, classified under the phylum Cnidaria, inhabit coastal waters throughout the world, but are particularly abundant in tropical oceans. They are distributed in intertidal to deep oceans and live attached with rocks, sea floor, shells and some forms burrow in the mud or sand. They are radial symmetric with columnar body have a single body opening, mouth which is surrounded by tentacles. However, body shape of the sea anemones is often related to the habitat in which they live. Sea anemones are solitary polyps and are considerably larger and heavier than the polyps of hydrozoans (Barnes, 1982). There are over 1000 species of sea anemones reported worldwide. The size is usually about 2.5-10 cm across, but few grow up to 1.8 meter across. They are carnivorous, prey upon small fishes, sea urchins, shrimps, crabs, worms with their nematocysts. Anemones of some species are capable of absorbing nutrients directly from seawater through their tissues, and that may be another source of nutrition for these animals as well (Fautin and Allen, 1992). Predators of sea anemone are very few animals which include nudibranchs, fishes, sea stars and snails. Scattered record on temperate sea anemones surviving many decades in commercial aquaria, and the life span of small sea anemone is calculated based on actuarial tables to be over 300 years (Fautin and Allen, 1992). They reproduce both sexually by

external fertilization followed by the development of planktonic planula larva and settled down as single polyp, and asexually by budding, binary fission and pedal laceration.

Though the sea anemone encompasses order Actiniaria, Corallimorpharia and Ptychodactylaria, however due to wide distribution, and sheer numbers, especially in the intertidal region, the actinarian sea anemones are received more attention for their potential uses in drugs and pharmaceuticals as well as sentinel organisms for ecological monitoring of estuarine and marine environment (Ross, 1967) and also played a role in the marine aquarium trade. Sea anemones are susceptible to overexploitation due to their long life spans, slower relative growth rates, and lower reproductive rates. Despite these facts, global trade in marine ornamentals is a rapidly expanding industry involving numerous countries around the world. In early 1980s, the import value of marine fish and invertebrates for the aquarium trade was estimated to be US \$24-40 million annually (Wood, 1985) and it increased to US \$ 200-330 million annually (Chapman *et al.*, 1997; Forum Secretariat, 1999; Larkin and Degner, 2001).

Studies on sea anemones gained attention across the world following Verrill's (1928) monograph 'Hawaiian shallow water Anthozoa' in which 21 sea anemone species described. Dunn (1974a) redescribed the species *Macranthea cookie* described by Verrill (1928) in Hawaii

and synonymized with *Radianthus papillosa*, first described by Kwietniewski (1898) as *Stichodactis papillosa* from Ambon. Another species *Anthopleurua nigrescens* was also redescribed by Dunn (1974b), originally described as *Tealiopsis nigrescens* by Verrill (1928). Dunn (1974c) identified *Actiniogeton sesere* from Hawaii which was earlier described from Torres Strait (Haddon and Shackleton, 1893). Dunn (1978) described a new species *Anthopleura handi* which is an internally brooding intertidal actinian from Malacca Strait, Malaysia. Fifteen species of sea anemones including 3 new species from two orders, Actiniaria and Ptychodactiaria (1 species) were reported by Dunn (1983) from Antarctic and sub-Antarctic areas. A new species of Acontiate sea anemone *Acontiphorum niveum* collected from Mission Bay, California was described by Fautin *et al.* (1987). Fautin (1988) identified 22 species of Actinarian and Corallimorpharian sea anemones from the waters less than 30m depth at Madang Province. Further, Fautin *et al.* (1989) studied the systematic of genus *Metridium* and described the new species *Metridium giganteum* from west coast of North America. Distribution, abundance and adaptations of Actinarian sea anemones *Bunodosoma cangicum* Correa in Belem and Preslercravo, 1973; *Actinia bermudensis* (Mc Murrich, 1889); and *Anthopleura krebsi* Duchassaing and Michelotti, 1860 were assessed in intertidal beach rock in Carneiros beach, Pernambuco, Brazil and their density was 1.1 to 24.5 ind/m² (Gomes *et al.*, 1998). Daly and Fautin (2004) described a new endemic species, *Anthopleura mariscali* from the intertidal zone of the islands of Galapagos Archipelago. Fautin *et al.* (2009) documented 16 species of sea anemones belong to the families Actiniidae, Actinodendridae, Aiptasiidae, Boloceroididae, Diadumenidae, Stichodactylidae and Thalassianthidae including a cosmopolitan invasive species *Diadumene lineata* in Singapore. Most of the species under these families are widespread in Indo-Pacific tropics as common intertidal and shallow

subtidal sea anemones in Singapore. Another new species *Anthopleura buddemeieri* described from Fiji and Papua New Guinea occurred in the intertidal zone and the taxonomical remarks on *Anthopleura asiatica* and *Gyaractis sesere* were also given from the same locality (Fautin, 2005). Fautin *et al.* (2007) reported the first inventory of eight species of actinarians represented by families Actiniidae, Actinostolidae, Aiptasiidae, Hormathiidae and Isophellidae from Galapagos Islands. Again, Fautin *et al.* (2008) documented 19 species of sea anemones from the Moreton Bay, eastern Australia based primary on specimens observed and collected during the Moreton Bay International Marine Biological Workshop in February 2005. Investigations on sea anemones of Panama coast resulted with 26 species, of which 14 species belonging to the order Actiniaria found in Pacific coast of Panama, while 11 species recorded from Caribbean coast of Panama and one species *Calliactis polypus* found to be new record to Panama (Garese *et al.*, 2009). Recently fourteen species of sea anemones of the orders Actiniaria and Corallimorpharia were observed greater than the depth of 1000 meters in the waters of the northeastern Pacific Ocean (Eash-Loucks and Fautin, 2012). Acuna *et al.*, (2013) has updated the inventory of sea anemones of Costa Rica to 16 species with the addition of 8 new records identified from Caribbean and Pacific coasts of Costa Rica and compared with the occurrence of 26 species of sea anemone in Panama. The study concluded that except *Anthopleura elegantissima*, *Anthopleura nigrescens*, *Nemanthus californicus*, *Alicia mirabilis*, *Lebrunia coralligens* and *Phialoba steinbecki* all other species are common to both the countries.

As evinced by scant literature, though India having 7600 km long coastline, studies on sea anemones in Indian waters are very limited, except the studies made by Annandale (1907 & 1915), Panikkar (1936, 1937a-c, & 1939) and Parulekar (1966, 1967, 1968, 1969a, b & 1971). However, these studies have discontinuously been

investigated and are better known through new species and new genera, rather than the magnitude and diversity of the fauna itself (Parulekar, 1990). Parulekar (1990) has enumerated 40 species of sea anemones belonging to 33 genera under 17 families from India, of which 13 species were reported for the first time. Out of 40 species, 24 species inhabit in marine, 13 species in estuarine, while 3 species are common to both the habitats. The actinarian sea anemone fauna of India is so far known from few places viz. West Bengal (Port Canning), Orissa (Chilka lake), Tamil Nadu (Adyar backwaters and Gulf of Mannar), Kerala (Cochin backwaters and Ashtamudi lake), Gujarat (Gulf of Kachchh), Maharashtra (Mumbai, Malvan), Goa, northern Karnataka and Andaman and Nicobar Islands. Probably since from the description of two new species *Edwardsia jonessi* Seshaiya and Cutress, 1969 from Porto Novo and *Paracondylactis sagarensis* Battacharya, 1979 in India, no species has been added in the sea anemone list of India. The studies on sea anemones of Andaman and Nicobar Islands are *terra incognita* except few reports. The Indian sea anemones were listed by Parulekar (1990) includes *Anthoplerua panikkarii*, *Bunodactis nicobarica* and *Parabunodactis inflexibilis* from Andaman and Nicobar Islands. Madhu and Madhu (2007) reported the occurrence of 10 species of sea anemones at 14 sites from Andamans. The present study provides the illustrated data on the diversity and distribution of sea anemones in Andaman and Nicobar Islands with their diagnostic features and also compilation of the known occurrence of sea anemones around Indian seas with existing literatures.

MATERIAL AND METHODS

Surveys on the occurrence of sea anemones along the fringing reefs of North Andaman, Middle Andaman, South Andaman, Richiès Archipelago, Mahatma Gandhi Marine National Park (MGMNP), Little Andaman and Nicobar regions in Andaman and Nicobar Islands (Fig.1)

were conducted during 2009-2012 from intertidal to the subtidal region up to the depth of 40 meters while undertaking coral reef monitoring studies under the project of National Coral Reef Research Institute sponsored by Ministry of Environment and Forests, Government of India. The specimens of different species were observed and studied in subtidal areas by snorkeling and at greater depth with SCUBA devices. Underwater photographs of all the observed sea anemones were made by the digital cameras with underwater housing. The collected specimens were narcotized with magnesium chloride to expand their polyps and tentacles before preserving them in 80% ethyl alcohol. The coordinates of the study area were collected using GARMIN 12 Channel GPS.

Species Identification

Sea anemone colour pattern can be important for field identification, but colour itself, being highly variable in most actinian sea anemones, is of little diagnostic value. Symbiotic algae may affect anemone colour, either by imparting their own golden brown colour, or by stimulating the animal to produce a pigment that protects the algae against excessive sunlight (Fautin and Allen, 1992). The external characters of the sea anemones were observed in the field itself and for some specimens the species confirmation was made by studying anatomy under a stereo-zoom microscope in the laboratory. The species level identification of all the species were made following the published literatures and monographs (Fautin and Allen, 1992; Gomes *et al.*, 1998; Fautin *et al.*, 2009; Eash-Loucks and Fautin, 2012).

Statistical applications

The species diversity of sea anemones was calculated according to the Shanon-Weiner formula.

$$H' = - \sum P_i \log_e P_i$$

Where P_i = proportion of the i th species in the collection and H' = Diversity of a theoretically infinite population.

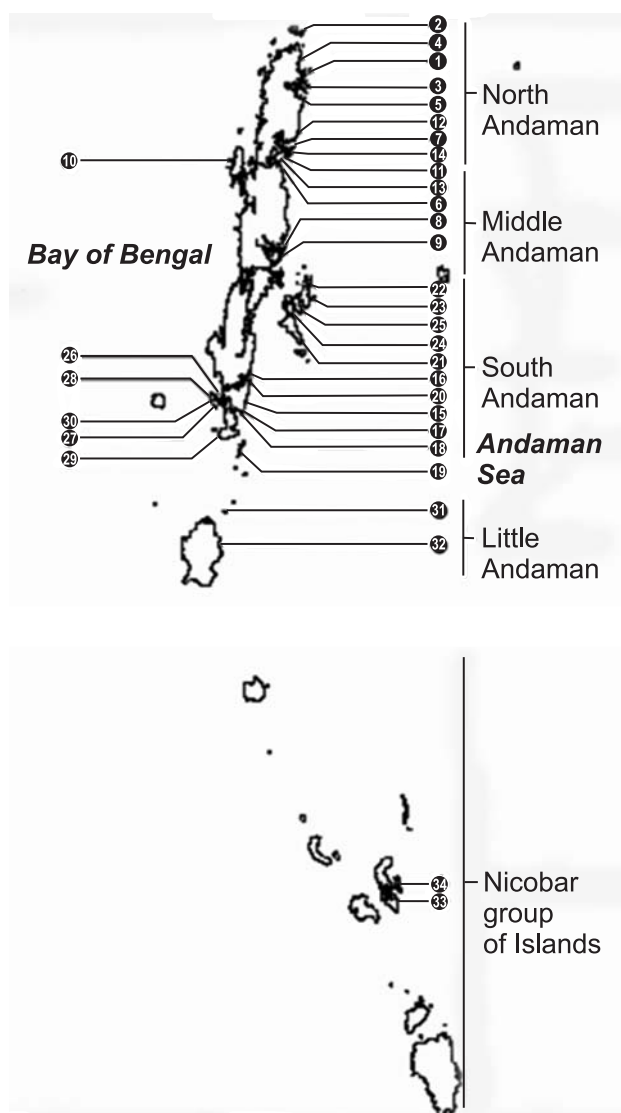


Fig. 1. Map showing study sites in Andaman and Nicobar Islands.

[1-Diglipur, 2-East Island, 3-Ross & Smith Island, 4-Kalipur beach, 5-Twin Island, 6-Mayabunder, 7-Sound Island, 8-Long Island, 9-Guitar Island, 10-Interview Island, 11-Carlew Island, 12-Oliver Island, 13-Avis Island, 14-Rail Island, 15-Burmanallah, 16-North Bay, 17-Pongibalu, 18-Chidiyatapu, 19-Cinque Island, 20-Sinclair's Bay, 21-Havelock Island, 22-South Button Island, 23-Inglis Island, 24-Peel Island, 25-Henry Lawrence Island, 26-Grub Island, 27-Boat Island, 28-Jolly Buoy Island, 29-Rutland Island, 30-Tarmugli Island, 31-South Brother Island, 32-Dugong creek, 33-Nancowry, 34-Trinket Island]

Similarity Index was calculated using the formula.

$$QS = (2C/A + B)$$

Where, A and B are the species numbers in

samples A and B respectively and C is the number of species shared by the two samples.

RESULTS

Diversity of Sea anemones in Andaman and Nicobar Islands

The present study revealed 15 species of Actiniarian sea anemones belonging to 11 genera and 8 families along the areas surveyed in 6 regions of Andaman and Nicobar Islands (Table 1). Of which, five species viz. *Actinodendron glomeratum* Hadden, 1898; *Calliactis miriam* Hadden and Shackleton 1893; *Anthopleura handi* Dunn, 1978; *Phymanthus buitendijki* Pax, 1924; *Telmatactis decora* (Hemprich and Ehrenberg in Ehrenberg, 1834) are new records to India. The diversity of sea anemones found to be maximum in South Andaman and it was represented by 9 species under 8 genera and 5 families with H' value of 0.98, whereas, minimum density was reported at both Little Andaman and Nicobar, where 4 species under 3 genera and 3 families with H' value of 0.55. Among the species found, *Cryptodendrum adhaesivum* and *Heteractis magnifica* were the only species found in all the regions. The *Entacmaea quadricolor* and *Heteractis crispa* were distributed in most of the regions, except Nicobar and South Andaman respectively. Nine species were found restricted to one particular region of the study area (Table 1), which are *Actinodendron glomeratum* in Ritchie's Archipelago (Havelock and South Button Islands); *Boloceroide mcmurricchi* in Nicobar (Nancowry Islands); *Calliactis miriam*, *Anthopleura handi*, *Phymanthus buitendijki* and *Telmatactis decora* in South Andaman (Burmanallah, Pongibalu, North Bay and Chidiyatapu), *Macroactyla doreensis* in Middle Andaman (Mayabunder and Avis Island); *Stichodactyla gigantea* in MGMNP (Jolly Buoy and Tarmugli Islands); *Stichodactyla merternsii* in North Andaman (Diglipur and Ross & Smith Islands). The occurrence of *H. magnifica* was found in hundreds at a depth of 20m in Nancowry Islands. The density and distribution of other species were sporadic in nature.

Table 1. Diversity and Distribution of sea anemones in Andaman and Nicobar Islands

Sl. No.	Order/Family/Genus/Species	North Andaman	Middle Andaman	South Andaman	Ritchie's Archipelago	MGMNP	Little Andaman	Nicobar
	Order: Actiniaria Family: Actinodendronidae Hadden, 1898 Genus: <i>Actinodendron</i> de Blainville, 1830							
1.	<i>Actinodendron glomeratum</i> Hadden, 1898*				xxi, xxii			
	Family: Boloceroidae Carlgren, 1924 Genus: <i>Boloceroides</i> Carlgren, 1899							
2.	<i>Boloceroides mcmurrici</i> (Kwietniewski, 1898)							xxxiii
	Family: Hormathiidae Carlgren, 1932 Genus: <i>Calliactis</i> Verrill, 1869							
3.	<i>Calliactis miriam</i> Hadden and Shackleton, 1893*			xv				
	Family: Thalassianthidae Milne Edwards, 1857 Genus: <i>Cryptodendrum</i> Klunzinger, 1877							
4.	<i>Cryptodendrum adhaesivum</i> Milne Edwards, 1857	i, ii, iii, iv	vi, vii, viii, ix	xvi, xvii, xviii, xix	xxi	xxvi, xvii	xxxi	xxxiii
	Family: Actiniidae Rafinesque, 1815 Genus: <i>Entacmaea</i> Ehrenberg, 1834							
5.	<i>Entacmaea quadricolor</i> (Rueppel and Leuckar, 1828)	i, ii, v	vi, ix, x, xi, xii	xvi, xvii, xviii, xix	xxi	xxvi, xxvii, xxviii, xxix	xxxii	
	Genus: <i>Macrodactyla</i> Haddon, 1898							
6.	<i>Macrodactyla dorensis</i> (Quoy and Gaimard, 1833)		vi, xiii					
	Genus: <i>Anthopleura</i> Duchassaing de Fombressin & Michelotti, 1860							
7.	<i>Anthopleura handi</i> Dunn, 1978*			xiv, xvii, xviii				
	Family: Stichodactylidae Andres, 1863 Genus: <i>Heteractis</i> Milne Edwards, 1857							
8.	<i>Heteractis aurora</i> (Quoy and Gaimard, 1833)			xvii		xxix		
9.	<i>Heteractis crispa</i> (Hemprich and Ehrenberg in Ehrenberg, 1834)	i, v	vi, xiv		xxi, xxiii, xxiv, xxv	xxix	xxxi	xxxiii
10.	<i>Heteractis magnifica</i> (Quoy and Gaimard, 1833)	i, ii, iii, v.	vi, vii, x, xi, xii, xiii,	xvi, xvii, xviii, xix	xxi	xxviii, xxvi, xxvii, xxix	xxxii	xxxiii, xxxiv

Table 1. contd.

Sl. No.	Order/Family/Genus/Species	North Andaman	Middle Andaman	South Andaman	Ritchie's Archipelago	MGMNP	Little Andaman	Nicobar
	Genus: <i>Stichodactyla</i> Brandt, 1835							
11.	<i>Stichodactyla gigantea</i> (Forskal, 1775)					xxviii, xxx		
12.	<i>Stichodactyla haddoni</i> (Saville-Kent, 1893)	i, iii.	vi, vii	xvi, xx		xxix		
13.	<i>Stichodactyla merternsii</i> (Brandt, 1835)	i, iii.						
	Family: Phymanthidae Andress, 1833 Genus: <i>Phymanthus</i> Milne Edwards, 1857							
14.	<i>Phymanthus buitendijki</i> Pax, 1924*			xvi, xvii				
	Family: Isophellidae Stephenson, 1935 Genus: <i>Telmatactis</i> Gravier, 1916							
15.	<i>Telmatactis decora</i> (Hemprich and Ehrenberg in Ehrenberg, 1834)*			xviii				
	Number of species	6	6	9	5	7	4	4
	Number of genera	4	5	8	4	4	3	3
	Number of families	3	3	5	4	4	3	3
	Species Diversity (H')	0.72	0.76	0.98	0.65	0.80	0.55	0.55

MGMNP- Mahatma Gandhi Marine National Park; * New record to Indian waters.

[i-Diglipur, ii-East Island, iii-Ross & Smith Island, iv-Kalipur beach, v-Twin Island, vi-Mayabunder, vii-Sound Island, viii-Long Island, ix-Guitar Island, x-Interview Island, xi-Carlew Island, xii-Oliver Island, xiii-Avis Island, xiv-Rail Island, xv-Burmanallah, xvi-North Bay, xvii-Pongibalu, xviii-Chidiyatapu, xix-Cinque Island, xx-Sinclair's Bay, xxi-Havelock Island, xxii-South Button Island, xxiii-Inglis Island, xxiv-Peel Island, xxv-Henry Lawrence Island, xxvi-Grub Island, xxvii-Boat Island, xxviii-Jolly Buoy Island, xxix-Rutland Island, xxx-Tarmugli Island, xxxi-South Brother Island, xxxii-Dugong creek, xxxiii-Nancowry, xxxiv-Trinket Island].

Distribution of Sea anemones in India

Table 2 depicts the updated list of Actinarian sea anemones in India with the existing reports of Parulekar (1990) and Madhu and Madhu (2007). The present paper provides the detailed distribution of 54 species of sea anemones belonging to 40 genera and 20 families in India. Sea anemones of Lakshadweep waters are not included in this list as no published reports available from this archipelago. Among the species reported, a maximum of 32 species belonging to 29 genera and 17 families found distributed in west coast of India, while 19 species under 16 genera and 11 families distributed in east coast of India and 19 species, out of 13 genera and 8 families were observed in Andaman and Nicobar Islands. *Metridium senile* and *Stichodactyla gigantea* were the only species distributed in both west and east

coasts of Indian peninsula as well as Andaman and Nicobar Islands. It is fascinating to note that except these two species, other 16 species of sea anemones are restricted to Andaman and Nicobar Islands as they were not found in east and west coasts of India, however, *Anthopleura panikkari* reported from west coast as well as South Andaman. Furthermore, 11 species such as *Cirrinopsis robertii*, *Paracondylactis sinensis*, *Boloceractis gopalayi*, *Diadumense schilleriana*, *Edwardsia tinctoria*, *Pelecoetes exul*, *Phytoetes gangeticus*, *Stephensonactis ornata*, *Metapeachia tropica*, *Nevadne glauca* and *Phymanthus loligo* distributed in both east and west coasts of India (Table 2). The species diversity (H') of sea anemones in India varied from 1.53 at Andaman and Nicobar Islands to 2.20 at west coast of India.

Table 2. Diversity and Distribution of sea anemones in India

(Data compiled from Parulekar, 1989; Madhu and Madhu, 2007; and the present study of ZSI)

Sl. No.	Order/Family/Genus/Species	West Coast	East Coast	Andaman and Nicobar Islands
	Order: Actiniaria Family: Acontiophoriidae, Carlgren 1938 Genus: <i>Acontiophorum</i> Carlgren, 1938			
1.	<i>Acontiophorum bombayensis</i> Parulekar, 1968	Mumbai, Malvan and Karwar		
	Family: Actiniidae Rafinesque, 1815 Genus: <i>Actinogeton</i> Carlgren, 1938			
2.	<i>Gyractis sesere</i> (Haddon & Shackleton, 1893)	Mumbai (Cuffe Parade)		
	Genus: <i>Entacmaea</i> Ehrenberg, 1834			
3.	<i>Entacmaea quadricolor</i> (Rueppel and Leuckart, 1828)			North, Middle, South and Little Andaman, Ritchie's Archipelago and MGNP
	Genus: <i>Anemonia</i> Risso, 1826			
4.	<i>Anemonia indica</i> Parulekar, 1968	Gulf of Kachchh, Maharashtra, Goa and North Karnataka		
	Genus: <i>Anthopleura</i> Duchassaing de Fonbressin and Michelotti, 1860			
5.	<i>Anthopleura asiatica</i> Uchida and Muramatsu, 1958	Mumbai, Malavan and Anjidiv Island		
6.	<i>Anthopleura midori</i> Uchida and Muramatsu, 1958	Maharashtra, Goa, and North Karnataka		
7.	<i>Anthopleura pacifica</i> Uchida and Muramatsu, 1958	Mumbai, Malvan and Goa		
8.	<i>Anthopleura panikkarii</i> Parulekar, 1969	Maharashtra, Goa, North Karnataka and Kerala (Vizhinjam)		South Andaman (Port Blair)
9.	<i>Anthopleura handi</i> Dunn, 1978			South Andaman
	Genus: <i>Bunodactis</i> Verrill, 1869			
10.	<i>Bunodactis nicobarica</i> Carlgren, 1928			Andaman Sea

Table 2. contd.

Sl. No.	Order/Family/Genus/Species	West Coast	East Coast	Andaman and Nicobar Islands
	Genus: <i>Bunodosoma</i> Verrill, 1899			
11.	<i>Bunodosoma granulifera</i> Leseur, 1917	Mumbai		
	Genus: <i>Cribrinopsis</i> Carlgren, 1921			
12.	<i>Cribrinopsis robertii</i> Parulekar, 1971	Maharashtra and Goa	Mandapam and Tuticorin	
13.	<i>Cribrinopsis</i> sp.	Mumbai		
	Genus: <i>Glyphoperidium</i> Roule, 1909			
14.	<i>Glyphoperidium bursa</i> Roule, 1909	Off Southwest coast		
	Genus: <i>Glyphostylum</i> Roule, 1909			
15.	<i>Glyphostylum calyx</i> Roule, 1909	Off southwest coast and Lakshadweep Sea		
	Genus: <i>Parabunodactis</i> Carlgren, 1928			
16.	<i>Parabunodactis inflexibilis</i> Carlgren, 1928			Andaman Sea
	Genus: <i>Paracondylactis</i> Carlgren, 1928			
17.	<i>Paracondylactis sinensis</i> Carlgren, 1934	Bombay and Gujarat (Sikka)	Gangetic delta	
18.	<i>Paracondylactis sagarensis</i> Bhattacharya, 1979		Sagar Island, Sunderbans	
	Genus: <i>Macrodactyla</i> Haddon, 1898			
19.	<i>Macrodactyla doreensis</i> (Quoy & Gaimard, 1833)			Middle Andaman
	Family: Actinodendronidae Haddon, 1898 Genus: <i>Actinodendron</i> de Blainville, 1830			
20.	<i>Actinodendron glomeratum</i> Haddon, 1898			Ritchie's Archipelago
	Family: Actinostoiidae Carlgren, 1938 Genus: <i>Bathydactylus</i> Carlgren, 1928			
21.	<i>Bathydactylus valdiviae</i> Carlgren, 1928	Off west coast		
	Family: Aiptasiidae Carlgren, 1924 Genus: <i>Aiptasia</i> Gosse, 1858			
22.	<i>Aiptasia</i> sp.	Mumbai		
	Genus: <i>Neoaipiasia</i> Parulekar, 1969			
23.	<i>Neoaipiasia commensali</i> Parulekar, 1969	Padmagad		

Table 2. *contd.*

Sl. No.	Order/Family/Genus/Species	West Coast	East Coast	Andaman and Nicobar Islands
	Family: Aiptasiomorphidae (Stephenson, 1920) Genus: <i>Haliplanella</i> Hand, 1956			
24.	<i>Haliplanella lineata</i> (Verrill, 1870)	Gulf of Kachchh, Mumbai, Central and southwest coast		
	Family: Aliciidae (Duerden, 1897) Genus: <i>Alicia</i> Johnson, 1861			
25.	<i>Alicia sansibarensis</i> Carlgren, 1900	Central and southwest coast		
	Family: Boloceroidae Carlgren, 1924 Genus: <i>Boloceractis</i> Panikkar, 1937			
26.	<i>Boloceractis gopalayi</i> Panikkar, 1937	Cochin backwaters and Asthamudi Lake	Chennai	
	Genus: <i>Bolocerooides</i> Carlgren, 1899			
27.	<i>Bolocerooides mcmurrichi</i> Kwiteriewski, 1898	Central west-coast		
	Genus: <i>Bunodeopsis</i> Andres, 1881			
28.	<i>Bunodeopsis</i> sp.		Chennai	
	Family: Diadumeneidae (Stephenson, 1920) Genus: <i>Diadumene</i> Stephenson, 1920			
29.	<i>Diadumene schilleriana</i> Stoliczka, 1863	West coast in general	Tuticorin, Mandapam, Chandipur and Digha	
	Family: Edwardsiidae Andres, 1880 Genus: <i>Edwardsia</i> Quatrefages, 1842			
30.	<i>Edwardsia jonesii</i> Seshaiya & Curtress, 1969		Port Novo (Tamil Nadu)	
31.	<i>Edwardsia tinctoria</i> Annandale, 1915	Mumbai, Malvan and Goa	Chennai, Chilka Lake	
	Family: Halcampidae Andreas, 1883 Genus: <i>Halcampa</i> Gosse, 1858			
32.	<i>Halcampa capensis</i> Carlgren, 1938	Northwest coast		
	Genus: <i>Mena</i> Stephenson, 1920			
33.	<i>Mena limnicola</i> Annandale, 1915		Chilka Lake and Balramghadi (Odisha)	

Table 2. contd.

Sl. No.	Order/Family/Genus/Species	West Coast	East Coast	Andaman and Nicobar Islands
	Family: Haliactiidae Carlgren, 1949 Genus: <i>Pelocoetes</i> Annandale, 1915			
34.	<i>Pelocoetes exul</i> (Annandale, 1915)	Gulf of Cambay, Mumbai, Malvan, Goa estuaries, and Cochin backwaters	Chennai and Gangetic delta	
35.	<i>Pelocoetes minima</i> Panikkar, 1939		Chennai and Sagar Island	
	Genus: <i>Phytocoetes</i> Annandale, 1915			
36.	<i>Phytocoetes gangeticus</i> Annandale, 1915	West coast in general	East coast in general	
	Genus: <i>Phytocoetopsis</i> Panikkar 1936			
37.	<i>Phytocoetopsis ramunni</i> Panikkar, 1936		Chennai	
	Genus: <i>Stephensonactis</i> Panikkar, 1936			
38.	<i>Stephensonactis ornata</i> Panikkar, 1936	West coast in general	East coast in general	
	Family: Haloclavidae Verrill, 1899 Genus: <i>Metapeachia</i> Carlgren, 1943			
39.	<i>Metapeachia tropica</i> Panikkar, 1938	Mumbai, Malvan and Goa	Kurusadai Island in Gulf of Mannar	
	Family: Hormathiidae Carlgren, 1932 Genus: <i>Calliactis</i> Verrill, 1869			
40.	<i>Calliactis miriam</i> Haddon & Shackleton, 1893			South Andaman
	Genus: <i>Paraphellia</i> Haddon, 1889			
41.	<i>Paraphellia sanzoi</i> Colabresi, 1926	Gulf of Kachchh		
	Family: Isophelliidae Stephenson, 1935 Genus: <i>Telmatactis</i> Gravier, 1916			
42.	<i>Telmatactis decora</i> (Hemprich and Ehrenberg in Ehrenberg, 1834)			South Andaman
	Family: Metridiidae (Carlgren 1893) Genus: <i>Metridium</i> de Blainville, 1824			
43.	<i>Metridium senile</i> (Linnaeus, 1761)	West coast in general	East coast in general	South Andaman (Port Blair)
	Family: Nevadneidae, Carlgren 1925 Genus: <i>Nevadne</i> Stephenson, 1922			
44.	<i>Nevadne glauca</i> Annandale 1915	Goa estuaries	Chilka Lake	

Table 2. *contd.*

Sl. No.	Order/Family/Genus/Species	West Coast	East Coast	Andaman and Nicobar Islands
	Family: <i>Phymanthidae</i> Andres, 1883 Genus: <i>Phymanthus</i> Milne Edwards, 1857			
45.	<i>Phymanthus buitendijki</i> Pax, 1924			South Andaman
46.	<i>Phymanthus loligo</i> Hand E Ehrenberg 1834	Gulf of Kachchh	Gulf of Mannar	
	Family: <i>Stichodactylidae</i> Andres, 1883 Genus: <i>Heteractis</i> Milne Edwards, 1857			
47.	<i>Heteractis aurora</i> (Quoy and Gaimard, 1833)			South Andaman and MGMNP
48.	<i>Heteractis crispa</i> (Hemprich & Ehrenberg in Ehrenberg, 1834)			North, Middle and Little Andaman, MGMNP, Ritchie's Archipelago and Nicobar
49.	<i>Heteractis magnifica</i> (Quoy and Gaimard, 1833)			North, Middle, South and Little Andaman, MGMNP, Ritchie's Archipelago and Nicobar
50.	<i>Heteractis malu</i> (Haddon & Shackleton, 1893)			South, Middle, and North Andaman
	Genus: <i>Stichodactyla</i> Brandt, 1835			
51.	<i>Stichodactyla gigantea</i> (Forskål, 1775)	Gulf of Kachchh	Gulf of Mannar	MGMNP
52.	<i>Stichodactyla haddoni</i> (Saville-Kent, 1893)			North, Middle and South Andaman, and MGMNP
53.	<i>Stichodactyla mertensii</i> (Brandt, 1835)			North Andaman
	Family: <i>Thalassianthidae</i> Milne Edwards, 1857 Genus: <i>Cryptodendrum</i> Klunzinger, 1877			
54.	<i>Cryptodendrum adhaesivum</i> Milne Edwards, 1857			South, Middle, and North Andaman
	Number of species	32	19	19
	Number of genera	29	16	13
	Number of families	17	11	8
	Species Diversity (H')	2.20	1.62	1.53

Similarity Index

The data calculated for species similarity index on the distributional pattern of sea anemones in Andaman and Nicobar Islands and the other region of India are given in Tables 3 and 4. In Andaman and Nicobar Islands, the maximum similarity of species (0.89) was observed between Ritchie's Archipelago & Little Andaman, while minimum (0.43) was found between South Andaman & MGMNP. However, in Indian coast, it showed 0.51 as maximum between West & East coasts and minimum (0.11) between East coast & Andaman and Nicobar Islands. The index clearly indicated that no definite degree of sea anemones distribution in Indian seas as it found occurred sporadically.

Table 3. Similarity Index of Sea anemones distribution in Andaman and Nicobar Islands

	North Andaman	Middle Andaman	South Andaman	Ritchie's Archipelago	MGMNP	Little Andaman	Nicobar Islands
North Andaman		0.83	0.53	0.73	0.62	0.80	0.60
Middle Andaman			0.53	0.73	0.77	0.80	0.60
South Andaman				0.43	0.50	0.62	0.46
Ritchie's Archipelago					0.67	0.89	0.67
MGMNP						0.73	0.55
Little Andaman							0.75
Nicobar Islands							

Table 4. Similarity Index of Sea anemones distribution in India

	West Coast	East Coast	A&N Islands
West Coast		0.51	0.12
East Coast			0.11
A&N Islands			

Morphology of Sea anemones

In general, sea anemones are cylindrical in shape. The lower end of the animal has a pedal disc which will help for the firm attachment with solid substratum especially rock, dead coral and often buried in sediment. Middle of the upper end is the mouth and the hollow tentacles arising from the oral disc surround it. The tentacles number may be few to hundreds and arranged in circlets which is the distinguished characters for species identification. Normally tentacles are short or long, thin or thick, pointed or blunt and globular or tree like. The cylindrical column of the sea anemones is tapered towards the pedal end and the oral disc is greater in diameter. The column of the animals may be patterned as splotches of colours or longitudinal stripes. Presence or absences of verrucae and an arrangement of tentacles are the characters defining the genera (Fautin and Allen,

1992). Thus, all species in a particular genus do (e.g. *Stichodactyla*) or do not (e.g. *Entacmaea*) have verrucae. There may be one tentacle per space between mesenteries or more than one tentacle between each two mesenteries. Members of the Actiniidae have one tentacle per space while Stichodactylidae and Thalassianthidae can have so many tentacles because up to several, radially arrayed rows of tentacles arise from alternate spaces (the endocoels), whereas only one tentacle arises from other spaces (exocoels). The single tentacle is positioned at the extreme margin of the oral disc. This arrangement may be obvious, when the animals are well extended (Fautin and Allen, 1992). Though the occurrence of 19 species of sea anemones reported, the morphological features of 15 species recorded during the present study are illustrated herewith for field identification of live specimens.

Phylum CNIDARIA

Class ANTHOZOA

Order ACTINIARIA

Family ACTINIIDAE Rafinesque, 1815

Genus *Anthopleura* Duchassaing de Fombressin
& Michelotti, 1860

1. *Anthopleura handi* Dunn, 1978 (Fig. 2)



Fig. 2. *Anthopleura handi*

1978. *Anthopleura handi* Dunn (Original description)

Diagnostic characters: Oral disc is small; tentacles are moderately long and tapered at the tip. Verrucae is not prominent to which pieces of shell and gravels adhere at the distal part. Oral disc is dark brown in colour, mouth raised on the cone. Tentacles are transparent with prominent irregular lines (spots) can be seen on upper side and they are broad at the base and tapered at the tip. Column is white in colour, firmly attached with substratum.

Distribution: India: Andaman and Nicobar

Islands: Pongibalu (Lat. 11° 31. 030'N, Long. 92° 39.159'E), Chidiyatapu (Lat. 11° 29. 460'N, Long. 92° 42.530'E) and Burmanallah (Lat. 11° 33. 468'N, Long. 92° 43.873'E). *Elsewhere:* Singapore, Malaysia, Australia and New Zealand.

Depth: 2-3m

Remarks: Mostly attached on manmade structures i.e. seawall and jetty. The occurrence of *Anthopleura handi* Dunn, 1978 in Andaman and Nicobar Islands is a new distributional record to Indian waters.

Genus *Entacmaea* Ehrenberg, 1834

2. *Entacmaea quadricolor* (Rüppell & Leuckart, 1828) Fig. 3

1828. *Actinia quadricolor* Leuckart in Rüppell & Leuckart, (Original description)

1981. *Entacmaea quadricolor* Dunn.

Diagnostic characters: Pedal disc is well developed, usually narrower than oral disc. Column is 500mm long, flared, without verrucae, typically rich brown but may be greenish or reddish. The tentacles are 100mm long, cylindrical, bulbous, usually with a pear-shape or smooth and tapered all over the surface of the oral disc; inner tentacles 2-3 times longer than marginal; most of the tentacles forms near to margin; typically brown with greenish cast and pink or purple tip; tentacle usually with bulb at or somewhat below tip may have white equator. Tentacles without bulbs are blunt-ended a white ring where equator would form. Bulb seems to be related to presence of fish. Oral disc is flat; brown, greenish or pink in colour with radial white stripes around the mouth. Animal commonly attached deeply in crevice or hole, so that only emergent tentacles visible.

Distribution: India: Andaman and Nicobar Islands: Havelock Is. (Lat. 12° 00. 005'N, Long. 92° 56.808'E), Interview Is. (Lat. 12° 59. 125'N, Long. 92° 42.981'E), Carlew Is. (Lat. 12° 56. 084'N, Long. 92° 53.378'E), Oliver Is. (Lat. 12°59.585'N, Long. 092°58.154'E), East Is. (Lat. 13°38.172'N, Long. 93°02.572'E), Twins Is. (Lat. 13°25.671'N, Long. 93°05.938'E), Long Is. (Lat.

12°21.749'N, Long. 93°55.410'E), Guitar Is. (Lat. 12°21.136'N, Long. 92°55.218'E), North Bay (Lat. 11° 42. 068'N, Long. 92° 45.116'E), Pongibalu (Lat. 11° 31. 030' N, Long. 92° 39.159'E), Jolly Buoy Is. (Lat. 11° 30. 251'N, Long. 92° 32.591'E), Rutland Is. (Lat. 11° 25. 504'N, Long. 92° 40.301'E), Grub Is. (Lat. 11° 35. 391'N, Long. 92° 35.637'E), Boat Is. (Lat. 11° 30.464'N, Long. 92° 33.242'E), Chidiyatapu (Lat. 11° 29. 460'N, Long. 92° 42.530'E), Cinque Is. (Lat. 11° 18.660'N, Long. 092° 42.570'E), Dugong creek in Little Andaman (Lat. 10° 48. 385'N, Long. 92° 64.000'E). *Elsewhere*: Micronesia and Melanesia to East Africa and the Red Sea and from Australia to Japan.

Depth: 1-25m



Fig. 3. *Entacmaea quadricolor* (Rüppell & Leuckart, 1828)

Remarks: Found in reef environments; pedal end attached in crevices of rock or corals; hence the animal could be seen, when the tentacles expanded. *Entacmaea quadricolor* is a host for

anemone fishes *Amphiprion bicinctus*, *A. clarkii*, *A. ephippium*, *A. frenatus*, *A. melanopus* and *Premnas biaculeatus* in Andaman and Nicobar Islands.

Genus *Macrodactyla* Haddon, 1898

3. *Macrodactyla doreensis* (Quoy & Gaimard, 1833) Fig. 4

- 1830. *Actinia doreensis* de Blainville.
- 1833. *Actinia doreensis* Quoy & Gaimard, (Original description).
- 1857. *Paractis doreensis* Milne Edwards.
- 1883. *Cereactis doreensis* Andres.
- 1893. *Condylactis gelam* Haddon & Shackleton, (Original description)
- 1898. *Aulactinia gelam* Haddon.
- 1949. *Anthopleura gelam* Carlgren.
- 1972. *Radianthus gelam* Allen.
- 1972. *Macrodactyla gelam* Mariscal.
- 1973. *Radianthus gelam* Allen.
- 1976. *Radianthus malu* Moyer
- 1981. *Macrodactyl adoreensis* Dunn.
- 1987. *Heteractis gelam* Cutress & Arneson
- 2001. *Antheopsis gelam* Uchida & Soyama.

Diagnostic characters: Pedal disc distinct, circular and narrower than oral disc, buried in sand or muddy substrate. The colour is brown to orange, have distinctive white spots on their foot. The anemone has a tube shaped soft squishy body. Column with adhesive verrucae distally, without marginal spherule, up to 150mm long, distal end broadly flared; lower part dull orange to brilliant red, upper part brownish with non-adhesive, prominent white circular to eye shaped verrucae in longitudinal rows. Tentacles few (around 100-200 in numbers), sparse, 175 mm long, tapering to slender tip, some with corkscrew form. Each pointed tentacles grey with pink or mauve tip, may have longitudinal white streak. Tentacles are more concentrated at the margin of oral disc, few tentacles scattered on oral disc closer to mouth. Oral disc is on central, lipped mouth; sometimes on an elevated cone, widely flared, 500mm diameter with radial white lines that may extend onto tentacles.

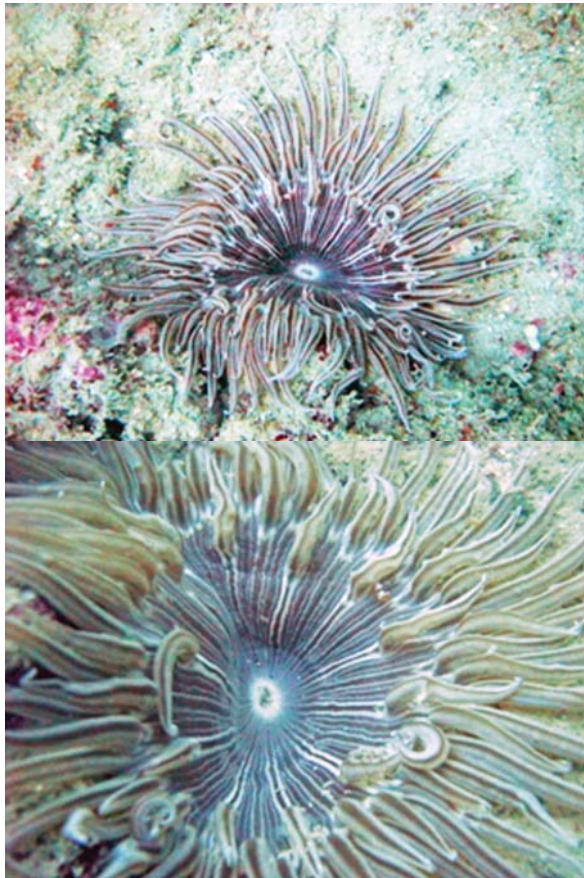


Fig. 4. *Macrodictyla doreensis* (Quoy & Gaimard, 1833)

Distribution: India: Andaman and Nicobar Islands: Avis Island (Lat. 12° 56. 210'N, Long. 92° 33.066'E). **Elsewhere:** Japan south to New Guinea and northern Australia.

Depth: 9-11m

Remarks: Found in deep waters, buried in sediments. *Macrodictyla doreensis* is a host for anemone fishes *Amphiprion chrysogaster*, *A. clarkii*, *A. perideraion* and *A. polymnus* in Andaman and Nicobar Islands.

Family ACTINODENDRONIDAE Haddon, 1898

Genus *Actinodendron* de Blainville, 1830

4. *Actinodendron glomeratum* Haddon, 1898 (Fig. 5)

Diagnostic characters: The tentacles are branched, long with a leaf shaped or feather-like appearance with each tentacle having a space in between, cream in colour, thick at base with

grayish to green in colour. Pedal column that buried in rubble or sand, but only the oral disc and the tentacles are visible. Oral disc projects inward, circular, filled with dark spots. Each tentacle has a cluster of vesicles that look like a cauliflower.

Distribution: India: A&N Islands: South Button Is. (Lat. 12° 13. 467'N, Long. 92° 01.334'E) **Elsewhere:** Fiji, Marshall Islands and Australia.

Depth: 15-23m



Fig. 5. *Actinodendron glomeratum* Haddon, 1898

Remarks: Look more like colonies of soft corals, buried in sand. *Actinodendron glomeratum* from Andaman and Nicobar Islands is a first record to Indian waters.

Family BOLOCEROIDAE Carlgren, 1924

Genus *Bolocerooides* Carlgren, 1899

5. *Bolocerooides mcmurrici* Kwitewski, 1898 (Fig. 6)

Diagnostic characters: Column smooth, thin-

walled, semi-transparent, about to very small in length. Tentacles are thick at the base, tapering to slender tips, transparent with white or cream transverse stripes; tentacles number variable (usually around 400). Inner tentacles are much longer than marginal ones. The tentacles hide the small oral disc and the mouth which is on a cone. Some have a white band on the oral disc across the mouth. Sometimes, two of the tentacles near the mouth are prominently lighter. Pedal disc is present but, weakly adherent.



Fig. 6. *Bolocerooides mcmurrici* Kwitewski, 1898

Distribution: India: Central West-Coast of India, and Andaman and Nicobar Islands: Nancowry Is. (Lat. 08° 02. 151'N, Long. 93° 33.182'E). *Elsewhere:* Indonesia, Hawaiian Islands and Red Sea.

Depth: 6-8m

Remarks: Mostly found in sandy and sea grass environments, often confused with sea grasses.

Family HORMATHIIDAE Carlgren, 1932

Genus *Calliactis* Verrill, 1869

6. *Calliactis miriam* Haddon & Shackleton, 1893 (Fig. 7)

Diagnostic characters: Pedal disc is well developed, the body column smooth, without verrucae, 10-15 mm long, brightly coloured; usually purple in colour; middle part of column with white spot and white lines are radiated towards distal column. Oral disc is flat and circular. Tentacles are small, sturdy and transparent.



Fig. 7. *Calliactis miriam* Haddon & Shackleton, 1893

Distribution: India: Andaman and Nicobar Islands: Burmanallah (Lat. 11° 33. 468'N, Long. 92° 43.873'E). *Elsewhere:* Micronesia, Panama, Philippines and America.

Depth: Intertidal

Remarks: Attached on gastropod shell (hermit crab); may be more than one anemone in a shell.

Family: ISOPHELLIIDAE Stephenson, 1935

Genus *Telmatactis* Gravier, 1916

7. *Telmatactis decora* (Hemprich and Ehrenberg in Ehrenberg, 1834) Fig. 8

Diagnostic characters: Oral disc is very small, mouth present on the cone and cone occupies 2/3 of oral disc. There are two types of tentacles in this species, big tentacles arranged near to cone and the small ones occurred in outer. All the tentacles are thick, blunt tips forming bulbs, from the base to middle of the tentacles are white in colour, remaining parts are coloured with irregular brown stripes, base of the tentacles are brownish grey in colour. Column is long, prominent verrucae and brown in colour.

Distribution: India: Andaman and Nicobar Islands: Chidiyatapu (Lat. 11° 29. 460'N, Long. 92° 42.530'E). *Elsewhere:* Maldives and Seychelles.

Depth: 0-6m



Fig. 8. *Telmatactis decora* (Hemprich and Ehrenberg in Ehrenberg, 1834)

Remarks: Usually found on rocks and dead corals. *Telmatactis decora* from Andaman and Nicobar Islands is a new record to Indian waters.

Family PHYMANTHIDAE Andres, 1883

Genus *Phymanthus* Milne Edwards, 1857

8. *Phymanthus buitendijki* Pax, 1924 (Fig. 9)

Diagnostic characters: Column is smooth, inconspicuous verrucae and bluish grey in colour. Oral disc is dark greenish blue, mouth located on the cone in most of the animals, oral disc covered with sediments. Tentacles are arranged in 2 or 3 orders at periphery of the oral disc. Tentacles are long, tapered tips, small flower like projections attached right to the tentacles, arranged alternatively, highly branched and brightly coloured. Purple lines between oral disc and tentacle tip. Most of the tentacles are curved inward which looks like fishing hook.

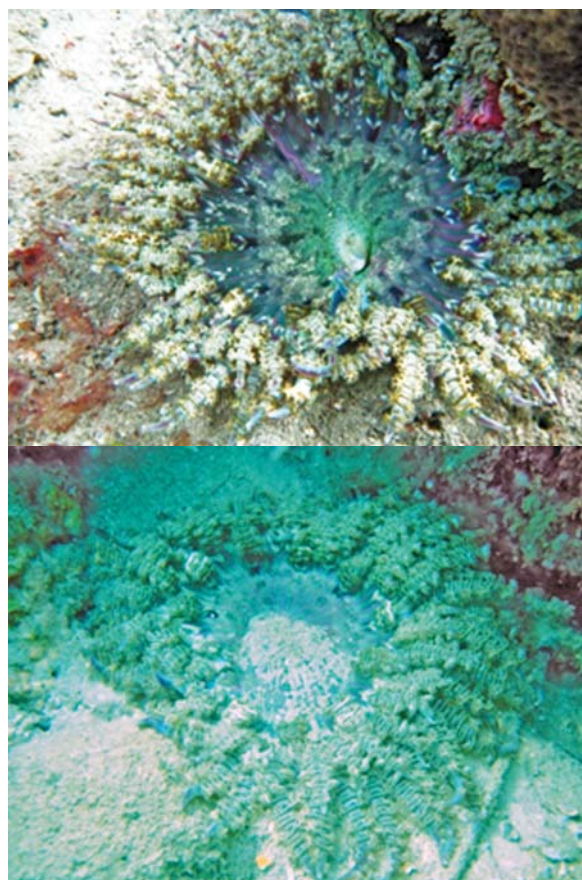


Fig. 9. *Phymanthus buitendijki* Pax, 1924

Distribution: India: Andaman and Nicobar Islands: North Bay (Lat. 11° 42. 068'N, Long. 92° 45.116'E) and Pongibalu (Lat. 11° 31. 030'N, Long. 92° 39.159'E). **Elsewhere:** Indonesia.

Depth: 0-2m

Remarks: *Phymanthus buitendijki* is a new record to India through Andaman and Nicobar Islands.

Family STICHODACTYLIDAE Andres, 1883

Genus *Heteractis* Milne Edwards, 1857

9. *Heteractis aurora* (Quoy and Gaimard, 1833) Fig. 10

1972. *Radianthus koseirensis* (Mariscal 1970)

1976. *Radianthus simplex* (Allen 1972, Moyer)

1975. *Bartholomea* sp. (Uchida)

Diagnostic characters: The sticky foot at the pedal end adheres to various surface; upper column lighter in colour with adhesive verrucae, whereas

lower column mottled or solid orange or red in colour. Tentacles are up to 50mm long, sticky with white spots which enlarge into bead-like swellings; tapered to point that may be magenta in colour. These swelling run entire length of tentacles forming as 'strings of bead' like appearance. The tentacles can be brown, tan, various shades of green, purple with white markings, arising from oral disc of the similar colour; inner tentacles much longer than marginal ones. Oral disc is broad, up-to 250mm or possibly more, spread flat or slightly undulating at surface of sediment. The tentacles are relatively sparse; and larger portion of the oral disc is exposed. The disc has often white radiating lines continued onto tentacles.



Fig. 10. *Heteractis aurora* (Quoy and Gaimard, 1833)

Distribution: India: Andaman and Nicobar Islands: Pongibalu (Lat. 11° 31. 030'N, Long. 92° 39.159'E) and Rutland Is. (Lat. 11° 25. 504'N, Long. 92° 40.301'E). **Elsewhere:** Micronesia and Melanesia to East Africa and the Red Sea, Australia and Ryukyu Island.

Depth: 2-6m

Remarks: Found in sandy environments. *Heteractis aurora* is a host to anemone fishes such as *Amphiprion bicinctus*, *A. chrysogaster* and *A. frenatus* in Andaman and Nicobar Islands.

10. ***Heteractis crispa*** (Hemprich & Ehrenberg in Ehrenberg, 1834) Fig. 11



Fig. 11. *Heteractis crispa* (Hemprich & Ehrenberg in Ehrenberg, 1834)

1834. *Actinia (Entacmaea) crispa* Hemprich & Ehrenberg in Ehrenberg, (Original description)

1846. *Actinia poumatensis* Couthouy in Dana, (Original description)

1893. *Radianthus kukenthali* Haddon & Shackleton, (Original description)

1896. *Discosoma macrodactylum* Kwietniewski, (Original description)

Diagnostic characters: The sticky foot at the base of pedal column adheres to various substrata. Column is grey in colour, leathery in texture, flared at oral end, prominent adhesive verrucae with raised rim; lower part rarely mottled with

yellow, buried in sediment and the oral disc lies at surface of sediment. Tentacles up to 45 mm long, typically intertwined, numerous in number (around 800), tapered at tip, sometimes blue or mauve tip. Oral disc flat, 500 mm long, usually brownish violet or grey, rarely bright green, mouth is elongated.

Distribution: India: Andaman and Nicobar Islands: Inglis Is. (Lat. 12° 08. 639'N, Long. 93° 06.786'E), Peel Is. (Lat. 12° 03.315'N, Long. 92° 59.929'E), Henry Lawrence Is. (Lat. 12° 05. 000'N, Long. 93° 06.312'E), Rail Is. (Lat. 12° 56. 860'N, Long. 92° 54.620'E), Twin Is. (Lat. 13°25.671'N, Long. 93°05.938' E), Rutland Is. (Lat. 11° 25. 504'N, Long. 92° 40.301'E), South brother Is. (Lat. 10° 55. 830'N, Long. 92° 07.023'E), and Kardeep of Nancowry Is. (Lat. 08° 02. 151'N, Long. 93° 33.182'E). *Elsewhere:* French Polynesia, Micronesia and Melanesia to the Red Sea, Australia and Japan.

Depth: 5-15m

Remarks: Found in reef environment; attached to dead corals and rocks. *Heteractis crispa* is a host for anemone fishes *Amphiprion bicinctus*, *A. ephippium*, *A. melanopus*, *A. percula*, *A. perideraion*, *A. polymnus* and *A. sandaracinos* in Andaman and Nicobar Islands.

11. ***Heteractis magnifica*** (Quoy and Gaimard, 1833) Fig. 12

1830. *Actinia magnifica* de Blainville.

1833. *Actinia magnifica* Quoy & Gaimard.

1857. *Corynactis magnifica* Milne Edwards.

1883. *Roplactis magnifica* Andres.

1898. *Helianthopsis ritteri* Kwietniewski.

1900. *Helianthopsis mabrucki* Carlgren, (Original description)

1922. *Radianthus mabrucki* Stephenson.

1922. *Antheopsis ritteri* Stephenson.

1930. *Anemone* sp. Verwey.

1949. *Radianthus ritteri* Carlgren.

1972. *Radianthus paumotensis* Friese.

1978. *Radianthus malu* Allen.

1981. *Heteractis magnifica* Dunn.

1987. *Heteractis ritteri* Cutress & Arneson.

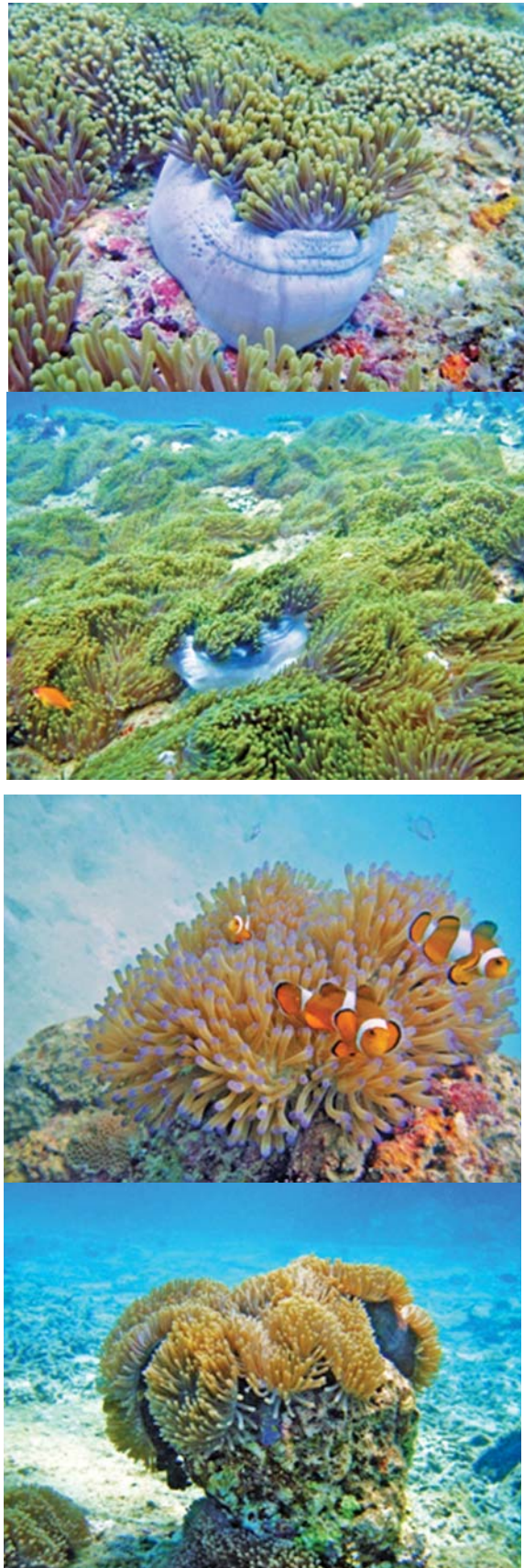


Fig. 12. *Heteractis magnifica* (Quoy and Gaimard, 1833)

Diagnostic characters: Sticky foot at the base of pedal column that adhere to various surface such as coral boulder, foot is larger than column, fully exposed. Column cylindrical, with distal verrucae, intensely coloured (commonly avocado green, blue, red, white, chestnut brown and magenta). The tentacles all over the surface of the oral disc, moderately long tentacles (to 75mm long), finger shaped that topped with spherical or bulb shaped tips which are lighter and usually colored an iridescent yellowish green. Oral disc flat with 1m diameter, gently undulating, tend to be brown, but can be green, yellow or white and mouth in the centre of the oral disc; may be raised in the cone.

Distribution: India: Andaman and Nicobar Islands: Havelock Is. (Lat. 12°00.005'N, Long. 92°56.808'E), Interview Is. (Lat. 12° 59.125'N, Long. 92°42.981'E) Carlew Is. (Lat. 12°56.084'N, Long. 92° 53.378'E), Avis Is.(Lat. 12° 56.210'N, Long. 92° 33.066'E), Rail Is. (Lat. 12° 56.860'N, Long. 92° 54.620'E), Sound Is. (Lat. 12° 56. 084'N, Long. 92°57.345'E), Oliver Is. (Lat. 12°59.585'N, Long. 092°58.154'E), East Is. (Lat. 13°38.172'N, Long. 93°02.572'E), Ross & Smith Is. (Lat.13°18.406'N, Long. 93° 04.207'E), Twin Is. (Lat. 13°25.671'N, Long. 93°05.938'E), Long Is. (Lat. 12°21.749'N, Long. 93°55.410'E), Guitar Is. (Lat. 12°21.136'N, Long. 92°55.218'E), North Bay (Lat. 11° 42.068'N, Long. 92°45.116'E), Pongibalu (Lat. 11° 31.030'N, Long. 92° 39.159'E), Jolly Buoy Is. (Lat. 11° 30.251'N, Long. 92°32.591'E), Rutland Is.(Lat. 11°25.504'N, Long. 92°40.301'E), Grub Is. (Lat. 11°35.391'N, Long. 92°35.637'E), Boat Is. (Lat. 11°30.464'N, Long. 92°33.242'E), Chidiyatapu (Lat. 11° 29.460'N, Long. 92° 42.530'E), Cinque Is. (Lat. 11°18.660'N, Long. 092° 42.570'E), Dugong Creek in Little Andaman (Lat. 10° 48.385'N, Long. 92° 64.000'E) and Trinket Is. (Lat. 08° 02.806'N, Long. 93° 34.556'E). *Elsewhere:* French Polynesia to East Africa and Australia to the Ryukyu Island.

Depth: 0-18m

Remarks: Often found associated with

Heteractis crista and found in rocky environments. *H. magnifica* is a host to anemone fishes *Amphiprion akallopisos*, *A. bicinctus*, *A. chrysogaster*, *A. clarkii*, *A. ephippium*, *A. frenatus*, *A. melanopus*, *A. ocellaris*, *A. percula*, *A. perideraion*, *A. sandaracinos* and *Premnas biaculeatus* in Andaman and Nicobar Islands.

Genus *Stichodactyla* Brandt, 1835

12. *Stichodactyla gigantea* (Forskål, 1775)

Fig. 13



Fig. 13: *Stichodactyla gigantea* (Forskål, 1775)

1948. *Discosoma giganteum* (Gohar; Schlichter 1968)

1969. *Stoichactis kenti* (Mariscal, 1970, 1972; Allen 1972, 1973, 1978; Uchida *et al.*, 1975)

Diagnostic characters: Oral disc is thick, wide, smooth, highly folded and bare around the cone; mouth is grey in colour. Tentacles are numerous, small, sturdy, evenly distributed, extremely sticky, tip slightly tapered. Column usually brown, sometimes purple in colour, attached to hard substratum.

Distribution: India: Gulf of Kachchh, Gulf of Mannar, and Andaman and Nicobar Islands: Jolly Buoy Is. (Lat. 11° 30. 251'N, Long. 92° 32.591'E) and Tarmugli Is. (Lat. 11° 33. 261'N, Long. 92° 36.809'E). *Elsewhere:* Micronesia to the Red Sea, and Australia to the Ryukyu Island.

Depth: 0-10m

Remarks: Often found in shallow water and animals may expose during low tide. *Stichodactyla gigantea* is a host to anemone fishes *Amphiprion akallopisos*, *A. bicinctus*, *A. clarkii*, *A. ocellaris*, *A. percula* and *A. perideraion* in Andaman and Nicobar Islands.

13. *Stichodactyla haddoni* (Saville-Kent, 1893)

Fig. 14



Fig. 14. *Stichodactyla haddoni* (Saville-Kent, 1893)

1893. *Discosoma haddoni* Saville-Kent.

1924. *Stoichactis ambonensis* Pax.

1981. *Stichodactyla haddoni* Dunn.

Diagnostic characters: Oral disc is flat, broad, deeply folded with numerous short tentacles which

are highly robust at periphery of disc. Tentacles are grey in colour and adhesive, no tentacles around the mouth, upper side of the oral disc is pale orange and the column is brown in colour.

Distribution: India: Andaman and Nicobar Islands: North Bay (Lat. 11° 42.068'N, Long. 92° 45.116'E), Grub Is. (Lat. 11° 35.391'N, Long. 92° 35.637'E), Sinclair's Bay (Lat. 11°40.057' N, Long. 92°44.587' E), Sound Is.(Lat. 12° 56. 084'N, Long. 92° 57.345'E), Rutland Is.(Lat. 11° 25. 504'N, Long. 92° 40.301'E) and Ross & Smith Is. (Lat.13° 18. 406'N, Long. 93° 04.207'E). *Elsewhere:* Fiji Islands to Mauritius, and Australia to the Ryukyu Island.

Depth: 2-11m

Remarks: It is very similar to *Stichodactyla mertensii*, found in sandy environments. *Stichodactyla haddoni* is a host to anemone fishes *Amphiprion chrysogaster*, *A. clarkii*, *A. frenatus*, *A. polymnus* and *A. sebae* in Andaman and Nicobar Islands.

14. *Stichodactyla mertensii* (Brandt, 1835)

Fig. 15



Fig. 15: *Stichodactyla mertensii* (Brandt, 1835)

1970. *Stoichactis giganteum* (Mariscal, Allen and Mariscal 1971, Allen 1972, 1973, 1975)

Diagnostic characters: Oral disc are flared, thick, slightly undulated, pale in colour. Tentacles are in two types, short tentacles evenly distributed on the oral disc, which is greenish orange in colour and the long ones are pale or white in colour, which are radially arranged from center of the

oral disc to periphery at even distance. All the tentacles are bubble in shape.

Distribution: India: Andaman and Nicobar Islands: Ross & Smith Is. (Lat. 13° 18. 406'N, Long. 93° 04.207'E). *Elsewhere:* Micronesia and Melanesia to East Africa, and Australia to the Ryukyu Island.

Depth: 6-9m

Remarks: Symbiotic fishes may be melanistic. Found in clear water, attached inside the crevices. *Stichodactyla mertensii* is a host to *Amphiprion akallopisos*, *A. merensii*, *A. chrysagaster*, *A. clarkii*, *A. ocellaris* and *A. sandaracinos* in Andaman and Nicobar Islands.

Family: THALASSIANTHIDAE Milne Edwards, 1857

Genus *Cryptodendrum* Klunzinger, 1877

15. *Cryptodendrum adhaesivum* Milne Edwards, 1857 (Fig. 16)

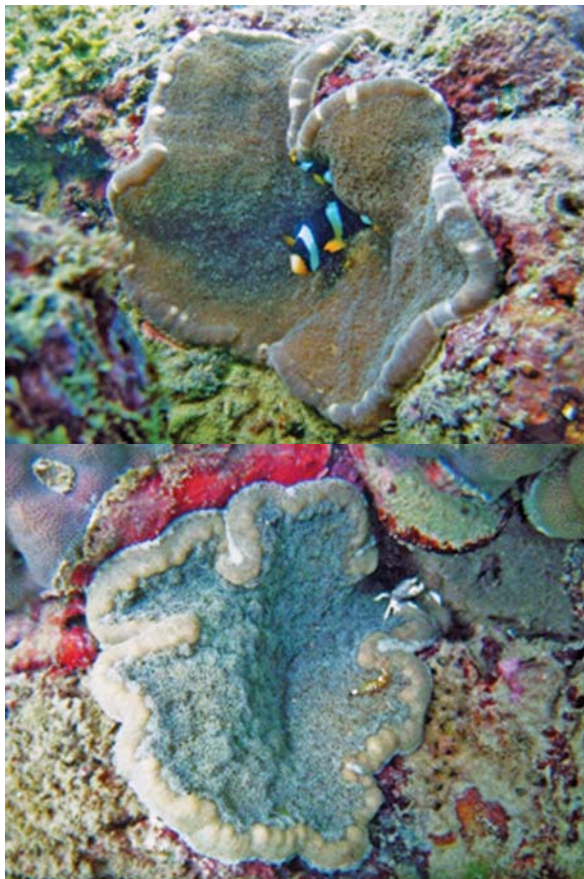


Fig. 16: *Cryptodendrum adhaesivum* Milne Edwards, 1857

1877. *Cryptodendrum adhasivum* Klunzinger, (Original description)

1973. *Stoichactis digitata* Doumenc, (Original description)

Diagnostic characters: The pedal column with sticky foot at the bottom adheres to various surfaces. The body column is brightly coloured; generally smooth with tiny verrucae of the same colour or slightly darker. The pedal column has lines and spots on it. The tentacles on the oral disc are short, tiny and tightly packed. Two different forms of dense sticky tentacles up to 5mm in length; in centre a narrow stalk with five and more short branches at end, whereas at very extreme margin, spherical tentacles with fewer branches. Tentacles of the two forms are blue and grey in colour. The mouth is small, about 1 cm in diameter at the centre of the oral disc. It is usually a contrasting colour to the disc; colour like yellow, white green, or violet.

Distribution: India: Andaman and Nicobar Islands: Havelock Is. (Lat. 12°00.005'N, Long. 92°56.808'E), Sound Is. (Lat. 12°56.084'N, Long. 92° 57.345'E), East Is. (Lat. 13°38.172'N, Long. 93°02.572'E), Ross & Smith Is. (Lat.13° 18.406'N, Long. 93°04.207'E), Kalipur beach (Lat. 13°13.286'N, Long. 93°02.560'E), Long Is. (Lat. 12°21.749'N, Long. 93°55.410'E), Guitar Is. (Lat. 12°21.136'N, Long. 92°55.218'E), North Bay (Lat. 11°42.068'N, Long. 92°45.116'E), Pongibalu (Lat. 11° 31. 030'N, Long. 92° 39.159'E), Grub Is. (Lat. 11° 35. 391'N, Long. 92° 35.637'E), Boat Is. (Lat. 11° 30.464'N, Long. 92° 33.242'E), Chidiyatapu (Lat. 11°29.460'N, Long. 92°42.530'E), Rutland Is. (Lat. 11°25.504'N, Long. 92°40.301'E) South brother Is. (Lat. 10°55. 830'N, Long. 92° 07.023'E) and Nancowry (Lat. 08°02.151'N, Long. 93°33. 182'E). *Elsewhere:* Australia to southern Japan and Polynesia, Micronesia, and Melanesia westward to Thailand, Maldives, and the Red Sea.

Depth: 1-20m

Remarks: Mostly found in shallow water crevices.

DISCUSSION

The present study described 15 species of Actiniarian sea anemones from Andaman and Nicobar Islands out of 19 species recorded as evinced by earlier literatures. The sea anemone fauna of these islands contribute 35.19% of a total of 54 species reported from India. The occurrence of sea anemones identified in the present study was from intertidal region to the maximum depth of 40 m in the reef area. Though nearly 1000 species of sea anemones reported from world waters, only 10 species are host to anemone fishes (Fautin and Allen, 1992). All the 10 host species are found to be occurred in Andaman and Nicobar Islands, of which except *Heteractis malu*, 9 species were observed during the study. Most of the species belonging to family Actiniidae and Stoichactiidae harbour a number of symbiotic species, both algae and invertebrates. Many of the species live as commensal with diverse partners like, zoantharians, corals bivalve and gastropod molluscs barnacles, hermit crabs, cirripedes, polychaete worms, crabs and fishes. These host anemones normally exist only in shallow water, no deeper than 50m because within the cells of an anemone's tentacles and oral disc, live microscopic, single-celled dinoflagellates called zooxanthellae which require sunlight for photosynthesis (Fautin and Allen, 1992).

Out of the 19 species of sea anemones reported in Andaman and Nicobar Islands, only 3 species found in peninsular coast of mainland India, while 16 species were restricted to these islands only. However, among these 16 species 9 species such as *Anthopleura handi*, *Bolocerooides mcmurricchi*, *Cryptodendrum adhaesivum*, *Entacmaea quadricolor*, *Heteractis crispa*, *Heteractis magnifica*, *Macroactyla doreensis*, *Stichodactyla haddoni* and *Stichodactyla gigantea* are shared with their distribution in Singapore waters as reported by Fautin *et al.* (2009). Five species viz., *Actinodendron glomeratum*, *Calliactis miriam*, *Anthopleura handi*, *Phymanthus buitendijki* and *Telmatactis decora* were reported from Andaman and Nicobar Islands through this study, which

are new record to India, however, no endemism of these anemones could be found in these islands. Earlier, *Actinodendron glomeratum* is known from Fiji, Marshall Islands and Australia; *Calliactis miriam* reported from Marshal Island and Australia; *Anthopleura handi* found in Singapore, Malaysia, Australia and New Zealand; *Phymanthus buitendijki* reported at Indonesia; while *Telmatactis decora* was reported from Maldives and Seychelles.

Reporting of 54 species of sea anemones in Indian waters is quite high, when compared with their records in other tropical and subtropical regions such as 16 species from Singapore (Fautin *et al.*, 2009), 16 species from Costa Rica (Acuna *et al.*, 2013), 26 species from Panama (Garese *et al.*, 2009), 14 species from Abyssal plain (> 1000 m depth) of northwestern Pacific Ocean (Eash-Loucks and Fautin, 2012), 15 species from Antarctic and sub-Antarctic waters (Dunn, 1983), 8 species from Galapagos Islands (Fautin *et al.*, 2007), 22 species from Madang Province (Fautin, 1988) and 21 species from Hawaii (Dunn, 1974). Sea anemones reported from India represent diverse ecosystems like fringing mangroves, estuaries, coastal lagoons, rocky foreshores, sandy and muddy intertidal area, continental and oceanic islands, neritic and oceanic waters up to abyssal depths (Parulekar, 1990). Distribution of sea anemones in west coast of India represents 32 species in different ecosystems such as rocky, muddy, mangrove, estuarine, sandy etc., whereas in Andaman and Nicobar Islands itself, the diversity of sea anemones was little high in the coral reef area of South Andaman (9 species). Sea anemones are subjected to environmental factors that influence or determine their distribution, such as the type of substrate and competitiveness for it. The tidal fluctuation is also important because it influences food availability, gametes and larval dispersion and some adaptation is required to resist or avoid wave and current action (Wainwright and Koehi, 1976).

It is recommended that, considering the significance on aquarium trade, medicinal properties, potential of absorbing carbons etc. more

research effort on sea anemones is prerequisite not only in Andaman and Nicobar Islands but also east and west coasts of India and Lakshadweep in order to evolve comprehensive inventory of sea anemones as it plays an integral part of marine biodiversity and ecosystem services.

SUMMARY

Fifteen species of sea anemones were recorded during 2009-12 in the intertidal and sub-tidal regions of Andaman and Nicobar Islands. Of which, five species viz., *Actinodendron glomeratum* Hadden, 1898; *Calliactis miriam* Hadden and Shackleton 1893; *Anthopleura handi* Dunn, 1978; *Phymanthus buitendijki* Pax, 1924; *Telmatactis*

decora (Hemprich and Ehrenberg in Ehrenberg, 1834) are new record to India. Besides, diversity and distribution status of 54 species belonging to 40 genera and 20 families of sea anemones reported in Indian waters is given in the paper. Diagnostic characters of all 15 species of sea anemones identified from Andaman and Nicobar Islands during the study are also provided.

ACKNOWLEDGMENTS

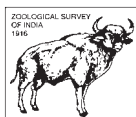
The authors are grateful to the Ministry of Environment and Forests, Government of India for financial support. Researchers of ZSI, Port Blair are duly acknowledged for their assistance in field surveys.

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WOLF SPIDERS OF BANGLADESH-II : GENUS *LYCOSA* LATREILLE (AREANEAE : LYCOSIDAE)

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INTRODUCTION

Spiders of the family Lycosidae (or wolf-spiders) are one of the common ground-dwelling predators of pest insects in different agricultural crops. Pocock (1900), Gravely (1924), Dyal (1935), Tikader (1970, '77a, '77b), Tikader and Biswas (1981), Tikader and Malhotra (1976, '80) and Tikader and Mkerjee (1971) made valuable contributions on the lycosids of Indian Sub-continent.

Recently, Biswas and Biswas (1992), Saha, *et al.* (1994), Majumber (2004, 2005, 2007) in India and Chowdhury and Nagari (1981), Chowdhury and Pal (1984), Biswas *et al.* (1993), Okuma *et al.* (1993), Begum and Biswas (1997) and Biswas and Raychudhuri (2003) recorded and described few lycosids of Bangladesh.

The present paper deals with the genus *Lycosa* Latreille represented by 6 (six) species from Bangladesh. Of these, 3 (three) species namely - *L. gravelyi*, *L. japhlongensis* and *L. picta* are recognised as new to science and the other 3 ones are new record for the country. The new species are described and illustrated. A key to the species together with the generic diagnosis is also provided.

The identity of the species were confirmed from the 'Zoological Survey of India', Kolkata. The types are at present in the collection of the

Department of Zoology, Govt. P.C. College, Bagerhat, Bangladesh and will be deposited to the Museum of the Department of Zoology, University of Dhaka, Bangladesh, in due course of time.

SYSTEMATICS

Genus *Lycosa* Latreille, 1804

1804. *Lycosa* Latreille, *Nouv. Dict., d' Hist. Nat.*, XXIV : 135.

Diagnosis: Cephalothorax rather long with cephalic region raised; ocular quad anteriorly narrowing and posteriorly broad. Labium always longer than wide, basal excavation prominent, usually rd of maxilla. Legs rather long and slender; tibia I and II armed with 3 pairs of ventral spines; IV metatarsi never longer than tibia and patella taken together.

Type-species: *Lycosa tarantula* Rossi.

Distribution: ASIA ; AFRICA ; AUSTRALIA ; AMERICA and EUROPE.

Key to the species

1. Abdomen decorated; without posteriorly pointed dorsal longitudinal band 2
- Abdomen not decorated; atmost with central longitudinal posteriorly pointed whitish band..... 3
2. Cephalothroax on either side with brown longitudinal band, but without any radii (fig. 11); inner and outer margins of chelicerae with

- 3 and 2 teeth respectively (fig. 12); sternum posteriorly produced (fig. 14); maxillae balloon-shaped (fig. 13)..... *mackenziei*
- Cephalothorax without any such band, with few distinct radii (fig. 18); inner and outer margins of chelicerae with 1 and 2 teeth respectively (fig. 19); sternum posteriorly not produced (fig. 21); maxillae cylindroid (fig. 20)..... *picta* n. sp.
 - 3. Abdomen with a whitish dagger-shaped band; leg formula 4213..... 4
 - Abdomen without any such band; leg formula 4123 5
 - 4. Outer margin of chelicerae with 3 teeth (fig. 7); sternum globose (fig. 9); cheliceral fang segmented (fig. 7); epigynum as in fig. 10.. *japhlongensis* n. sp.
 - Outer margin of chelicerae with 2 teeth (fig. 31); sternum elongate (fig. 33); fang not segmented; epigyne as in fig. 34 *tista*
 - 5. Cephalothorax with a distinct 'V'-shaped marking the fovea; radii distinct (fig. 1); outer margin of chelicerae with 2 teeth (fig. 2); sternum heart-shaped, posteriorly with a short projection (fig. 4); ocular quad squarish *gravelyi* n. sp.
 - Cephalothorax without any such marking; radii absent (fig. 24); outer margin of chelicerae with 1 tooth (fig. 25); sternum globose, posteriorly not produced (fig. 27); ocular quad rectangular *shyamae*

1. *Lycosa gravelyi* sp. nov.
(Figs. 1-5)

General : Male : Cephalothorax and legs dark brown; abdomen light brown. Total length 5.00

mm. Carapace 2.00 mm long, 1.90 mm wide; abdomen 3.00 mm long, 2.00 mm wide.

Cephalothorax: Longer than wide, broad, narrowing anteriorly, clothed with few spines; cephalic region raised. Anterior row of eyes straight; 2nd and 3rd row of eyes similar, basally with black patch; ocular quad squarish, a 'V'-shaped structure distinct between the deeply distinct black central fovea and the 3rd row of eyes. Chelicerae broad, moderately strong, each of inner and outer margins with 2 teeth, fang extremely elongated (fig. 2). Maxillae broad and scopulate anteriorly and narrowed posteriorly (fig. 3). Labium bowl-shaped, scopulate (fig. 3). Sternum brown, oval, broad below the middle, pointed posteriorly, clothed with sharp spines (fig. 4). Legs long and strong, covered with fine hairs and spines; leg formula 4123 and the measurements (in mm) as in Table-1. Male palp as in fig. 5.

Abdomen: Broad, elongate, wider posteriorly, clothed with hairs and spines; dorsum anteriorly with a 'V'-shaped markings; ventrally pale.

Female: Unknown.

Holotype: Male in spirit.

Paratype: 1♂, Shikaerpur, Jhenidah, 8.IV, 1993, Coll. V. Biswas.

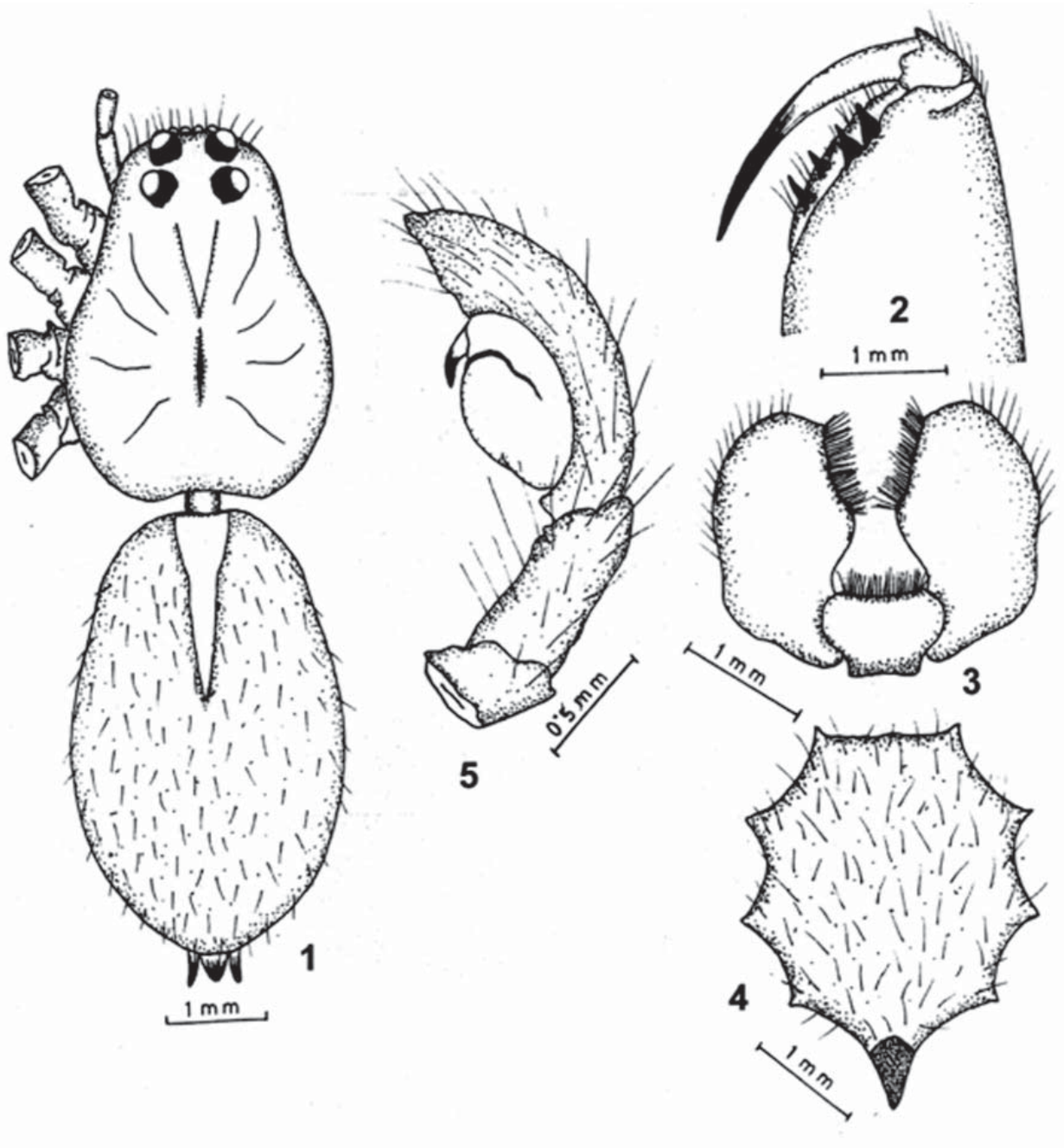
Distribution: BANGLADESH: Bagerhat, Jhenidah (type locality).

Etymology: The species is named after the famous Arachnologist Dr. F.H. Gravely.

Diagnosis: Present species *L. gravelyi* sp. nov. in having anterior row of eyes straight and total length less than 10 mm relates to *L. himalayensis* / *tista* / *distriata* group (Tikader & Malhotra, 1980) but none of the species lack a dorsal longitudinal band on the cephalothorax. Further these species

Table-1. Measurements (mm) of leg segments of male holotype of *Lycosa gravelyi* sp. nov.

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	2.9 / 2.9	0.9 / 0.9	2.4 / 2.4	3.0 / 3.0	1.9 / 1.9	11.10 / 11.10
II	2.8 / 2.8	0.8 / 0.8	2.4 / 2.4	2.9 / 2.9	1.7 / 1.7	10.60 / 10.60
III	2.6 / 2.6	0.6 / 0.6	2.3 / 2.3	2.8 / 2.8	1.7 / 1.7	10.00 / 10.00
IV	3.0 / 3.0	1.0 / 1.0	2.5 / 2.5	3.1 / 3.1	2.0 / 2.0	11.60 / 11.60



Figs. 1-5. *Lycosa gravely* sp. nov.

1. Whole body (dorsal view); 2. Chelicerae; 3. Maxillae and Labium; 4. Sternum; 5. Male palp

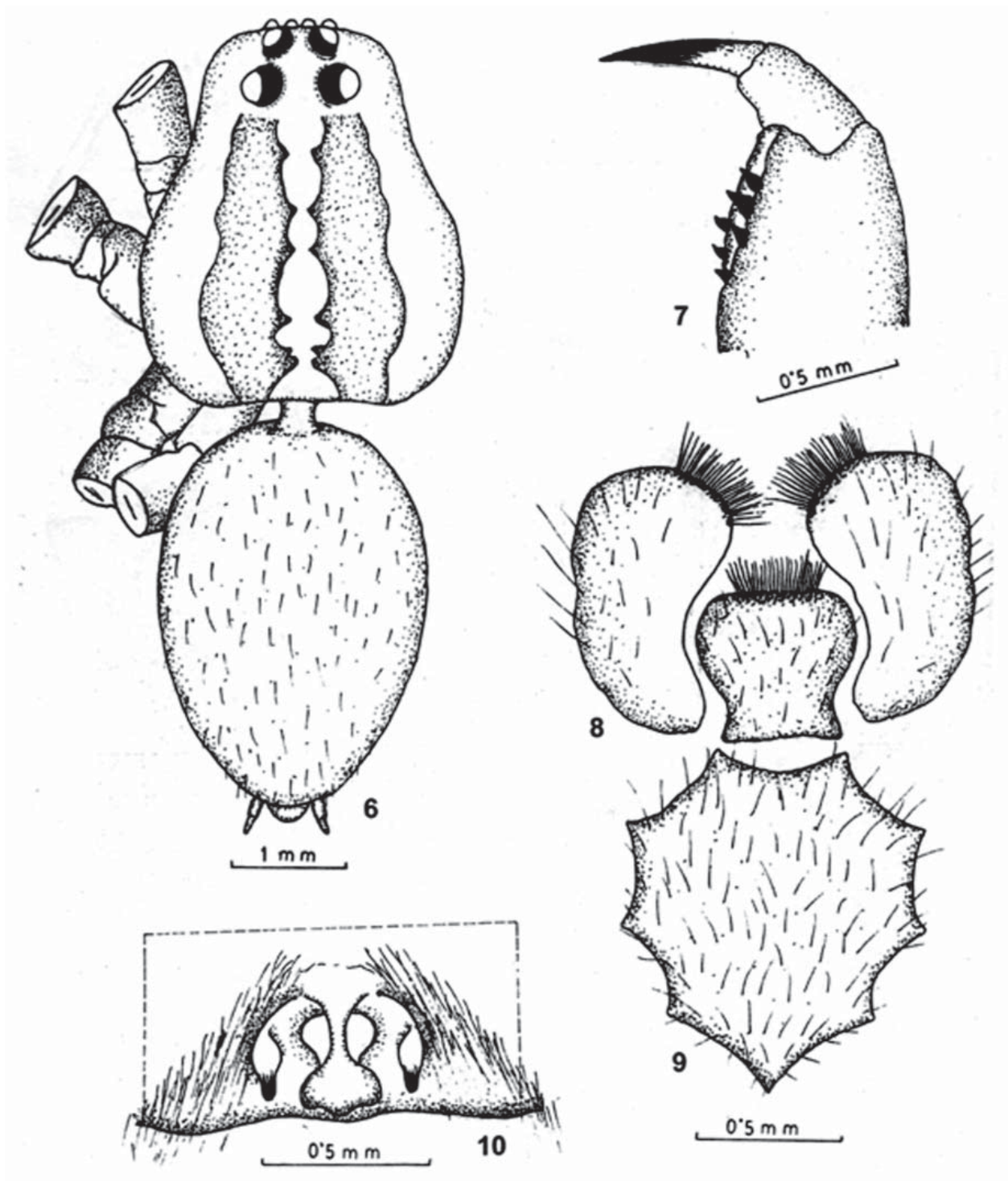
are with weakly to distinctly constricted cephalic region.

The species also shows a general resemblance with that of *L. suzuki* Yaginuma (Yaginuma, 1986; Paik, 1988) but differs in many respect.

The species, in therefore, described as new to science.

2. *Lycosa japhlongensis* sp. nov.
(Figs. 6-10)

General: Female: Cephalothorax and legs dark brown; abdomen yellowish brown with brown hairs and pubescence. Total length 6.30 mm. Carapace 2.50 mm long, 2.20 mm wide; abdomen 3.80 mm long, 4.05 mm wide.



Figs. 6-10. *Lycosa japhlongensis* sp. nov.

6. Whole body (dorsal view); 7. Chelicerae; 8. Maxillae and Labium; 9. Sternum; 10. Epigynum.

Cephalothorax: Light brown, broad, wider basally, narrowing anteriorly, clothed with fine hairs and spines; ocular area blackish. Anterior row of eyes straight; similar, slight longer than 2nd

row; eyes of 2nd and 3rd row with black patches basally; 3rd row of eyes larger and widely placed; ocular quad squarish. Dorsum of cephalothorax with 2 black longitudinal bands extended upto

Table-2. Measurements (mm) of leg segments of holotype of *Lycosa japhlongensis* sp. nov.

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	2.6 / 2.6	0.6 / 0.6	1.8 / 1.8	2.5 / 2.5	1.7 / 1.7	9.20 / 9.20
II	2.8 / 2.8	0.8 / 0.8	2.0 / 2.0	2.6 / 2.6	1.8 / 1.8	10.00 / 10.00
III	2.5 / 2.5	0.5 / 0.5	1.6 / 1.6	2.4 / 2.4	1.6 / 1.6	8.60 / 8.60
IV	3.0 / 3.0	0.9 / 0.9	2.1 / 2.1	2.8 / 2.8	2.0 / 2.0	10.80 / 10.80

the posterior margin. Chelicerae moderately strong, fang segmented, with broad base, each of inner and outer margins with 3 teeth (fig. 7). Maxillae anteriorly wide and scopulate, clothed with spines (fig. 8). Labium broad, vase-shaped, constricted basally, anteriorly wide and scopulate (fig. 8). Sternum globose, middle wide, narrowing posteriorly, covered with few spines (fig. 9). Legs long, strong and slender, covered with spines and hairs; leg formula 4213 and the measurements (in mm) as in Table-2.

Abdomen: Oval, longer than wide, anteriorly broad and posteriorly narrowing; clothed with hairs; ventrally pale, with few brown spots; epigyne as in fig. 10.

Male: Unknown.

Holotype: Female in spirit.

Paratype: 2 ♀, Otherwise data same as for the holotype.

Distribution: BANGLADESH: Japhlong, Sylhet (type locality).

Etymology: The species is named after the type locality.

Diagnosis: The closest rally of the species *L. japhlongensis* sp. nov. seems to be *L. tista* Tikader (Tikader & Malhotra, 1980) because of the presence of straight anterior row of eyes, cephalothorax larger than abdomen, with a median longitudinal band and each of cheliceral margins with 3 teeth. The species stands distinct from the

latter in not having the abdomen overhanging the cephalothorax, 2nd row of eyes larger (3rd row of eyes largest), fang unsegmented and dissimilar epigynum. There is however an apparent simili in the epigynum with that of *L. wulsini* Fox (Fox, 1933).

The species, in therefore, described as new to science.

3. *Lycosa mackenziei* Gravely

(Figs. 11-17)

1924. *Lycosa mackenziei* Gravely, *Rec. Indian Mus.*, **26**: 606.

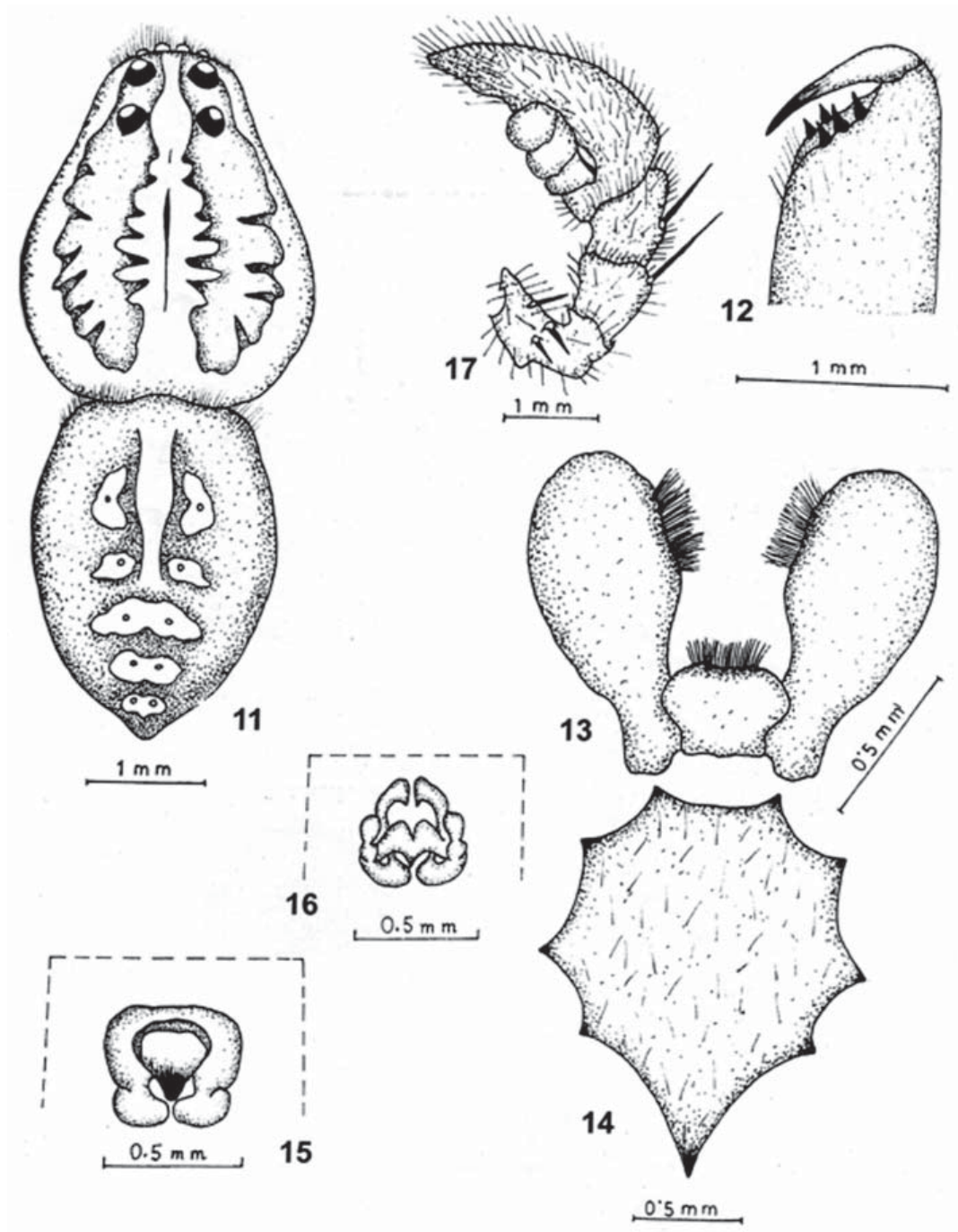
1980. *Lycosa mackenziei*: Tikader & Malhotra, *Faua of India*, Spiders (Lycosidae), **1(2)**: 419.

2009. *Lycosa mackenziei*: Biswas, *Flora & Fauna of Bangladesh*, Arachnida, **18(1)**: 221.

2014. *Lycosa mackenziei*: Platnick, *World Spider Catalogue*, Version 14.5. American Museum of Natural History, New York.

Material examined: 2 ♀, Faridpur, 12.III.1992, Coll. V. Biswas; 1 ♀, Dumuria, Khulna, 8.IX.1991, Coll. V. Biswas; 1 ♀, 1 ♂, Khajura, Jessore, 3.VII.1990, Coll. V. Biswas; 2 ♂, Mymensingh, 18.IX.1991, Coll. V. Biswas; 1 ♀, 1 ♂, Pirojpur, Rangpur, 17.VIII.1992, Coll. V. Biswas.

Distribution: BANGLADESH: Faridpur, Jessore, Khulna, Mymensingh, Pirjopur, Rajshahi and Rangpur; INDIA; PAKISTAN (Tikader and Malhotra, 1980)



Figs. 11-17. *Lycosa mackenziei* Gravely

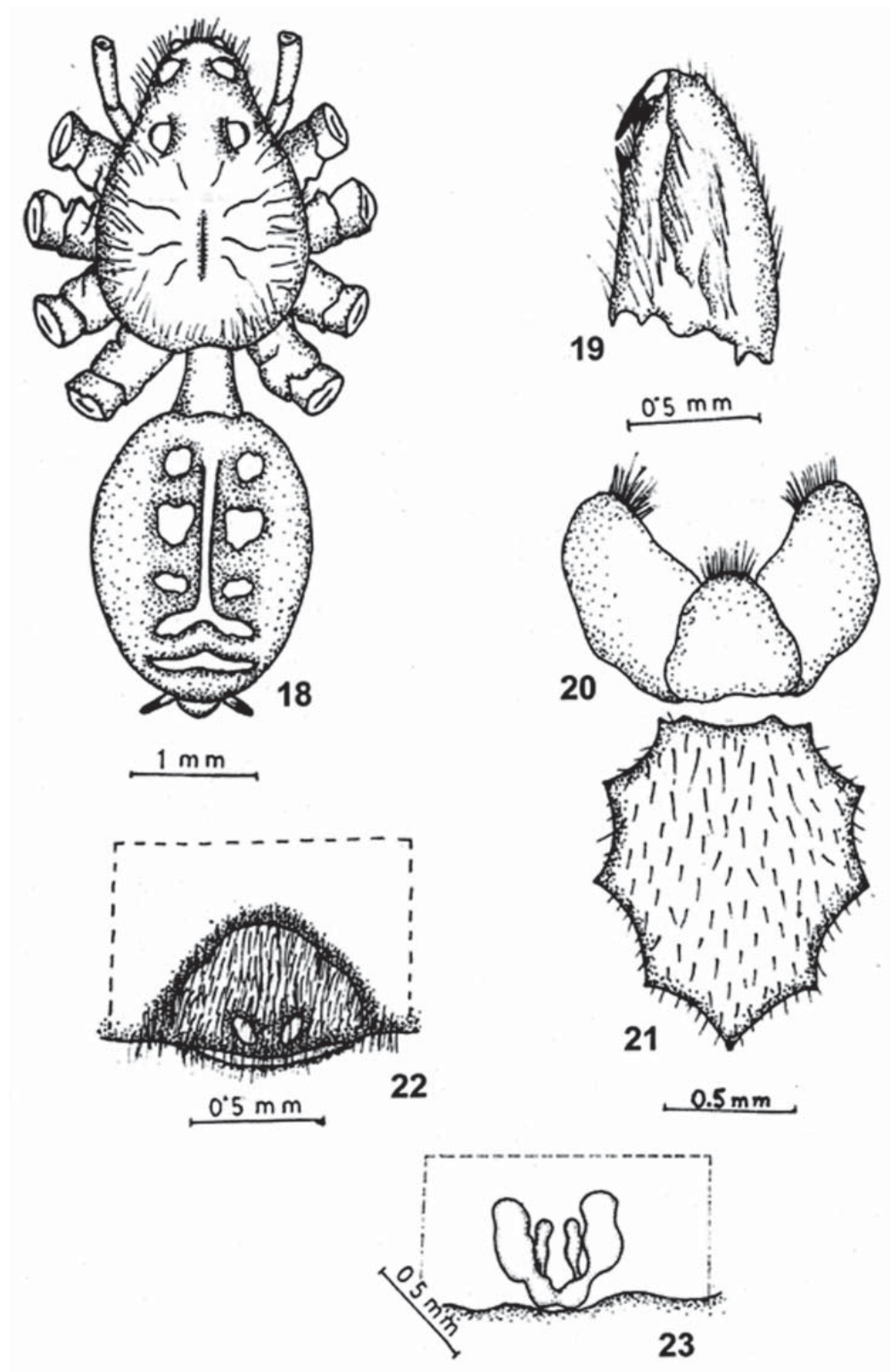
11. Whole body (dorsal view); 12. Chelicerae; 13. Maxillae and Labium; 14. Sternum;
15. Epigynum; 16. Internal genitalia; 17. Male palp

4. *Lycosa picta* sp. nov.
(Figs. 18-23)

General : Female : Cephalothorax pale brown; leg yellow with brown patches and abdomen brown black. Total length 6.30 mm. Carapace

2.30 mm long, 2.10 mm wide; abdomen 4.00 mm long, 3.00 mm wide.

Cephalothorax: Ovoid, narrowing anteriorly, basally wide, longer than wide, clothed with hairs and pubescence; cephalic region raised with



Figs. 18-23. *Lycosa picta* sp. nov.

18. Whole body (dorsal view); 19. Chelicerae; 20 Maxillae and Labium;
21. Sternum; 22. Epigynum; 23. Internal genitalia

ocular area brownish. Anterior row of eyes slightly recurved, similar; eyes of 2nd and 3rd rows similar

and widely placed; ocular quad black, rectangular, posteriorly broad. Thoracic region medially with

Table-3. Measurements (mm) of leg segments of holotype of *Lycosa picta* sp. nov.

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	3.0 / 3.0	0.9 / 0.9	2.4 / 2.4	3.0 / 3.0	2.4 / 2.4	11.70 / 11.70
II	2.8 / 2.8	0.6 / 0.6	2.2 / 2.2	2.7 / 2.7	2.1 / 2.1	10.40 / 10.40
III	2.9 / 2.9	0.8 / 0.8	2.3 / 2.3	2.9 / 2.9	2.3 / 2.3	11.20 / 11.20
IV	3.1 / 3.1	1.0 / 1.0	2.5 / 2.5	3.1 / 3.1	2.5 / 2.5	12.20 / 12.20

dark brown fovea; radii distinct; on either side with longitudinal brown band extending upto the base; lateral edges with brown markings; clothed with fine hairs and pubescence. Chelicerae brown, rather strong, inner margin with 2 teeth and outer margin with 1 tooth (fig. 19). Maxillae brown, cylindroid, longer than wide, anteriorly scopulate (fig. 20). Sternum yellow, medially broad and narrowing interiorly, clothed (fig. 21). Labium brown, basally broad, anteriorly narrowing and scopulate (fig. 20) with spine (fig. 21). Legs long and slender, covered with spines and hairs; leg formula 4132 and the measurement (in mm) as in Table-3.

Abdomen: Oval, posteriorly blunt, clothed with hairs and spines; dorsum decorated with yellowish patches; epigyne and internal genitalia as in figs. 22 and 23.

Male: Unknown.

Holotype: Female in spirit.

Paratype: 1 ♀, Otherwise data same as for the holotype.

Distribution: BANGLADESH : Pirojpur (type locality).

Etymology: The species is named due to the blackish nature of the body.

Diagnosis: The very typical epigynum of the

species *L. picta* sp. nov. separates it out from the Indian congeners that are with straight or nearly straight anterior row of eyes (Tikader and Malhotra, 1980). The species does not show any resemblance to the other congeneric species known from elsewhere (Paik, 1988; Yaginuma, 1986; Chen & Zhang, 1991; Shikai & Takano, 1984; Koh, 1989; Thanka, 1990).

The species, in therefore, described as new to science.

5. *Lycosa shyamae* Tikader (Figs. 24-29)

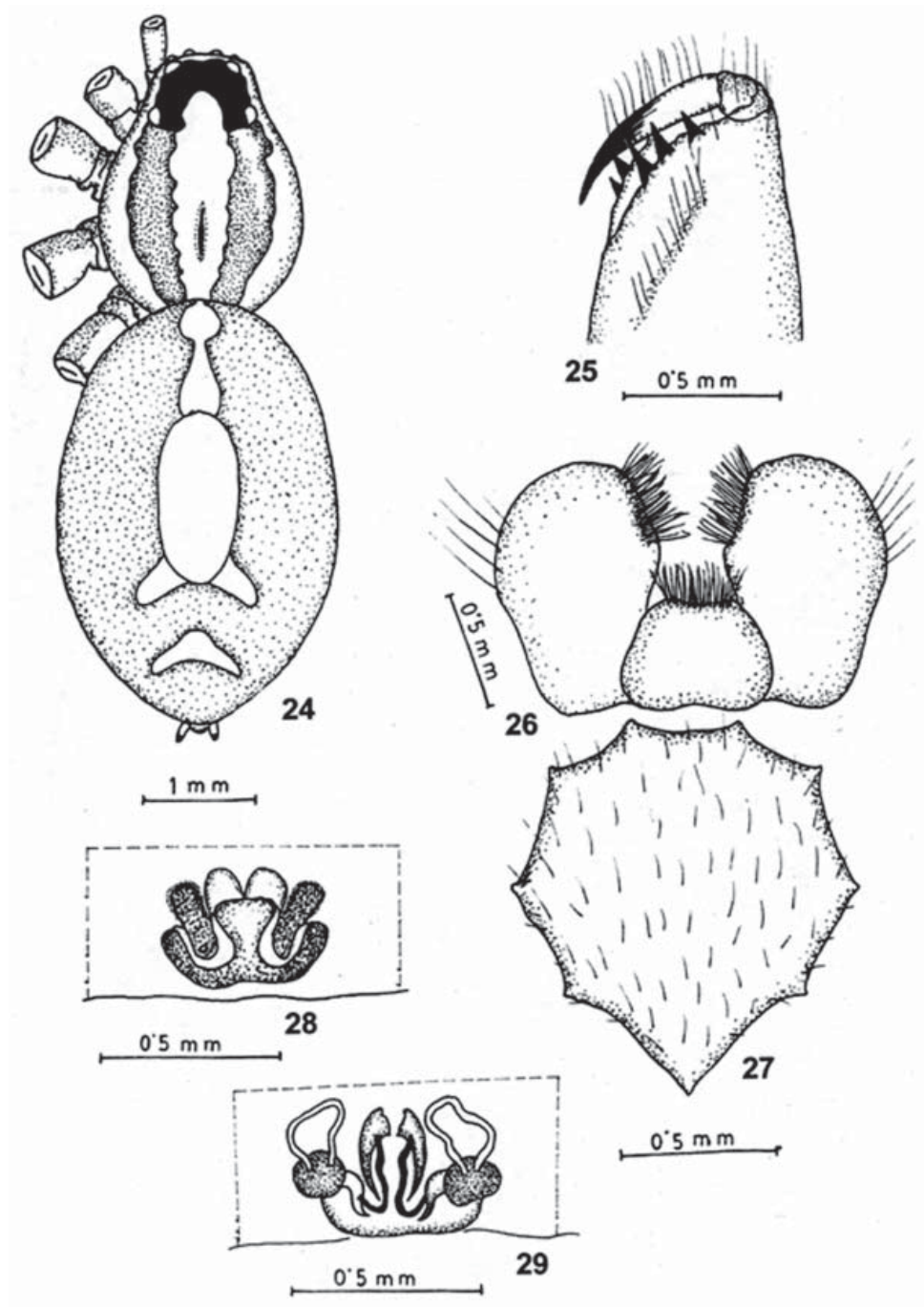
1970. *Lycosa shyamae* Tikader, *Rec. Zool. Surv. India*, **64**(1-4) : 67.

2009. *Lycosa shyamae* : Biswas, *Flora & Fauna of Bangladesh*, Arachnida, **18**(1) : 221.

2014. *Lycosa shyamae* : Platnick, *World Spider Catalogue*, Version 14.5. American Museum of Natural History, New York.

Material examined : 2 ♀, Bagerhat, 9.IX.1991, Coll. V. Biswas; 2 ♀, Fairdpur, 13.VII.1992, Coll. V. Biswas; 2 ♀, Jhenidah, 18.VIII.1989, Coll. V. Biswas; 1 ♀, Jessore, 9.IX.1992, Coll. V. Biswas; 1 ♀, Kustia, 19.XII.1991, Coll. V. Biswas.

Distribution: BANGLADESH: Bagerhat, Fairdpur, Jhenidah, Jessore, Kustia; INDIA (Tikader and Malhotra, 1980)



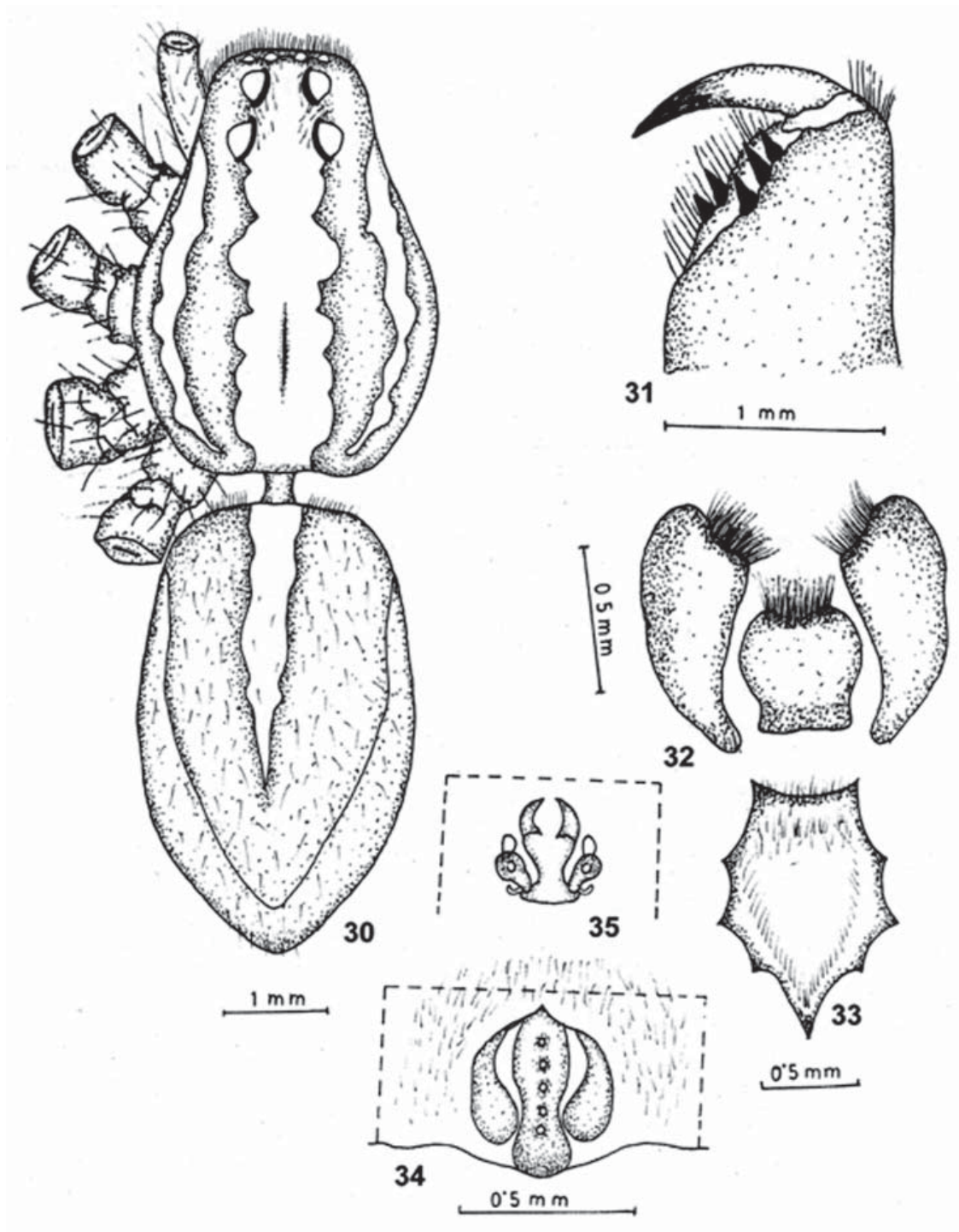
Figs. 24-29. *Lycosa shyamae* Tikader

24. Whole body (dorsal view); 25. Chelicerae; 26. Maxillae and Labium; 27. Sternum;
28. Epigynum; 29. Internal genitalia

6. *Lycosa tista* Tikader
(Figs. 30-35)

1970. *Lycosa tista* Tikader, *Rec. Zool. Surv. India*, **64**(1-4): 67.
1980. *Lycosa tista* Tikader & Malhotra, *Fauna of India*, Spiders, Lycosidae, **1**(2): 384.
2009. *Lycosa tista* : Biswas, *Flora & Fauna of Bangladesh*, Arachnida, **18**(1): 221.
2014. *Lycosa tista*: Platnick, *World Spider Catalogue*, Version 14.5. American Museum of Natural History, New York.

Material examined: 2♀, Bagerhat, 11.XII.



Figs. 30-35. *Lycosa tista* Tikader

30. Whole body (dorsal view); 31. Chelicerae; 32. Maxillae and Labium; 33. Sternum;
34. Epigynum; 35. Internal genitalia

1991, Coll. V. Biswas; 1♀, ADI, Fairdpur, 11.VIII.1992, Coll. V. Biswas; 1♀, Shikerpur, Jhenidah, 8.VII.1991, Coll. V. Biswas; 2♀, Khajura, Jessore, 1.X.1990, Coll. V. Biswas; 1♀,

Chalna, Khulna, 11.VII.1991, Coll. V. Biswas; 1♀, Kustia, 12.IX.1991, Coll. V. Biswas; 1♀, Manikganj, 8.IX.1993, Coll. V. Biswas; 2♀, Pirojpur, 5.III.1992, Coll. V. Biswas.

Distribution: BANGLADESH: Bagerhat, Fairdpur, Jhenidah, Jessore, Khulna, Kustia, Manikganj, Pirojpur; INDIA (Tikader and Malhotra, 1980)

started in 1994, has revealed the existence of the above species for a particular area of Bangladesh. Identity of the species were later confirmed by the 'Zoological Survey of India', Kolkata.

SUMMARY

The wolf spiders of the genus *Lycosa* Latreille, Bangladesh is represented by 6 (six) species namely *L. gravelyi* n. sp., *L. japhlongensis* n. sp., *L. mackenziei* Gravely, *L. shyamae* Tikader, *L. picta* n. sp. and *L. tista* Tikader.

The study of the spiders of this area was

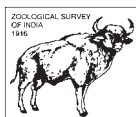
ACKNOWLEDGMENTS

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A COMPARATIVE LIMNOLOGY ON TWO DECCAN WETLANDS

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INTRODUCTION

Large, medium and small water bodies called lakes/ reservoirs / impoundments constitute the major freshwater resources of Andhra Pradesh and these water bodies were formed by the construction of dams across small rivulets and streams for irrigation or as a source of drinking water of the region. Pocharam lake that is situated in Medak-Nizamabad Districts and Wyra lake in Khammam District of Andhra Pradesh in South India are presently the major sources of water in the regions.

Some of the notable contributions on limnology in the state include Zafar (1966), Venkateswarlu (1969), Munawar (1970), Venu (1981), Ratna Rao (1984), Jaya Devi (1985), Chandrasekhar (1966, 2006), Chandrasekhar and Nageswara Rao (2006), Patil and Panda (2003), Malathi *et al.* (2003), Anitha *et al.* (2005), Siddiqi and Khan (2002). In an aquatic ecosystem, water quality influences its biotic components and it controls diversity, biomass and spatial distribution of the latter in time and space. The physico-chemical parameters exert their influence both individually and collectively and their interaction produces abiotic environment which conditions the origin, development and finally succession of biotic communities. Further, biotic communities in turn, continuously goes on in a dynamic ecosystem.

The Present study was undertaken to evaluate a comparative account of physico-chemical and biological conditions of two deccan wetlands viz., Pocharam lake and Wyra lake in Andhra Pradesh

which differed significantly in their limnological aspects and trophy (nutrient status) with emphasis on the structure and composition of zooplankton particularly Rotifera and Cladocera.

MATERIAL AND METHODS

The studies on Pocharam lake and had been carried out during three different seasons (November, 2003-winter, March, 2004-summer and July, 2004-monsoon) of 2003-04 and Wyra lake it was 2006-07 (November, 2006-winter, March-2007-summer and August, 2007-monsoon). In order to cover the whole topography of the water bodies seven surrounding villages located at the bank of Pocharam lake and nine at Wyra were selected and undertaken the surveys. Physical parameters and titrimetric parameters were analysed in the field laboratories itself and water samples were brought to Head Quarters by collecting in PVC bottles of one liter capacity and given to a private laboratory for the analysis of nutrients and light metals. Plankton samples were collected by diving the plankton net (No. 25) on the sub-littoral regions of the lake waters and the preserved in 4 % formaldehyde solution and the identification of Rotifer and cladoceran fauna was done with the aid of standard literature on these two groups.

Pocharam lake is situated at about 110 kms from Hyderabad city in its north-west direction / 17 kms from Medak town and Wyra lake is at about 250 kms from Hyderabad city in its northern side / 25 kms Khammam town.

Table 1. Comparative Case history and morphometry of two lakes.

Sl. No.	Details	Pocharam lake	Wyra lake
1	Construction year	1922	1929
2	Location	18° 18'N & 77° 57'E	17° 15'N & 80° 25'E
3	Catchment's area	16.835 sq. kms	19.166 sq. kms
4	Depth (depending on the season / fluctuation in rain fall)	5-6 feet	5-6 feet
5	Constructed on	Alair River	Godavari river
6	Usage	Irrigation, domestic and forestry exploitation	Irrigation and domestic

RESULTS AND DISCUSSION

Limnological investigations were restricted to the three major seasonal surveys *i.e.*, November (winter), March (summer) and July/August (monsoon) on both the lakes. The station-wise ranges and mean values (some of the mean values were rounded off to the nearest fractions) /overall values of different physico-chemical parameters of seven stations of Pocharam lake and nine of Wyra lake were given in a table during the three major seasons (winter, summer and monsoon) of the study periods 2003-04 and 2006-07 respectively.

The **pH** values during the study periods varied between 7.24-9.16 with mean value of 8.0 on Pocharam lake and 7.0-8.7 with mean value of 7.57 on Wyra lake indicating the general alkaline tendency of waters. The higher pH values may be attributed to the carbonates/ bicarbonates and higher photosynthetic activities. The lower (7.24) was noticed at Rajpet in winter and higher one (9.16) was during monsoon at Pochammaralu of Pocharam lake where as in Wyra lake the lower and higher values *i.e.*, 7.0 and 8.7 were found at Reddigudem in winter and summers. The **electric conductivity** was observed with a range of 230-810 micro siemens / cm and 360 – 810 with mean values 350 and 542 in Pocharam and Wyra lakes respectively. The **turbidity** values of Pocharam lake fluctuated between 15 – 300 NTU with mean value of 67, where as in Wyra lake it was 5 – 184 with a mean value of 53. The lower value (15) was observed at Rajpet in winter and higher one (300) was at Kottapalle of Pocharam lake. Similarly

in Wyra lake, the lower turbidity value (5) was found at Brahmanapalle during winter and the higher (184) was at Singarayapalem in summer. Its higher values are known to affect the primary productivity by restricting the light penetration and photosynthesis. The **Dissolved Oxygen** (DO) profile revealed a variation between 2.6-8.2 with an average value of 5.2 in Pocharam lake and in Wyra lake, it was 1.3-6.0 with a mean of 4.6. The lower 2.6 mg/L of Pocharam lake was observed at Burugapalle in monsoon and the higher one 8.2 was seen at Polkampet during winter and monsoon seasons. Likewise, the lower value (1.3) of Wyra lake was noticed at Wyra spot during summer and the higher (6.0) was at different localities of the water body in monsoon. Here the higher values of Dissolved Oxygen may be due to comparatively clear zones and increased photosynthetic activity by phytoplankton. The total absence of **carbonates** was noticed in monsoon in Wyra lake. In the case of Pocharam lake the carbonates fluctuated between Nil to 90 with an average of 54 mg/L and in Wyra lake it was found fluctuated between Nil to 50 with a mean value of 41. The **bicarbonate** values of Pocharam lake were seen from 35-100 mg/L with an average of 88 where as in the case of Wyra lake it was found between 125-320 mg /L with a mean value of 215.2. The **chloride** content at different stations of Pocharam lake varied 15-43 mg/L with a mean value of 27 while at Wyra lake it was 27-110 with an average value of 65. The maximum value (43) of Pocharam lake was found during summer at Polkampet, the minimum value (15) was noticed at Pocharam lake in Pocharam (V) spot in winter. Similarly the minimum value

(270) in Wyra lake was noticed at in summer at its Wyra locality and the maximum value of 110 was observed in Winter at Reddigudem. The peak in chloride values may be related to evapotranspiration and high evaporation due to the prevailing high temperature. The chloride content further involves the presence of organic matter of animal origin. Lower chloride values in the water body were probably due to its distant location and natural elevation that gives protection from inflows of domestic wasters and cattle feeding. The values of **total hardness** varied between 85-280 mg/L with a mean value of 159 in Pocharam lake where as in Wyra lake it was between 85-280 mg /L with a mean value of 149. The peak value total hardness value (245 mg/L) of Wyra lake was noticed at Singarayapalem during monsoon while its minimal value (95) was at Narayanapuram in winter. The maximum quantity of total hardness value (245 mg/L) of Wyra lake was noticed at Singarayapalem during monsoon while its minimal value (85) was seen at Wadalparti in monsoon. The ranges of hardness values recorded were invariably lesser in the case of Wyra lake, indicating the presence of other ions and therefore all excess hardness can be termed as carbonate hardness where as it is reverse in the case of Pocharam lake and hence Wyra lake waters may be classified as moderately hard to hard and indicate no physico-chemical deterioration. The **calcium** hardness in the case of Pocharam lake varied between 15 – 59 mg/L (mean 30) where as in Wyra lake it was between 21 – 42 (29). Higher concentration of calcium was observed at Pocharam (V) of Pocharam lake in winter season while it was at Reddigudem of Wyra lake in monsoon.

In general, aquatic ecosystems receive excess of nutrients through untreated domestic sewage and agriculture run off. Phosphate acts as a limiting nutrient responsible for the process of eutrophication and leads to ultimate degradation of an aquatic ecosystem. During the course of study on Pocharam lake the **phosphate** ranged between 0.01 to 0.09 mg/L (mean 0.4) while in Wyra lake it was 0.03 to 0.28mg/L with a mean of 0.86. The minimal value of Pocharam lake

was noticed at Pochammaralu and Burugapalle during winter and its maximum was at Polkampet in monsoon. In the case of Wyra lake the minimal and maximum values were obtained at Wyra spot and Siddikhnagar during monsoon and winter respectively. The higher phosphate content indicate the loading in of domestic sewage and agricultural run off from the surrounding colonies and agricultural fields respectively.

The quantity of **Nitrate** of Pocharam lake fluctuated from 1 (several localities during winter) to 15 mg/L (Burugapalle in summer) with a mean value of 5.23 where as its value at Wyra lake is ranged from 1.9 (Wyra spot in summer) – 10 mg /L with a mean value of 3.27, but the minimal and maximum values were obtained at Wyra spot and Siddikhnagar respectively during monsoon season. The overall **silicate** concentration of Pocharam lake were found around 10 only. The silicate values during winter in Wyra lake were comparatively low and summer values are more. High concentration of **sulphates** stimulates the action of sulphur reducing bacteria, which produce hydrogen sulphide, a gas highly toxic to fish life. Sulphates of Wyra lake water was observed from 16 – 97 mg /L with an average value of 39.1 wherein the minimum was noticed in summer at Lallapuram while the maximum was in winter at Siddikhnagar. The sulphate concentration in Pocharam lake waters fluctuated between 6 – 43 mg/L with a mean value of 16 where in the lower value was found at Burugapalle in summer and the higher one was in monsoon at the same spot. **Sodium** which can also be called as conservative metal, showed the variation in Pocharam lake waters from S Pocharam in winter - 46 mg/L (Rajpet in winter) with a mean value of 27. But in Wyra lake Sodium concentration fluctuated between 30 (Wyra –winter) and 92 (Lallapuram-summer) with a mean value of 61.3. The quantity of **potassium** in Pocharam lake waters found between 1 mg/L (several places in winter and summer) – 5 mg/L (Pochammaralu – winter) with a mean value of 1.95, where as in Wyra lake this concentration was between 2.0 (several places in winter and summer) to 5.0 (Lallapuram –summer), with an average value of 3.1.

Table 2. Showing the over all ranges and mean values of physico-chemical parameters of two lakes.

Sl. No	Parameter	Pocharam lake		Wyra lake	
		Range	Mean	Range	Mean
1.	pH	7.24 – 9.16	8.0	7.0 – 8.7	7.57
2	EC (micro siemens/cm)	230-810	350	360-810	542
3	Turbidity (NTU)	15 – 300	67	5 -184	52.8
4.	DO (mg/L)	2.6 -8.2	5.2	1.3 – 6.0	4.55
5	Carbonates (")	0 -90	54	0 -50	41
6	Bicarbonates (")	35 -180	88	125 – 320	215
7	Chloride (")	15 -43	26.5	27 - 110	65
8	Total Hardness (")	90 – 280	159	95 – 245	149
9	Calcium (")	15 – 59	30	21 – 42	29
10	Phosphates (")	0.01 – 0.09	0.36	0.03 -0.28	0.86
11	Nitrates (")	1 – 15	5.23	1.9 – 10.0	3.7
12	Silicates (")	5 – 21	9.5	3.0 – 16.0	10.5
13	Sulphates (")	6 - 43	16	16 – 97	39.1
14	Sodium (")	8 – 46	27	30 – 92	61.3
15	Potassium (")	1 – 5	1.95	2.0 -5.0	3.1

Table 3. Showing the occurrence of Zooplankton communities (Rotifera and Cladocera).

Sl. No	Species	Pocharam lake	Wyra Lake
	ROTIFERA		
1	<i>Brachionus angularis</i> Gosse	+	-
2	<i>B.caudatus</i> Barrios & Daday	+	-
3	<i>B.diversicornis</i> Daday	+	+
4	<i>B. forficula</i> Muller	+	+
5	<i>B. calyciflorus f. anureformis</i> Brehm	+	-
6	<i>B. calyciflorus f. borgerti</i> Apstein	+	-
7	<i>B. calyciflorus</i> var. <i>dorcas</i> Gosse	+	-
8	<i>B. calyciflorus</i> var <i>hymani</i> Dhanapathi	-	+
9	<i>B. falcatus</i> Zacharias	+	+
10	<i>B. plicatilis</i> Muller	+	-
11	<i>B. quadridentatus</i> Hermann	+	+
12	<i>B. patulus</i> (Muller)	-	+
13	<i>Platijas quadricornis</i> Ehrenberg	+	+
14	<i>Keratella tropica</i> Apstein	+	+
15	<i>Mytilina ventralis</i> (Ehrenberg)	+	+
16	<i>Macrochaetus serica</i> (Thorpe)	-	+
17	<i>Lepadella ovalis</i> Muller	-	+

Table 3. contd.

Sl. No	Species	Pocharam lake	Wyra Lake
18	<i>Lecane (Lecane) curvicornis</i> Murray	+	+
19	<i>L. lauterborni</i> Haner	+	-
20	<i>L. leotina</i> (Turner)	+	-
21	<i>L. luna</i> (Muller)	-	+
22	<i>L. papuana</i> (Murray)	+	-
23	<i>L. unguate</i> (Gosse)	+	-
24	<i>L. bulla</i> (Gosse)	+	+
25	<i>L. clostocerca</i> (Schmarda)	-	+
26	<i>L. tethis</i> (Harring & Myer)	-	+
27	<i>Cephalodella</i> sp.	-	+
28	<i>Scaridium longicaudum</i> (Muller)	-	+
29	<i>Trichocerca pusilla</i> (Jennings)	+	-
30	<i>Asplanchnopus bhimavaransensis</i> Dhanapathi	+	-
31	<i>Filinia opoliensis</i> (Zach.)	+	-
32	<i>F. terminalis</i> (Plate)	+	-
33	<i>Testudinella patina</i> (Hermann)	-	+
34	<i>T. mucronata</i> (Gosse)	+	+
CLADOCERA			
1	<i>Diaphanosoma sarsi</i> Richard	-	+
2	<i>Daphnia cornuta</i> (Jurine)	-	+
3	<i>Scapheloberis kingi</i> Sars	-	+
4	<i>Moina micrura</i> Kurz	+	-
5	<i>Macrothrix spinosa</i> King	-	+
6	<i>M.laticornis</i> (Jurine)	-	+
7	<i>Echinisca triserialis</i> (Brady)	-	+
8	<i>Hyocryptus spinifer</i> Herrick	+	+
9	<i>Chydorus sphaericus</i> (O.F.Muller)	-	+
10	<i>Chydorus parvus</i> (Daday)	+	-
11	<i>C. barroisi</i> Richard	+	+
12	<i>C. ventricosus</i> Daday	+	+
13	<i>C. reticulatus</i> Daday	+	-
14	<i>Alona rectangula rectangula</i> Sars	+	+
15	<i>A. rectangula richardi</i> (Stingelin)	+	+
16	<i>A. davidi davidi</i> Richard	+	+
17	<i>A. davidi punctata</i> (Daday)	-	+
18	<i>A. coastata</i> Sars	+	-
19	<i>A. pulchella</i> King	-	+
20	<i>Kurzia longirostris</i> Daday	+	-
21	<i>Camptocercus rectirostris</i> Schoedler	-	+

BIOTIC PROFILE:

Detailed studies were carried out on the diverse rotifer and cladoceran faunal assemblage in Pocharam lake and Wyra lake during the study periods and given in a Table-4 wherein the occurrences of the species of these two groups were compared. The shallow littoral regions and also near by limnetic zones play a host to a wide variety of the two zooplankton communities under study viz., Rotifera and Cladocera. Rotifera (34 species) ranked one in order of abundance followed by cladocerans (21 species) in both the lakes. There are 34 species belonging to 14 genera of Rotifera and 21 species belonging to 11 genera in both the lakes. In Pocharam lake 24 species belonging to 9 genera of rotifers and 11 species belonging to 5 genera of cladocerans were observed whereas in Wyra lake it was 20 species belonging to 10 genera of rotifers and 16 species belonging to 9 genera of cladocera were noticed. There are also 10 species belonging to 6 genera of rotifers and 6 species belonging to 3 genera of cladocerans that are commonly available in both the lakes.

Among the Cladocera, chydorids, which is well known to occur in littoral vegetated zone of freshwaters in general, have dominated qualitatively in both the lakes. The species like *Moina micrura*, *Chydorus parvus*, *C. reticulatus*, *Alona coastata*, and *Kurzia longirostris* are available in Pocharam lake only. Of the 24 species of rotifers available in Pocharam lake, *Brachionus angularis*, *B. caudatus*, *B. calyciflorus f. annuliformis*, *B. calyciflorus borgetti*, *B. calyciflorus var. dorcasi*, *B. plicatilis*, *Lecane lauterborni*, *L. luna*, *L. papuana*, *L. unguiculata*, *Trichocerca pusilla*, *Asplanchnopus bhimavaraniensis*, *Filinia opoliensis* and *F. terminalis*, are available in Pocharam lake only.

The species, like *Brachionus calyciflorus var. hymani*, *B. patulus*, *Macrochaetus sericeus*, *Lepadella ovalis*, *Lecane luna*, *L. clostocerca*, *L. tethys*, *Cephalodella* sp., and *Testudinella patina* are available in Wyra lake only. Similarly

the cladocerans like *Diaphanosoma sarsi*, *Ceriodaphnia cornuta*, *Scaphelobris Macrothrix spinosa*, *Echinisca triserialis*, *Chydorus sphaericus*, *Alona davidi punctata*, *A. pulchella* and *Camptocerus rectirostris* are available in Wyra lake only.

In Wyra lake the rotifers showed high diversity represented by families viz., Brachionidae, Mytilinidae, Trochotridae, Colurellidae, Lecanidae, Notommatidae and Testudinellidae out of which Brachionidae and Lecanidae equally dominated with eight species each and the rest are of representatives only. Among the cladocerans in Wyra lake, Chydorids have dominated with 9 species and the rest are of representatives only.

Rotifers formed the most dominant plankters of Pocharam lake and showed higher diversity and represented by families viz., Brachionidae (9 species), Mytilinidae, Trichotridae, Asplanchnidae and Testudinellidae (each one species), Lecanidae (6 species) and Filinidae (2 species). Cladocerans in Pocharam lake were represented by the families Chydoridae (9 species), Moinidae and Macrothricidae (each one species).

Among the Rotifers in Pocharam lake, Brachionids dominated the rest taxa, represented by three genera viz., *Brachionus*, *Keratella* and *Platias*. Out of the three brachionid genera, *Brachionus* was constituted by eight species with three varieties / forms, the genera *Keratella* and *Platias* were represented each with one species. The other important group, Lecanidae, was represented by six species of the genus *Lecane*. In general, most of the tropical alkaline waters are dominated by the genus *Brachionus*, as it has got adopted with its large number of species, subspecies and polymorphs to the alkaline conditions of the waters. The second dominant group, Cladocera have represented with 11 species belonging to the chydorid family with three genera viz., *Chydorus*, and *Alona* each with four and *Kurzia* with one species. The other two families, Moinidae and Macrothricidae got one species each.

Table 3. showing the station-wise ranges and mean values of physico-chemical parameters of two lakes

Locality	pH		EC		Turbidity		DO		Carb.		Bicarb.		Chloride		T. Hard.		Calcium		Phos.		Nitrates		Sili.		Sulph.		Sod.		Pot.		
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
POCHARAM LAKE																															
Poch (V)	7.76-8.36	8.0	250-290	273	19-156	70	3.4-8.0	5	45-60	53	35-90	65	15-28	21	100-260	162	21-59	35	0.02-0.08	0.05	1-5	3.3	8-11	10	8-10	9	8-32	22	1-3	1.7	
Pochl.	7.77-9.16	8.3	250-320	277	24-72	46	3.5-7.6	5.1	40-50	43	30-90	68	18-20	19	100-265	162	19-57	32	0.01-0.06	0.04	2-4	3	8-12	10	9-12	10	9-29	18	1-5	2.7	
BGP	7.51-7.76	7.6	320-470	407	8-88	37	2.6-7.5	5.3	0-65	65	85-170	123	33-38	34	155-175	167	26-34	31	0.01-0.05	0.04	1-15	5	9-11	10	6-43	20	11-44	31	1-3	2	
RP	7.24-8.64	7.8	250-810	487	15-107	56	3.5-7.0	4.3	30-65	48	60-135	92	23-28	25	90-180	140	16-48	32	0.04-0.07	0.06	6-9	7.3	5-21	12	15-32	25	32-46	38	2-2	2	
WP	7.57-9.09	8.3	230-330	267	31-128	73	3.8-7.5	5.4	35-70	58	40-85	55	20-28	24	85-140	122	15-42	24	0.05-0.08	0.07	3-9	6	5-11	8	9-18	13.0	11-28	20	1-2	1.7	
KP	7.5-7.8	7.6	350-430	367	49-300	136	2.9-7.8	4.8	0-90	90	75-125	108	23-33	30	160-190	178	26-40	31	0.04-0.07	0.06	1-6	4	7-11	9	15-35	22	13-40	29	1-3	2	
PP	7.74-8.78	8.3	270-400	350	38-68	52	4.0-8.2	5.6	40-55	48	50-180	103	18-43	31	95-280	180	19-33	26	0.01-0.09	0.06	1-8	5	6-9	8	10-19	13	24-36	30	1-2	1.7	
WYRA LAKE																															
SN	7.2-7.6	7.3	580-510	660	46-170	127	3.9-5.5	5	0-50	50	135-320	238	58-93	71	135-150	142	21-37	29	0.05-0.28	0.18	2.0-10	6.3	5.7-28	14.2	43-97	64	73-90	79	3.0-7.0	4	
LP	7.3-7.7	7.6	520-700	603	25-128	70	2.5-4.8	3	0-40	40	215-250	235	50-65	59	140-150	145	21-23	22	0.04-0.13	0.07	3.0-8.0	5.2	3.3-22	12.1	16-46	30	64-92	76	3.0-5	4	
WY	7.1-7.9	7.5	420-590	507	6-61	27	1.36.0	4	0-45	45	125-235	190	27-88	59	150-175	165	22-32	26	0.03-0.12	0.08	1.9-4.32	2.7	5.2-14	9.4	19-43	32	30-79	57	2.0-4.0	3	
SP	7.1-7.9	7.6	490-620	547	15-18.4	76	1.0-6.0	4	0-40	40	190-235	218	55-73	64	125-245	187	25-29	27	0.04-0.1	0.07	2.0-3.15	2.72	5.0-16.0	10.3	25-42	34	38-68	57	2.0-3.0	8	
LG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MV	7.4-7.7	7.5	440-560	500	12.64	38	5.0-6.0	6	0-45	45	140-260	200	48-98	73	105-155	130	21-37	29	0.05-0.13	0.09	3.0-4.0	3.5	5.0-10	7.5	30-44	37	30-68	49	3.0-4.0	4	
NP	7.3-7.6	7.4	360-510	435	15-54	35	5.1-5.8	5	0-45	45	130-265	198	38-95	67	95-145	120	27-39	33	0.04-0.09	0.065	2.0-5.0	3.5	4.0-12.0	8	13-38	25.5	40-65	53	2.0-3.0	2.5	
RG	7.0-8.7	7.8	440-600	523	6-57	27	3.9-5.4	5	0.25	25	175-240	215	43-110	79	125-165	150	25-42	33	0.04-0.11	0.08	2.0-5.0	3	3.0-15.0	9.7	18-90	49	42-66	58	2.0-3.0	3	
BP	7.3-8.2	7.8	440-580	513.3	5-12	11	4.0-5.6	5	0-35	35	180-250	217	38.65	71	125-150	137	28-37	33	0.04-0.11	0.07	2.0-3.0	2.3	6.0-14.0	10.7	23-45	35	40-64	55	2.0-3.0	2	

I – Ranges II – Mean values / Poch. (V)-Pocharam (V), Pochl.-Pochammaralu, BGP-Burugapalle, RP-Rajpet, WP-Wadialparti, KP-Kpttapalle, PP-Polkampet / SN-Siddikmagar, LP-Lallapuram, WP-Wyra, SP-Singarayapalem, LG-Lallurugudem, MV-Mallavaram, NP-Narayanapuram, RG-Reddigudem, BP-Brahmanapalle

Brachionus diversicornis, *B. falcatus*, *B. quadridentatus*, *Platylabus quadricornis*, *Lecane curvicornis*, *L. bulla* and *Testudinella mucronata* among rotifers where as *Ilyocryptus spinifer*, *Chydorus barroisi*, *C. ventricostus*, *Alona rectangula rectangula* A. *rectangula richardi* and *A. davidi* *davidi* are available in both the lakes.

As is quite obvious from the above results that these two impoundments differed significantly in their limnological attributes and these two can be categorized as oligotrophic lakes. In general, these two lake waters showed seasonality in most of the physico-chemical factors which mainly depend on the monsoon *i.e.*, insufficient rains or heavy rains in the preceding periods. The physico-chemical parameters of both the lakes are also indicating that these two are clean waters, but abnormal values of the nutrients indicate that these are slightly polluted and the reason can be attributed to agricultural run off or anthropogenic activities. Both the lakes were characterized by highly alkaline, soft to hard, moderate turbidity and the chloride content of these two water bodies re indicating their potability.

The parameters like pH, turbidity, Dissolved Oxygen (DO), carbonates and silicates are at higher side in Pocharam lake than the other, where as the factors like electric conductivity, bicarbonates, chloride, phosphates, sulphates, sodium and potassium of Wyra lake were at side but total hardness and calcium are more or less equal both the water bodies . The reasons for the variations in the levels of ranges of physico-chemical parameters of both the lakes, can be

attributed to the differences in the quantum of rain fall, domestic sewage that is letting into the water bodies, agricultural run off, anthropogenic activities at the lake basins... *etc.*, during the study periods.

SUMMARY

Studies on the comparative study on physico-chemical and biological characteristics with special reference to Rotifera and Cladocera of two Deccan wetlands viz., Pocharam lake and Wyra lake that are situated in Andhra Pradesh have been carried out during 2003-04 and 2006-2007. These studies were conducted on seasonal basis *i.e.*, winter, summer and monsoon during the periods. The abiotic factors revealed that the parameters like pH, turbidity, DO, carbonates and silicates are at higher side in Pocharam lake waters than the other and the factors like electric conductivity, Bicarbonates, chloride, phosphates, sulphur, sodium and potassium of Wyra lake waters are at higher side. But total hardness and calcium values are more or less equal in both the lakes. The biotic factors revealed the presence of 24 species belonging to 9 genera of Rotifera and 11 species in 5 genera of cladocera in Pocharam lake while in Wyra lake it was 20 species under 10 genera of Rotifers and 16 species belonging to 9 genera of cladocerans.

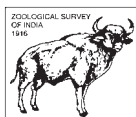
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MORPHOLOGICAL AND MOLECULAR CHARACTERIZATION OF GENUS *ANOPHELES* (DIPTERA: CULICIDAE) OF GANJAM DISTRICT ORISSA, INDIA

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INTRODUCTION

The District Ganjam is located 19.4° North Latitude to 20.17° North Latitude and 84.7° East Longitude to 85.12° East Longitude spread over the geographical area of 8070.60 square km. Ganjam district is broadly divided into two divisions, the coastal plains on the east and hill and table lands on the west. There are 22 blocks with 18 Urban Bodies under 3212 villages in the district (file:///E:/Molecular%20studies/GIS,%20Ganjam.htm). The district is surrounded by Khurda, Phulbani, Gajapati and Nayagarh districts in four different directions. The Eastern Ghats run along the western side of the district. The extreme north east is occupied by a portion of the famous Chilika Lake. The district is characterized by hot temperature all through the year, particularly in the coastal regions with higher humidity. The human malarial transmission is very high in this district.

The application of molecular approaches to systematic studies ranging from sub-generic and species level is helping to address various questions such as anopheline phylogenetics and biogeography, nature of species boundaries and the forces that have structured genetic variation within species.

In India, 58 *Anopheles* have been described, six of which have been implicated to be main malaria vectors, namely *An. culicifacies*, *An. dirus*, *An. fluviatilis*, *An. minimus*, *An. sundaicus* and *An. stephensi*. Besides, some vectors of

local importance, termed as secondary vectors viz. *An. philippinensis-nivipes*, *An. varuna*, *An. annularis* and *An. jeyporiensis*. The six recognized primary malaria vectors in India, all except *An. stephensi* are species complexes. The five species complexes are *Culicifacies* complex, *Fluviatilis* complex, *Minimus* complex, *Dirus* complex and *Sundaicus* complex. There are growing evidences that the members of species complexes differ significantly in biological characteristics that are vital for malaria control such as vectorial potential, host-preference, resting behaviour and response to insecticides.

Twenty two species has been reported from the Jeypore hills of Koraput district of Orissa by Gunasekaran *et al.*, (1989) which is the nearest district to the Ganjam district, Orissa. However Rajavel (2005) reported only 8 species from the same place. The relatively higher humidity and the stagnant water bodies of Ganjam district provide a good breeding ground for the mosquitoes throughout the year especially in coastal areas. Thus diversity of the species is remarkably high in this area. During the past three decades, due to various changes in the ecological conditions by extensive deforestation, frequent cyclones and extensive use of insecticides. More number of malaria cases have been recorded, however there are no study on mosquitoes.

There are a few sporadic studies on the distribution of the fauna Dash *et al.* (1984) Nagpal and Sharma (1983), Rajavel (2005). It is likely

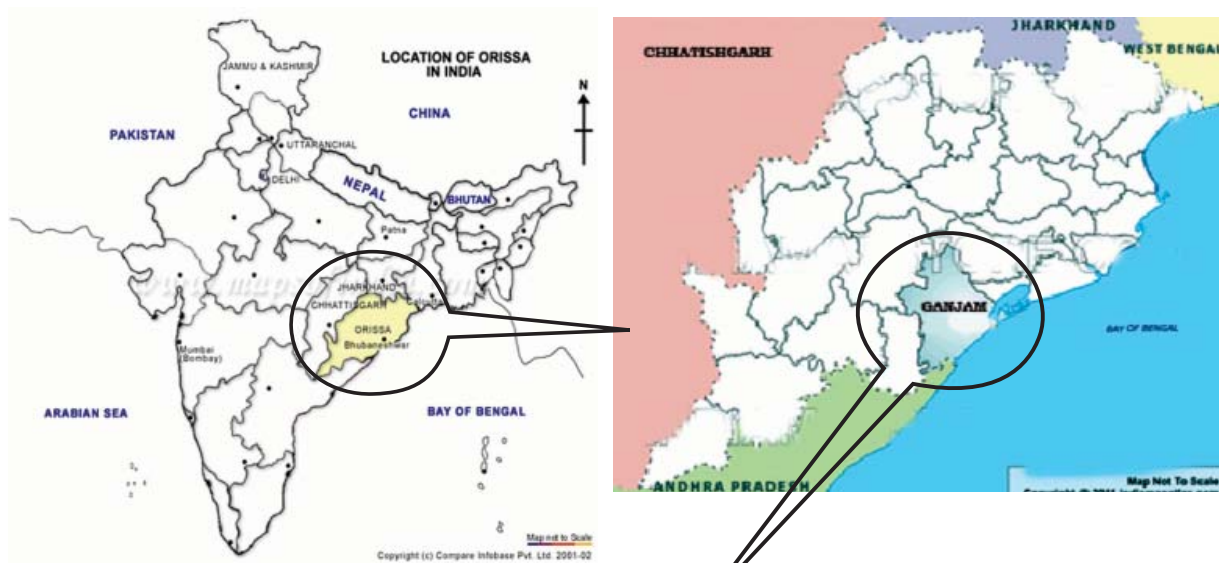
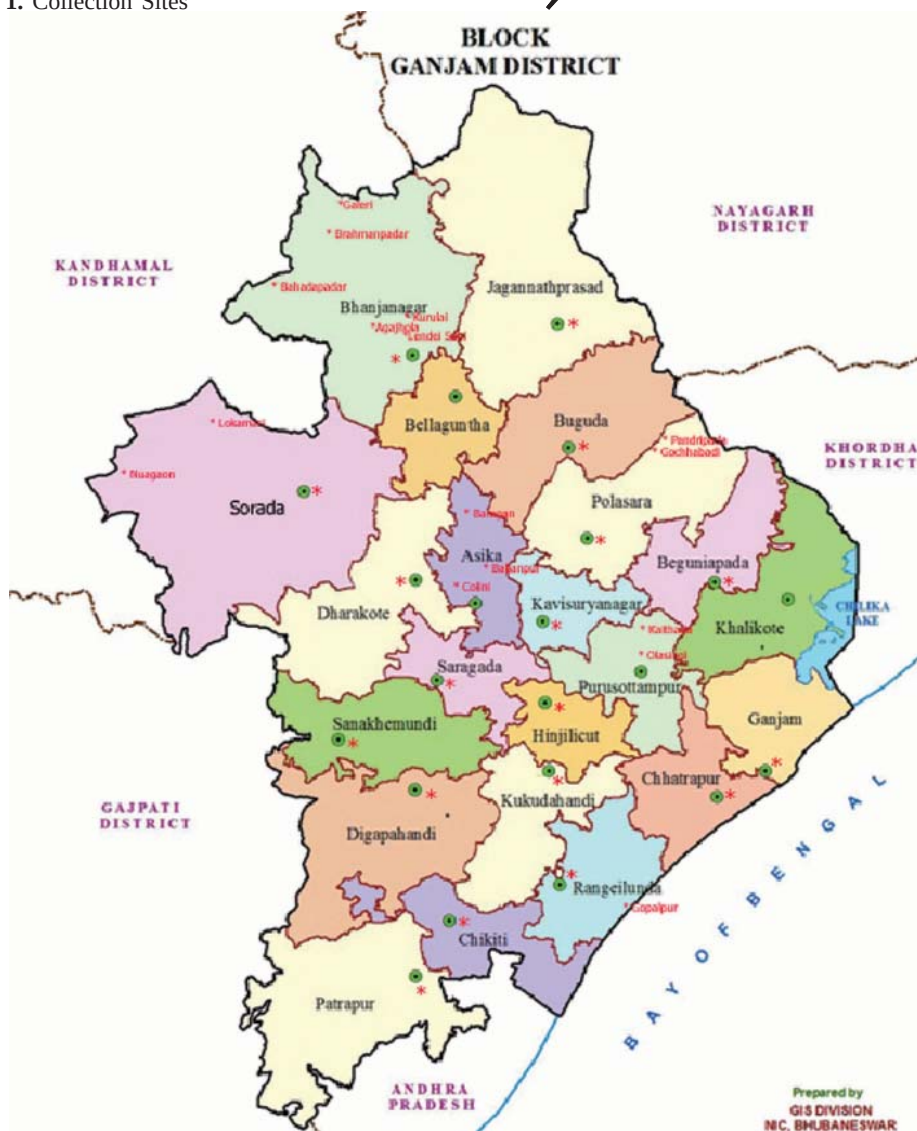


Fig. 1. Collection Sites



that some of the previously reported species would have disappeared or reappeared. This phenomenon has already been observed in other states like Meghalaya, Madhya Pradesh, Chhatisgarh, Delhi [Rajagopal (1976), Kalra (1978), Jambulingam, P. (2005)]. The application of molecular approaches to systematic problems ranging from sub-generic relationships to relationships at and below the species level is helping to address the phylogenetics and biogeography of *Anopheles*, the nature of species boundaries (Jaroslaw and Nora (2003). In the present study, 24 species of *Anopheles* are described on morphological basis and the samples processed for sequencing.

MATERIALS AND METHOD

Mosquito collections were undertaken in sixteen villages of 22 blocks of Ganjam District during the year 2009-2010. The villages are viz., Kurulai, Agajhola, Lendei sahi, Colini, Baragan, Babanpur, Lokamari, Nuagaon, Sorada, Baharapadar, Galeri, Brahmanpadar, Olasinghi, Kaithada, Pandripada, Gochabadi and all other block headquarters. (Fig. 1). Adult mosquitoes that were resting indoor, outdoor, biting man and cattle were collected by suction tube; spray sheet, cdc-light trap collections used during dawn and dusk. The indoor resting mosquitoes collected from both human dwelling and cattle sheds. The total catch collection made by spraying pyrethrum in a close room to knock down the mosquitoes then the mosquitoes which were collected from a white bed sheet by the entomological forceps and transferred to the test tube. Out door resting adult mosquitoes were collected by netting from shrubs near cowsheds, paddy fields, littoral forest etc. The mosquito samples were identified by using the key of (Christophers, 1933, Barraud, 1934 and Rao, 1984, Nagpal *et al.*, 2005). The species are distinguished on the basis of characters of adult females.

MOLECULAR STUDY

DNA isolation: The DNA extraction from single adult mosquito was performed as per modified phenol chloroform method (Coen *et al.*, 1982).

Polymerase Chain Reaction (PCR)

Standardization of PCR amplification of the D₃ region

The D₃ domain of 28S rDNA region was amplified by PCR using universal primers with slight modification with annealing temperature 50°C.

Sequence of universal primers

Forward D₃A: 5' GAC CCG TCT TGA AAC ACG GA 3'

Reverse D₃B: 5' TCG GAA GGA CCA GCT ACT A 3'

AGAROSE GEL ELECTROPHORESIS

The amplified products were separated by electrophoresis through 1.5% agarose gel in 1X TBE buffer pH 8 (Sambrook *et al.*, 1989) visualized and photographed using gel documentation system (Bio rad USA) after staining with ethidium bromide.

DNA SEQUENCING

Automated sequencing DNA

In automated DNA sequencing method the dideoxy nucleotides not the primers are tagged with different coloured fluorescent dyes, thus all four reactions occur in the same tube and are separated in the same lane on the gel. As each labeled DNA fragment passes a detector at the bottom of the gel, the colour is recorded and the pattern of colours representing each nucleotide in the sequence.

Molecular characterization of the collected samples is under investigation using molecular biology techniques (Wilkerson *et al.*, 1993). The D3 forward 5'-GACCCGTCTTGAAACACGGA-3' and D3 reverse 5'TCGGAAGGAACCAGCTACTA-3' primers were used to amplify the D3 region of 28S rDNA (Litvaitis *et al.*, 1994) seven members of Funestus group of Myzomyia and Annularis group of Neocellia series.

Sequencing of the D3 fragment

Nucleotide alignment of the D3 region for the three species of the *An. annularis* group is shown in Figure 2. The D3 sequences are present in the large subunit 28S of rDNA.

Performing a BLAST search (<http://blast.ncbi.nlm.nih.gov/Blast.cgi>) using the *Anopheles* mosquitoes nucleotide sequence.

Data: The Indian Anopheline mosquito species broadly fall into two categories viz. (i) subgenus *Anopheline* (ii) subgenus *Cellia*.

TAXONOMIC LIST

Subgenus *Anopheles* Meigen

1. *Anopheles (Anopheles) ahomi* Chowdhury, 1929.
2. *An. (An.) aikenii* James, 1903.
3. *An. (An.) annandalei* Prasad, 1918.
4. *An. (An.) argyropus* (Swellengrebel), 1914
5. *An. (An.) barbirostris* Vander Wulp, 1884.
6. *An. (An.) barbumbrosus* Strickland & Chowdhury, 1927.
7. *An. (An.) barianensis* James, 1911.
8. *An. (An.) bengalensis* Puri, 1930.
9. *An. (An.) crawfordi* Reid, 1953.
10. *An. (An.) culiciformis* Cogill, 1903.
11. *An. (An.) gigas* Giles, 1901.
12. *An. (An.) insulaeflorum* (Swellengrebel & Swellengrebel de Graaf), 1919.
13. *An. (An.) interruptus* Puri, 1929.
14. *An. (An.) lindesayi* Giles, 1900.
15. *An. (An.) nigerrimus* Giles, 1900.
16. *An. (An.) nitidus* Harrison, Scanlon & Reid, 1973.
17. *An. (An.) peditaeniatus* (Leicester), 1908.
18. *An. (An.) pinjaurensis* Barraud, 1932.
19. *An. (An.) roperi* Reid, 1950.
20. *An. (An.) sinensis* Weidemann, 1828.
21. *An. (An.) sintoni* Puri, 1929.
22. *An. (An.) umbrosus* (Theobald), 1903
23. *An. (C.) aconitus* Doenitz, 1902.

Subgenus *Cellia* Theobald

24. *An. (C.) annularis* Vander Wulp, 1884.
25. *An. (C.) culicifacies* Giles, 1901.
26. *An. (C.) dirus* Peyton & Harrison, 1979.
27. *An. (C.) dithali* Patton, 1905.
28. *An. (C.) elegane* (James), 1903.
29. *An. (C.) fluvialititis* James, 1902
30. *An. (C.) jamesii* Theobald, 1901.
31. *An. (C.) jeyporiensis* James, 1902.

32. *An. (C.) karwari* (James), 1902.
33. *An. (C.) kochi* Doenitz, 1901.
34. *An. (C.) maculates* Theobald, 1901.
35. *An. (C.) majidi* Young & Majid, 1928.
36. *An. (C.) minimus* Theobald, 1901.
37. *An. (C.) moghulensis* Christophers, 1924.
38. *An. (C.) multicolor* Cambouliu, 1902.
39. *An. (C.) nivipes* (Theobald), 1903.
40. *An. (C.) pallidus* Theobald, 1901.
41. *An. (C.) philippinensis* Ludlow, 1902.
42. *An. (C.) pseudojamesi* Strickland & Chowdhury, 1927.
43. *An. (C.) pseudwillmori* Theobald, 1910.
44. *An. (C.) pulcherrimus* Theobald, 1902.
45. *An. (C.) splendidus* Koidzumi, 1920.
46. *An. (C.) stephensi* Liston, 1901.
47. *An. (C.) subpictus* Grassi, 1899.
48. *An. (C.) sundaicus* (Rodenwaldt), 1925.
49. *An. (C.) tessellates* Theobald, 1901.
50. *An. (C.) theobaldi* Giles, 1901.
51. *An. (C.) turkhudi* Liston, 1901.
52. *An. (C.) vagus* Doentiz, 1902.
53. *An. (C.) varuna* Iyengar, 1924.
54. *An. (C.) willmori* (James), 1903.

Species Groups of Indian *Anopheles*:

Subgenus *Anopheles*

Aitkenii group: *aitkeii*, *bengalensis*, *insulaeflorum*, *pnnjaurensis*.

Asiaticus group: *annandalei*.

Barbirostris group: *ahomi*, *barbirostris*, *barbumbrosus*.

Barianensis group: *barianensis*.

Culiciformis group: *culiciformis*.

Hyrceanus group: *argyropus*, *crawfordi*, *nigerrimus*, *nitidus*, *peditaeniatus*, *sinensis*.

Lindesayi group: *gigas*, *lindesayi*. (These two species could not be segregated as a separate group in the key).

Subgenus *Cellia*

Umbrosus group: *roperi*, *umbrosus*. (This subgenus is not divided into groups in the key, although some of the species can be arranged into groups).

Annularis group: *annularis*, *nivipes*, *pallidus philippinensis*.

Maculates group: *maculates*, *pseudowillmori*, *willmori*.

Minimus group: *aconitus*, *minimus*, *varuna*.

RESULTS AND DISCUSSION

24 species of anopheles are identified from the studied area. The lists are given below:

TAXONOMIC LIST OF ANOPHELES MOSQUITOES OF GANJAM DISTRICT, ODISHA (MORPHOLOGY)

Class INSECTA

Order DIPTERA

Family CULICIDAE

Genus *Anopheles*

Subgenus *Anopheles*

1968. Asiaticus Group (Reid)

1. *An. annandelei* Prasad, 1918

Interruptus Subgroup (Rattanaarithikul et al., 2006b)

2. *An. interruptus* Puri, 1929

1961. Lindesayi Group (Reid & Knight)

1991. Gigas Complex (Harrison et al.)

3. *An. gigas* Giles, 1901

1961. Culiciformis Group (Reid & Knight)

4. *An. culiciformis* Cogill, 1903

1953. Hyrcanus Group (Reid)

5. *An. sinensis* Weidemann, 1828

1972. Nigerrimus Subgroup (Harrison)

6. *An. nigerimus* Giles, 1900

7. *An. nitidus* Harrison, Scanlon and Reid, 1973

Subgenus *Cellia*

1968. Annularis Group (Reid)

1999. Annularis Complex (Atrie et al.)

8. *An. annularis* Van der Wulp

9. *An. pallidus* Theobald, 1901

1949. Leucosphyrus Group (Reid)

Leucosphyrus complex (Sallum et al., 2005a)

10. *An. balabacensis* Baisas, 1936

Dirus complex (Sallum et al., 2005b)

11. *An. elegans* (James), 1903

Funestus Group (Garros et al., 2005b)

Culicifacies subgroup (Garros et al., 2005b).

12. *An. culicifacies* Giles, 1901

13. *An. karwari* (James), 1902

1987. Maculates Group (Rattanaarithikul & Green)

Maculates subgroup (Rattanaarithikul et al., 2006b)

14. *An. maculates* Theobald 1901

15. *An. pseudowillmori* Theobald 1910

2003. Minimus Subgroup (Chen et al.)

1990. Minimus Complex (Green et al.)

16. *An. minimus* Theobald, 1901

Neocellia Series (Christophers, 1924a)

17. *An. moughulensis* Christophers, 1924

18. *An. vagus* Doenitz, 1902

19. *An. subpictus* Grassi, 1899

Jamesii Group (Rattanaarithikul et al., 2006b)

20. *An. pseudojamesi* Strickland and Chowdhury, 1927

Myzomyia Series (Christophers, 1924a)

21. *An. majidi* Young and Majid, 1928

Tessellatus Group (Rattanaarithikul et al., 2006b)

22. *An. tessellates* Theobald, 1901

Funestus Group (Garros et al., 2005b)

Aconitus Subgroup (Chen et al., 2003)

23. *An. varuna* Iyengar, 1924

24. *An. aconitus* Doenitz, 1902

The morphological characterization has been done by dataset provided by Nagpal et al., 2005. The species found are grouped under two sub genus, (i) *Cellia* (ii) *Anopheles* 11 Groups and 7 complexes. The malarius complex and groups like Funestus Group; *An. culicifacies*, Annularis complex; *An. Annulais* found abundantly in coastal blocks of Ganjam whereas the Maculatus Group;

An. maculates, Minimus complex; *An.minimus* found abundantly at the Western part of Ganjam district.

1. Ganjam Mosquito Species: ***Anopheles (C.) balabacensis*** Baisas, 1936

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***balabacensis***

1949. The Subgenus *Cellia* includes Leucosphyrus Group (Reid) and Leucosphyrus complex (Sallum *et al.*, 2005a)

Characteristics:

Bionomics: Baharapadar, Galleri, Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

2. Ganjam Mosquito Species: ***Anopheles (C.) elegans*** (James), 1903

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***elegans***

1949. The Subgenus *Cellia* comprises Leucosphyrus Group (Reid) and Dirus complex (Sallum *et al.*, 2005b)

Characteristics:

Bionomics: Baharapadar, Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

3. Ganjam Mosquito Species: ***Anopheles (C.) tessellates*** Theobald, 1901

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***tessellates***

2006. The Subgenus *Cellia* includes Tessellatus Group (Rattanaarithikul *et al.*, 2006b). (www.mosquito-taxonomic-inventory.info/)

Characteristics:

Bionomics: Baharapadar, Brahmanpadar, Ganjam.

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

4. Ganjam Mosquito Species: ***Anopheles (C.) pseudojamesi*** Strickland and Chowdhury, 1927

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***pseudojamesi***

2006. The Subgenus *Cellia* belongs to Jamesii Group (Rattanaarithikul *et al.*, 2006b). (www.mosquito-taxonomic-inventory.info/)

Characteristics:

Bionomics: Baharapadar, Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

5. Ganjam Mosquito Species: ***Anopheles (C) maculates*** Theobald 1901

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***maculates***

1987. The Subgenus *Cellia* belongs to maculates Group (Rattanaarithikul & Green) and maculates subgroup (Rattanaarithikul *et al.*, 2006b). (www.mosquito-taxonomic-inventory.info/)

Characteristics:

Bionomics: Sorada, Galeri, Gopalpur Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

6. Ganjam Mosquito Species: ***Anopheles (C) pseudowillmori*** Theobald 1910

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***pseudowillmori***

1987. The Subgenus *Cellia* belongs to maculates Group (Rattanaarithikul & Green).

Characteristics:

Bionomics: Baharapadar, Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

7. Ganjam Mosquito Species: ***Anopheles (C) annularis*** Van der Wulp 1884

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***annularis***

1968. The Subgenus *Cellia* belongs to Annularis Group (Reid) and Annularis Complex (Atrie *et al.*, 1999).

Characteristics:

Bionomics: Gopalpur, Baharapadar Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

8. Ganjam Mosquito Species: ***Anopheles (C) pallidus*** Theobald 1901

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***pallidus***

1968. The Subgenus *Cellia* belongs to Annularis Group (Reid) and Annularis Complex (Atrie *et al.*, 1999).

Characteristics:

Bionomics: Brahmanpadar, Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

9. Ganjam Mosquito Species: ***Anopheles (C) culicifacies*** Giles 1901

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***culicifacies***

2005. The Subgenus *Cellia* is monophyletic. It belongs to Funestus Group (Garros *et al.*, 2005b) and Culicifacies subgroup (Garros *et al.*, 2005b).

Characteristics:

Bionomics: Gopalpur, Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

10. Ganjam Mosquito Species: ***Anopheles (C) moghulensis*** Christophers, 1924

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***moghulensis***

1924. The Subgenus *Cellia* is monophyletic. It belongs to *Neocellia Series* (Christophers, 1924a)

Characteristics:

Bionomics: Baharapadar, Nuagaon, Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

11. Ganjam Mosquito Species: ***Anopheles (C) subpictatus*** Grassi 1899

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***subpictatus***

1924. The Subgenus *Cellia* belongs to *Neocellia Series* (Christophers, 1924a)

Characteristics:

Bionomics: Baharapadar, Ganjam

Feeding time: Evening

Medical and Economic Importance: Common

Host: Human, Livestock

12. Ganjam Mosquito Species: ***Anopheles (C) vagus*** Iyengar, 1924

Classification:

Genus ***Anopheles***

Subgenus ***Cellia***

Species ***vagus***

1924. The Subgenus *Cellia* is monophyletic. It belongs to *Neocellia Series* (Christophers, 1924a)

*Characteristics:**Bionomics:* Baharapadar, Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock

13. Ganjam Mosquito Species: **Anopheles (C) aconitus** Doenitz, 1902

*Classification:*Genus **Anopheles**Subgenus **Cellia**Species **aconitus**

2003. The Subgenus *Cellia* belongs to Aconitus Subgroup (Chen *et al.*, 2003)

*Characteristics:**Bionomics:* Baharapadar, Brahmanpadar, Gopalpur Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock

14. Ganjam Mosquito Species: **Anopheles (C) majidi** Young and majid, 1928

Classification: Genus :**Anopheles**Subgenus: **Cellia**Species: **majidi**

1924. The Subgenus *Cellia* belongs to Myzomyia Series (Christophers, 1924a)

*Characteristics:**Bionomics:* Nuagaon, Gopalpur Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock

15. Ganjam Mosquito Species: **Anopheles (C) minimus** Theobald, 1901

*Classification:*Genus **Anopheles**Subgenus **Cellia**Species **minimus**

2003. The Subgenus *Cellia* belongs to Minimus Subgroup (Chen *et al.*,) and Minimus Complex (Green *et al.*, 1990)

*Characteristics:**Bionomics:* Baharapadar, Galeri, Brahmanpadar, Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock.

16. Ganjam Mosquito Species: **Anopheles (C) varuna** Iyengar, 1924

*Classification:*Genus **Anopheles**Subgenus **Cellia**Species **varuna**

2003. The Subgenus *Cellia* belongs to Funestus Group (Garros *et al.*, 2005b) and Aconitus Subgroup (Chen *et al.*,)

*Characteristics:**Bionomics:* Lokamari, Gopalpur, Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock

17. Ganjam Mosquito Species: **Anopheles (C) karwari** (James), 1902

*Classification:*Genus **Anopheles**Subgenus **Cellia**Species **karwari**

1924. The Subgenus *Cellia* belongs to Neocellia Series (Christophers, 1924a)

*Characteristics:**Bionomics:* Nua gaon, Baharapadar Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock

18. Ganjam Mosquito Species: **Anopheles annandalei** Prashad, 1918

*Classification:*Genus **Anopheles**Subgenus **Anopheles**Species **annandalei**

1968. The Subgenus *Cellia* belongs to Asiaticus Group (Reid,)

*Characteristics:**Bionomics:* Brahmanpadar, Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock19. Ganjam Mosquito Species: ***Anopheles interruptus*** Puri, 1929*Classification:*Genus ***Anopheles***Subgenus ***Anopheles***Species ***interruptus***1968. The Subgenus *Cellia* belongs to Asiaticus Group (Reid) and *Interruptus* Subgroup (Rattanarithikul *et al.*, 2006b)*Characteristics:**Bionomics:* Brahmanpadar, Ganjam*Feeding time:* Evening, Night*Medical and Economic Importance:* Common*Host:* Human, Livestock20. Ganjam Mosquito Species: ***Anopheles gigas*** Giles, 1901*Classification:*Genus ***Anopheles***Subgenus ***Anopheles***Species ***gigas***1961. The Subgenus *Cellia* belongs to Lindesayi Group (Reid & Knight) and *Gigas* Complex (Harrison *et al.*, 1991)*Characteristics:**Bionomics:* Sorada, Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock21. Ganjam Mosquito Species: ***Anopheles nigerimus*** Giles, 1900*Classification:*Genus ***Anopheles***Subgenus ***Anopheles***Species ***nigerimus***1953. The Subgenus *Cellia* belongs to Hyrcanus Group (Reid) and *Nigerrimus* Subgroup (Harrison, 1972)*Characteristics:**Bionomic:* Brahmanpadar, Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock22. Ganjam Mosquito Species: ***Anopheles nitidus*** Harrison, Scanlon and Reid, 1973*Classification:*Genus ***Anopheles***Subgenus ***Anopheles***Species ***nitidus***1953. The Subgenus *Cellia* belongs to Hyrcanus Group (Reid) and *Nigerrimus* Subgroup (Harrison, 1972)*Characteristics:**Bionomic:* Brahmanpadar, Ganjam*Feeding time:* Evening*Medical and Economic Importance:* Common*Host:* Human, Livestock23. Ganjam Mosquito Species: ***Anopheles sinensis*** Wiedemann, 1828*Classification:*Genus ***Anopheles***Subgenus ***Anopheles***Species ***sinensis***1953. The Subgenera *Cellia* belongs to Hyrcanus Group (Reid)*Characteristics:**Bionomic:* Brahmanpadar, Ganjam*Feeding time:* Evening, Night*Medical and Economic Importance:* Common*Host:* Human, Livestock24. Ganjam Mosquito Species: ***Anopheles culiciformis*** Cogill, 1903*Classification:*Genus ***Anopheles***Subgenus ***Anopheles***Species ***culiciformis***1961. The Subgenus *Cellia* belongs to *Culiciformis* Group (Reid & Knight)*Characteristics:**Bionomic:* Brahmanpadar, Ganjam

Feeding time: Evening, Night

Medical and Economic Importance: Common

Host: Human, Livestock

The anopheline diversity especially the subgenus *Anopheles* has been increased in comparison to *Anopheles* species recorded during the following Periods [1939 (Senior White & Adhikari), 1942 (Covell & Singh), 1983 (Nagpal & Sharma) and 2000 (Dash *et al.*,)] in the coastal district Ganjam (Table. 3).

Molecular study:

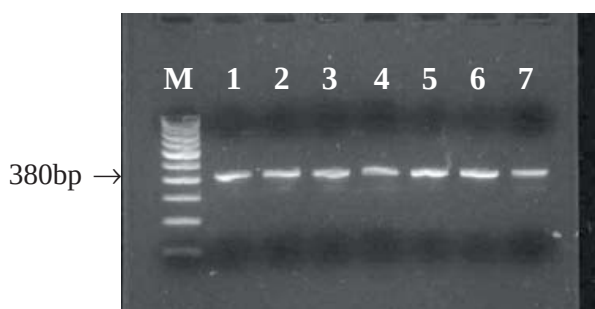


Fig.2. Lanes 1: *An. annularis* species; lanes 2: *An. pallidus* species; lanes 3: *An. culicifacies*; lanes 4: *An. subpictus* species; lanes 5: *An. vagus* species; lanes 6: *An. varuna* species; lanes 7: *An. aconitus* species. Lane M, 100-bp DNA ladder, lanes 1–7 showed common 380-bp product from the D3 domain of 28S rDNA of members of the Myzomyia and Neocellia series. Ethidium bromide-stained agarose gel-electrophoresis D3 PCR products of members of Funestus group of Myzomyia and Annularis group of Neocellia series.

Sequencing analysis was done to identify the species collected from villages of Ganjam District. After sequencing the samples were matched with the data present in the genbank and they were matched. The following results are obtained in the sequencing.

The 309 bp 28S rRNA Sequence of *An. balbacensis* was taken as a reference sequence and blasted in NCBI it shows 94% similarity score with 98% Query coverage with *Anopheles tessellatus* isolate FAts2 NCBI accession number is FJ159601. Similarly when 295 bp 28S rRNA Sequence of *An. interruptus* was taken as a reference sequence and blasted in NCBI it shows 83% similarity score with 37% Query coverage with *Anopheles hyrcanus* NCBI accession number is AY376903. It indicates very poor homology of this sequence is available in the database till date. It concludes that it may be a new species and to further characterize it

whole genome sequencing is essential. The 149 bp 28S rRNA Sequence of *An. Bengalensis* was taken as a reference sequence and blasted in NCBI it shows 95% similarity score with 67% Query coverage with *Anopheles sinensis* NCBI accession number is AY376321. The blast result of 505 bp 28S rRNA Sequence of *An. Varuna* shows 99% similarity score with 62% Query coverage with *Anopheles vagus* NCBI accession number is EU570062 at the same time 279 bp 28S rRNA Sequence of *An. Lindesayi* shows 98% similarity score with 93% Query coverage with *Anopheles culicifacies* isolate FAcu1 NCBI accession number is FJ159604. When 313 bp 28S rRNA Sequence of *An. tessellatus* was taken as a reference sequence and blasted in NCBI it shows 99% similarity score with 94% Query coverage with *Anopheles tessellatus* isolate FAts2 NCBI accession number is FJ159601. The 313 bp 28S rRNA Sequence of *An. Subpictus* was taken as a reference sequence and blasted in NCBI it shows 77% similarity score with 92% Query coverage with *Anopheles albimanus* NCBI accession number is L78065 whereas with *Anopheles lesteri* NCBI accession number is AY376317 shows 92% similarity score and 80% Query coverage. When 306 bp 28S rRNA Sequence of *An. Vagus* was taken as a reference sequence and blasted in NCBI it shows 78% similarity score and 99% Query coverage with *Anopheles jeyporiensis* NCBI accession number is AJ512724.1 whereas with *Anopheles lesteri* NCBI accession number is AY376317 shows 96% similarity score and 80% Query coverage. When 345 bp 28S rRNA Sequence of *An. insulaeflorum* was taken as a reference sequence and blasted in NCBI it shows 100% similarity score and 100% Query coverage with *Anopheles ulicifacies* isolate FAcu1 NCBI accession number is FJ159604.

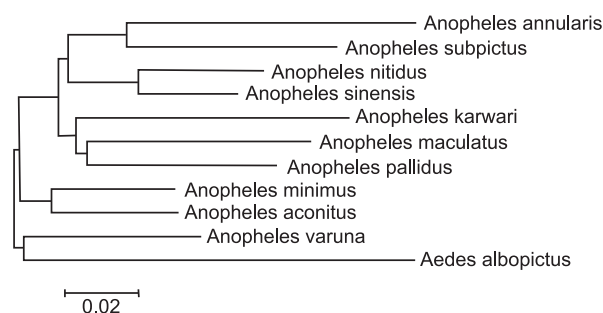


Fig. The analysis of sequence Phylogenetic tree of COII gene of *Anophelines* collected from Ganjam, Odisha.

Table 2. *Anopheles* mosquito Diversity of Ganjam District.

<i>An. aconitus</i>	+	+	+		+			+	+	+					+		+		+			
<i>An. varuna</i>	+	+	+			+			+											+	+	
<i>An. tessellates</i>															+	+						
<i>An. majidi</i>									+											+		
<i>An. pseudojamesi</i>					+											+						
<i>An. vagus</i>					+	+		+				+			+	+	+	+				
<i>An. moughulensis</i>																+					+	
<i>An. minimus</i>												+	+			+						
<i>An. pseudowillmori</i>																+						
<i>An. maculates</i>									+												+	
<i>An. karwari</i>						+						+				+		+			+	
<i>An. culicifacies</i>									+													
<i>An. elegans</i>																+						
<i>An. balabacensis</i>					+											+						
<i>An. pallidus</i>											+					+						
<i>An. annularis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>An. subpictatus</i>	+	+	+	+			+	+		+						+						
<i>An. nigerimus</i>		+			+	+								+		+						
<i>An. nitidus</i>			+	+	+	+								+	+	+						
<i>An. sinensis</i>				+		+										+						
<i>An. culiciformis</i>																+		+				
<i>An. gigas</i>				+														+			+	
<i>An. interruptus</i>	+	+	+		+	+										+						
<i>An. annandelei</i>	+	+	+	+	+	+					+	+			+	+						
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Blocks of Ganjam	Chatrapur	Ganjam	Khalikote	Beguniapada	Polasara	Purrushottampur	Kabisurya Nagar	Hinjli	Rangeilunda	Kukudakhandi	Sanakhemundi	Digapahandi	Chikti	Patrapur	Bhanjanagar	Belaguntha	Jaganathprasad	Buguda	Dharakot	Aska	Sorada	Sheragada

Table 3. Anopheles fauna of coastal Orissa: Surveys Separated by over Half a Century.

Anopheles Species or Group	1937-1942 Reported by Senior-White & Adhikari(1939) and/or Covel & Singh(1942)	1995-1996 Reported by Dash et.al.	2010-11 detected during present survey.
<i>annandelei</i> Prasad, 1918	-	-	+
<i>interruptus</i> Puri, 1929.	-	-	+
<i>gigas</i> Giles, 1901	-	-	+
<i>culiciformis</i> Cogill, 1903	-	-	+
<i>sinensis</i> Weidemann, 1828	-	-	+
<i>nigerimus</i> Giles, 1900	+	-	+
<i>nitidus</i> Harrison, Scanlon and Reid, 1973	-	-	+
<i>annularis</i> Van der Wulp	+	+	+
<i>pallidus</i> Theobald, 1901	+	+	+
<i>balabacensis</i> Baisas, 1936	-	-	+
<i>elegans</i> (James), 1903	-	-	+
<i>culicifacies</i> Giles, 1901	+	+	+
<i>karwari</i> (James), 1902	+	+	+
<i>maculatus</i> Theobald 1901	+	-	+
<i>pseudowillmori</i> Theobald 1910	-	-	+
<i>minimus</i> Theobald, 1901	+	-	+
<i>moughulensis</i> Christophers, 1924	-	-	+
<i>An. vagus</i> Doenitz, 1902	+	+	+
<i>subpictus</i> Grassi, 1899	+	+	+
<i>pseudojamesi</i> Strickland and Chowdhury, 1927	-	-	+
<i>majidi</i> Young and Majid, 1928	-	-	+
<i>tessellatus</i> Theobald, 1901.	-	+	+
<i>varuna</i> Iyengar, 1924	-	+	+
<i>aconitus</i> Doenitz, 1902	+	+	+

The Phylogeny tree is based on COII gene sequence of *Anophelines* generated by using Neighbor Joining method using the Tamura-Nei model of Mega 6 software showed that the *Anophelines* from Odisha were clustered into 1 groups. COII gene sequence of *Ae. albopictus* was taken as outgroup.

Homology data of D3 domain of 28S ribosomal RNA gene sequences of ten *Anopheles* sp. revealed that the species identification results both at morphological and molecular level not substantiates each other. The sequence revealed one species named *An. listeri* which is having no distributional record from Indian subcontinent although it is a member of the Hyrcanus complex found in South-east Asia and morphologically similar to species *An. sinensis* (Subbarao, 2007; Reid, 1953) found in this sub-continent. Hence it was concluded that 28S ribosomal RNA gene sequencing is not sufficient for species level identification and whole genome sequencing of the same has to be done further for confirmation at species level.

The anopheline fauna was surveyed in the Koraput district which is an adjacent district to Ganjam District of Orissa by Gunasekaran et al. 1989. The district is known for malaria and consists of anophelines belonging to 22 species and two

varieties. Later Rajavel et al. in the year 2004 surveyed the Jeypore Hills of Koraput District and identified only 8 species of *Anopheles*. The malarious anopheline complex of Ganjam district never highlighted although this district is badly affected by Malaria. It does not need to be emphasized that revisionary studies on the taxonomy of the anopheline fauna of the country are urgently required (Das et al., 1990). During the past two or three decades numerous studies on the various groups of anophelines such as *Anopheles annularis*, *culicifacies*, *hyrcanus*, *maculatus*, *subpictus*, etc have been made leading to many changes in the nomenclature of the anopheline species (Subbarao, 2007). An important step in the assessment of the disease potential of an insect is the rapid separation and identification is needed therefore the present study holds significant reasons in studying the taxa of anophelines of Studied area.

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file:///E:/Molecular%20studies/GIS,%20Ganjam.htm

PLATE I

Chacteristics of Species *balabacensis*



4 banded Palpi



White spot at tibiotersal joint of hind leg



Pre-sector dark mark of vein 1(R1) not reaching upto the distal end of humeral dark mark on the costa

Chacteristics of Species *elegans*



4 banded Palpi



Length of Proboscis longer than fore femur

Chacteristics of Species *tessellates*



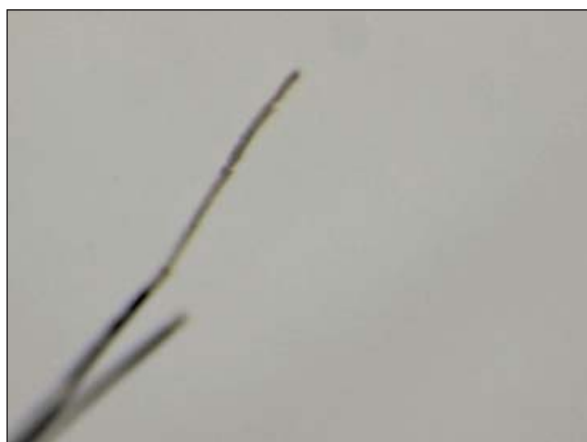
4 banded Palpi, Speckling in legs



Narrowly banded hind leg tarsomeres

PLATE IIChacteristics of Species *Pseudojamesi*

Apical Pale band on Palpi nearly equal to the pre-apical dark band

Area at the bifurcation of wing vein 5 (Cu)
dark and inner-costa interrupted

Hind tarsomeres 5,4,3 completely pale

Chacteristics of Species *maculates*Apical Pale band on Palpi nearly equal to the
Sub-apical Pale bandDark band at 4th tarsomeres of hind leg

PLATE III

Chacteristics of Species *pseudowillmori*



Apical Pale band on Palpi nearly equal to the Sub-apical Pale band



Dark band at 4th tarsomeres of hind leg



Abdomen without any broad golden scales

Chacteristics of Species *annularis*



Anopheles annularis



Hind leg tarsomeres 5, 4, 3 completely pale



Apical Pale band on Palpi nearly equal to the pre-apical dark band



Area at the bifurcation of Wing vein 5(Cu) Dark

PLATE IV

Chacteristics of Species *Pallidus**Anopheles pallidus*

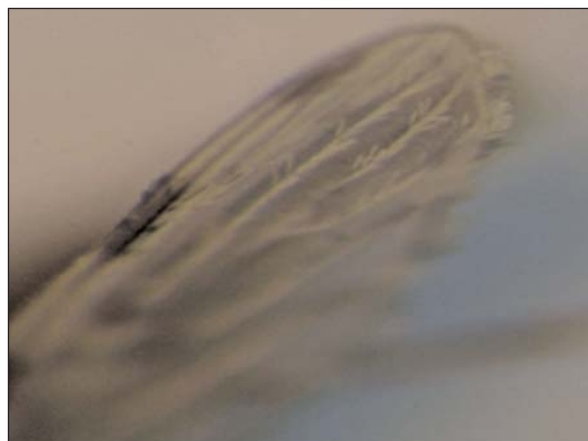
Apex of Hind tarsomere without any pale band



Apical Pale band on Palpi nearly equal to the pre-apical dark band



Area at the bifurcation of Wing vein 5(Cu) Pale

Chacteristics of Species *culicifacies*Pre-apical dark band $\frac{1}{4}$ of the Apical Pale band on Palpi

Fringe spot on vein 3(R4+5) absent

PLATE V

Chacteristics of Species *moghulensis*



Band on fore leg tarsomeres very small



Distance of the anterior forked cell from the base of the costa compared to that of posterior forked cell more

Chacteristics of Species *subpictatus*



Anopheles (C) subpictatus



Apical Pale band on Palpi nearly equal to the pre-apical dark band



Bands on fore leg tarsomeres broad

Chacteristics of Species *vagus*



Anopheles (C) vagus



Pre-apical dark band $\frac{1}{4}$ or $\frac{1}{5}$ of Apical Pale band on Palpi



Bands on fore leg tarsomeres broad

PLATE VIChacteristics of Species *aconitus*

Intervening dark band on the palpi very small



Apical half of the proboscis light yellow

Chacteristics of Species *majidi*

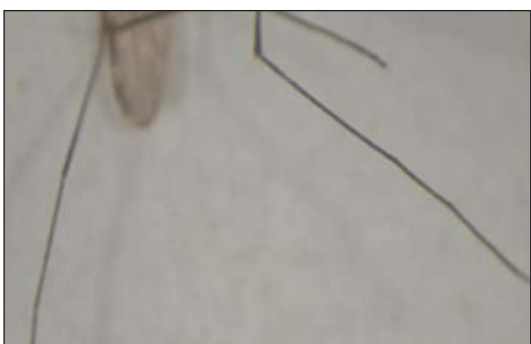
Intervening dark band on the palpi very small



Tip of hind leg tarsomere and bands on legs pale and bands present

Chacteristics of Species *minimus**Anopheles (C) minimus*

Apical and sub-apical pale band equal



Tip of hind leg tarsomere and bands on leg black and bands absent



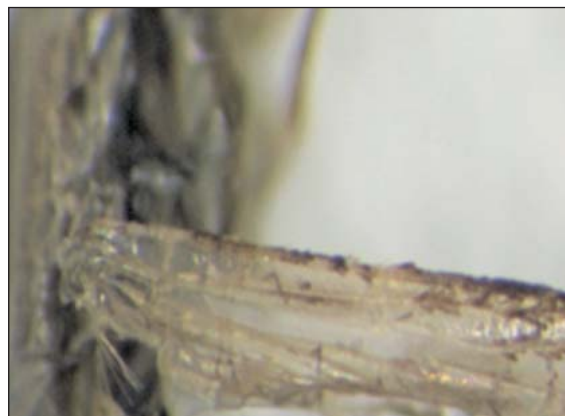
Inner costa interrupted can be seen at least in one wing

PLATE VII

Chacteristics of Species *varuna*



Apical pale band equal to pre-epical dark band



Innecosta Dark

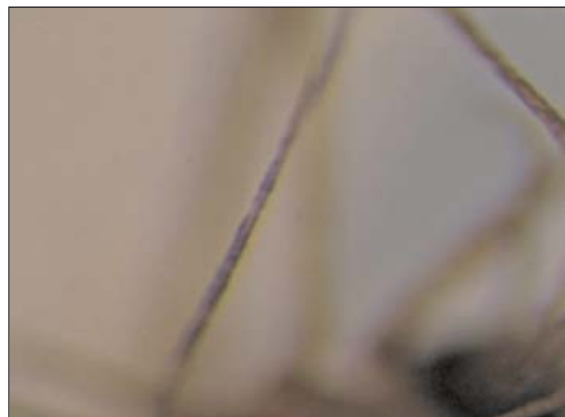


Tip of hind leg tarsomere and bands on legs black and bands absent

Chacteristics of Species *karwari*



Four banded palpi



Legs without speckling and 5th tarsomere of hind leg pale

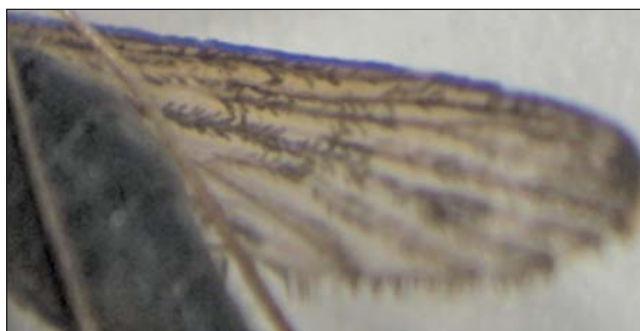
PLATE VIII

Chacteristics of Species *annandalei**Anopheles annandalei*

A tuft of pale and black scales towards apex of hind femur present



Small bpale bands at the joints of Palpi



Wing with sub costal pale spot absent on costa

Chacteristics of Species *interruptus**Anopheles annandalei*
 A tuft of pale and black scales towards apex of hind femur present

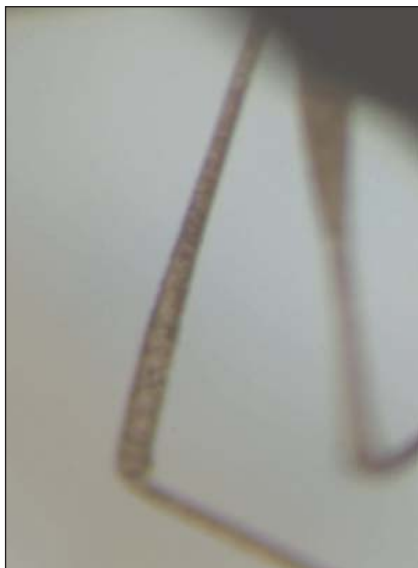

Small bpale bands at the joints of Palpi



Wing with sub costal pale spot absent on costa

PLATE IX

Characteristics of Species *gigas*



Pale ring on dorsal side towards the apex of mid leg femur absent

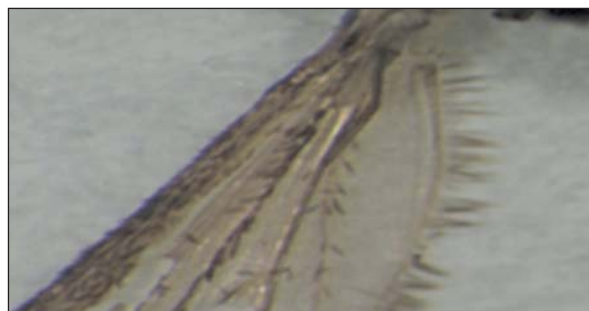


Pale spot on vein 6 present

Characteristics of Species *nigerimus*



Four banded palpi (tip of the palpi pale)

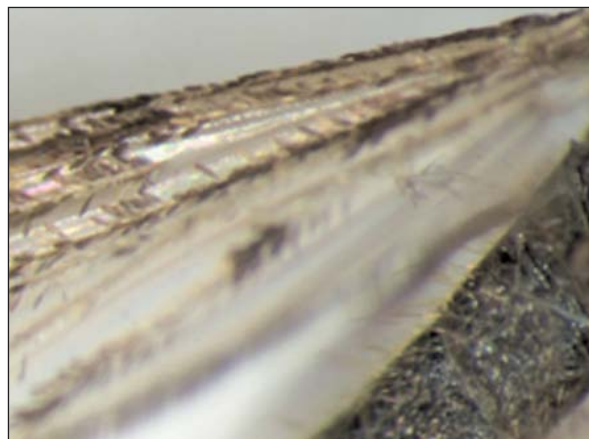


Size of basal dark mark on wing vein 5(Cu) long

Characteristics of Species *nitidus*



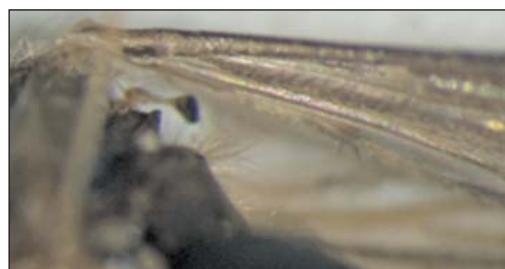
Four banded palpi (tip of the palpi pale)



Size of basal dark mark on wing vein 5(Cu) small

PLATE XChacteristics of Species *sinensis*

Four banded palpi (tip of the palpi pale)



Pale scale on inner costa and fringe spot on vein 5.2(cu2) abset



Size of pale bands on hind leg tarsomeres very small

Chacteristics of Species *culiciformis**Anopheles culiciformis*

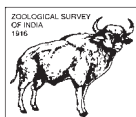
Palpi smaller than proboscis



Costa and sub-costa including vein 1(R1) completely dark



Scales on the head completely dark and broad in size



STUDY OF MACRO-BENTHIC (INVERTEBRATE) FAUNA AROUND DIGHA COAST

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INTRODUCTION

The organisms that live on, or in, the bottom of a water body with $>1.0\text{mm}$ size are known as macrobenthic organisms which mainly consists of different invertebrates viz., molluscs, cnidarians, crustaceans, sponges, worms, etc. Benthic invertebrates play an important role in transitional ecosystems, by filtering phytoplankton and then acting as a food source for larger organisms such as fish, thereby linking primary production with higher trophic levels. They also structure and oxygenate the bottom by reworking sediments and play a fundamental role in breaking down organic material before bacterial remineralization. In addition, a number of benthic invertebrates, particularly bivalves, are also consumed by humans and others, such as worms, are used for recreational purposes as fishing bait. They are often used as biological indicators because they can provide information on environmental conditions either due to the sensitivity of single species (indicator species) or because of some general feature that makes them integrate environmental signals over a long period of time. Due to habitat loss, overexploitation and impact of various anthropogenic pressures, the macrobenthic invertebrates are under continuous threats and which may impact on higher group of animals. Few studies on macro-benthic fauna of India are available (Ref). Many of these studies

restricted to either few areas or few groups (Ref). However, there is no baseline information available for Digha coast in West Bengal. Few studies on marine biodiversity of Digha coast as well as surrounding coastal area were carried out in the past (Goswami, 1992, Subba Rao, *et al.*, 1992; Talukdar *et al.*, 1996, Ramkrishna *et al.*, 2003). Keeping view of these studies, the study was planned to evaluate the the recent population and distribution of macrobenthic invertebrates around Digha coast.

MATERIALS AND METHODS

The study area: Digha beach is situated close to the Gangetic mouths on the northern east coast of India where the sea is quite shallow with very little wave action and large intertidal expanses. Digha and the surrounding coastal area are with variable



Fig. 1. A map showing study locations around Digha coast.

habitats. The coastline, here, is straight and the beach is flat and compact. The beach is made up of sand grains mixed with variable proportions of silt and which makes it very compact. The different study locations in the present study were Talsari, Udaipore, Digha, Mohana & Shankarpur. These five locations are having different type of habitats which was represented through dominance of various species. The beach slope is shore is very gradual upto the low water mark.

Sampling: The study was carried out during August, 2008 to September, 2010 and the examples of benthic invertebrate representing various groups were collected from different habitats. Standard sampling techniques were employed at different study locations using line transects and quadrates in different zones. The sampling protocol were designed using the techniques of beach profiles by Emery, 1961. Generally, the collection of benthic animals were done at the time of low tide, however, fish catches at the time beach trawl operation were also monitored for the collection of sessile invertebrates. The macrobenthic fauna collections were preserved in 70% alcohol mixed with 3% of formalin.

RESULTS

Composition of marine benthic invertebrate groups: The overall comparison of all the marine benthic invertebrate groups recorded during the study at different study locations are represented in the Fig. 2. The comparison of benthic faunal group shows that the mollusc contributes the major part in the marine benthic fauna around Digha coast. Among molluscs, the bivalve shared 58 % and gastropods 21 %. The overall contribution of molluscs was 79 %. The phylum arthropods were second largest group with 14 % followed by Cnidaria with 4 %. However, Annelids, Brachiopods & Echinoderms contributes only 1% of total faunal composition. Among molluscs, the bivalve shared 58 % and gastropods 21 %. The overall contribution of molluscs was 79 %. The phylum arthropods were second largest group with

14 % followed by Cnidaria with 4 %. However, Annelids, Brachiopods & Echinoderms contributes only 1% of total faunal composition.

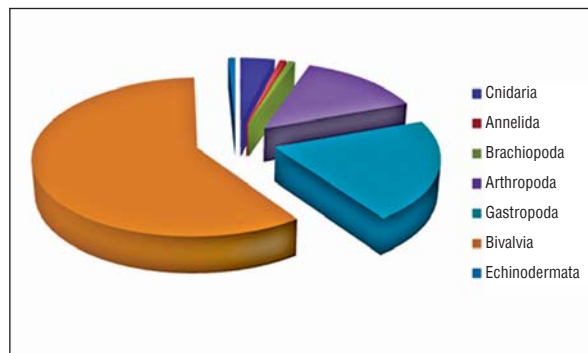


Fig. 2. Composition of major marine benthic invertebrate groups.

The diversity of macro-benthic fauna among all the study locations during the study period was given in Table 2. There were a total of 141 species under different groups were recorded from 88 genera and 52 families. The group-wise contribution shows that Phylum Mollusca was most abundant among all the study location. It has recorded 106 species from 32 families. The further division of this groups shows that Bivalvia contributes 79 species from 16 families and gastropods contributed 27 species from 16 families. Among the most abundant group i.e. bivalve, family Veneriidae was observed to be most diverse with 19 species from 10 genera. The other diverse families in bivalves were family Mactriidae with 13 species from 4 genera and family Tellinidae with 12 species from 4 genera. The second most abundant group among the benthic fauna during the study was observed as Phylum Arthropoda which contributed 21 species from 11 families. Further division of faunal composition was contributed by Phylum Cnidaria with 7 species from 4 families, Phylum Annelida with 4 species from 2 families, Phylum Echinodermata with 2 species from one family and Brachiopoda with one species only.

Faunal diversity among study locations: Faunal diversity among different study location shown in Fig. 3. The maximum diversity of benthic fauna was recorded in Udaipur with 84 species from

different groups which was followed by Talsari & Shankarpur with 77 species. Digha location was reported minimum diversity of benthic fauna with 55 species. However, Mohana was reported with 57 species. Group wise species composition at different localities shows that Talsari location was recorded maximum 39 species from 12 families of Bivalves, 10 species from 9 families of Gastropods and 15 species from 7 families of Arthropods. The group like Cnidaria, Brachiopod & Echinoderms were not recorded at Talsari and Annelids were reported only two species. Udaipur location although had maximum number of species diversity, shows same number of bivalve diversity as in Talsari i.e. 39 species from 14 families. Other fauna in Udaipur reported were the gastropods 15 species from 10 families, arthropods 21 species from 11 families, Cnidaria 6 species from 4 families and annelids 2 species from one family. The brachiopod were represented by only one species at Udaipur and echinoderm were totally absent during the sampling at this location. Digha was represented with 32 species of bivalves from 10 families, 9 species of gastropods from 8 families, 8 species of arthropods from 6 families and only one species of cnidaria. Annelida, Brachiopoda and echinodermata were totally absent in Digha.

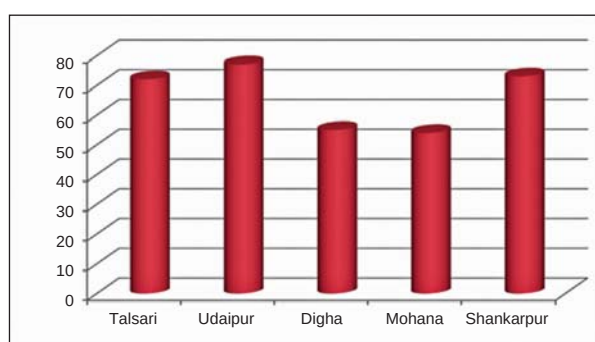


Fig. 3. Faunal diversity among study locations

Mohana benthic fauna comprised of 27 species of bivalves from 10 families, 7 species of gastropods from 5 families, 10 species of arthropods from 5 families, 2 species of annelids and 1 species each of cnidaria, brachiopod &

echinodermata. Shankarpur represented with 45 species of bivalve from 13 families which was maximum number of bivalves among other study locations. Other benthic fauna of Shankarpur comprised of 11 species of gastropods from 9 families, 11 species of arthropods from 6 families, 2 species of annelids & echinoderms and 1 species of cnidaria. Brachiopods was also absent in this location.

Percentage species composition at different study locations: Percentage species composition of various benthic invertebrate groups at different study locations is shown in Fig. 4. At Talsari, the percentage of different faunal groups shows that the bivalve had maximum percentage with 60% composition which was followed by arthropods with 20% and gastropods with 15% composition among other fauna. Udaipur location observed bivalve composition 47%, arthropods 26%, gastropods 17%, cnidaria 6% & others 4%. The percentage composition at Digha location was 65% bivalve, 18% gastropods, 14% arthropods and 2% cnidaria and Mohana it was 59% bivalve, 21% arthropods, 15% gastropods and 2% each of cnidaria and other invertebrates. In Shankarpur, faunal composition consisted with 64% bivalve, 16% each of gastropods & arthropods and 3% other fauna. The overall comparison of faunal percentage composition shows that the bivalve contributed major part followed by Arthropoda and Gastropoda in the study locations.

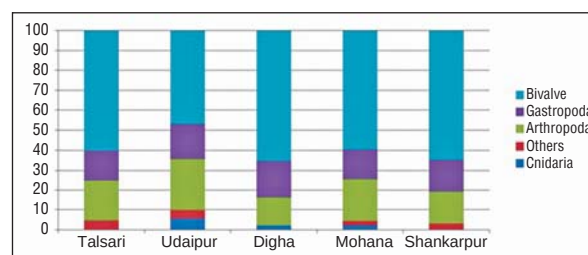


Fig. 4. Percentage species composition at different study locations

Species diversity index: Graphical representation of Shannon-Wiener index of

species diversity of molluscan fauna which was one of the major component of benthic diversity among the study locations in different seasons is shown in Figure 5. The major dominant species are *Mactra cuneata* (Gmelin, 1791), *Mactra dissimilis* (Reeve, 1854), *Mactra luzonica* (Reeve, 1854), *Mactra mera* (Reeve), *Bernea candida* (Linnaeus, 1758) and majority of the species are distributed in the region but does not reflected its dominance throughout the sampling.

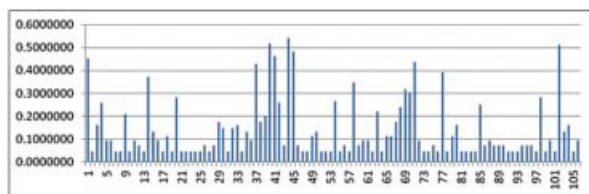


Fig. 5. Species diversity index.

(Species name: 1. *Umbonium vestiarium* (Linnaeus, 1758); 2. *Nerita (Ritena) grayana* (Recluz, 1843); 3. *Telescopium telescopium* (Montfort); 4. *Amaea (Acrilla) acunimata* (Sowerby, 1844); 5. *Natica tigrina* (Roeding, 1798); 6. *Polinices (Glossaulox) didyma* (Roeding); 7. *Polinices trigona*; 8. *Sinum laevigatum*; 9. *Turritella attenuata* (Reeve, 1849); 10. *Turritella columnaris*; 11. *Lamellaria (Corvicella) indica* (Leach); 12. *Bursa (Bufonaria) rana*; 13. *Gyrinum natator*; 14. *Thais blanfordi* (Melvill, 1893); 15. *Thais lacera* (Born, 1778); 16. *Cronia konkanensis* (Melvill, 1893); 17. *Murex tribulus* (Linnaeus, 1758); 18. *Nassarius (Hima) stolatus* (Gmelin, 1791); 19. *Nassarius drsatus*; 20. *Amalda ampla* (Gmelin, 1791); 21. *Olivancilaria globosa*; 22. *Oliva olive*; 23. *Agaronia nebulosa*; 24. *Melo melo* (Solander, 1786); 25. *Turricula javana*; 26. *Pugilina (Hemifusus) cochlidium* (Linnaeus, 1758); 27. *Archectionica perspective* (Linnaeus, 1758); 28. *Anadara granosa* (Linnaeus, 1758); 29. *Anadara antiquata* (Linnaeus, 1758); 30. *Scapharca inaequivalvis* (Bruguiere, 1789); 31. *Scapharca indica* (Gmelin, 1791); 32. *Scapharca cornea*; 33. *Perna viridis* (Linnaeus, 1758); 34. *Modiolus undulates* (Dunker); 35. *Modiolus striatulus*; 36. *Atrina bicolor*; 37. *Saccostrea cucullata* (Born, 1778); 38. *Crassostrea cuttackensis* (Newton & Smith); 39. *Crassostrea graphoides*; 40. *Mactra luzonica* (Reeve, 1854); 41. *Mactra mera* (Reeve); 42. *Mactra violacea* (Gmelin, 1791); 43. *Mactra stultum* (Linnaeus, 1758); 44. *Mactra cuneata* (Gmelin, 1791); 45. *Mactra dissimilis* (Reeve, 1854); 46. *Mactra parkensiana* (Hadley, 1902); 47. *Mactra echatina* (Holten, 1802); 48. *Mactra echinata*; 49. *Mactra symmetrica*; 50. *Roetella pulchella*; 51. *Roeta peliculla*; 52. *Spisula (Standella) annandalei*; 53. *Tellina angulosa* (Gmelin, 1791); 54. *Tellina (Tellinids) opalina*; 55. *Tellina (Homalina) myaeformis* (Sowerby); 56. *Tellina timorensis*; 57. *Tellina sinuate*; 58. *Macoma blairensis*; 59. *Macoma (Psammocoma)*

truncate; 60. *Macoma birmanica*; 61. *Macoma truncate*; 62. *Macoma candida* (Lamarck, 1818); 63. *Apolymetis edentula*; 64. *Arcopagia remis* (Linnaeus); 65. *Donax pulchellus*; 66. *Donax incrnatus* (Gmelin, 1791); 67. *Donax compressus*; 68. *Donax deltoids* (Lamarck, 1818); 69. *Donax scortum* (Linnaeus, 1758); 70. *Sanguinolaria (Soletellina) acuminata* (Deshays); 71. *Mertrix meretrix*; 72. *Meretrix casta*. 73. *Circe scripta*; 74. *Pitar affinis*; 75. *Pitar morhuansis*; 76. *Pitar textile*; 77. *Mercia opima* (Gmelin, 1791); 78. *Paphia schnelliana*; 79. *Paphia semirugata*; 80. *Paphia gallus*; 81. *Pahia malabrica*; 82. *Paphia alapailiones* (Roeding); 83. *Sunetta (Sunetta) scripta*; 84. *Sunetta (Sunetta) meroi*; 85. *Pelecyrora trigona* (Reeve); 86. *Tapes belcheri*; 87. *Dosinia bruguieri*; 88. *Katelesiya japonica*; 89. *Katelesiya mermorata*; 90. *Diplodonta semiaspera* (Philippi, 1836); 91. *Diplodonta berhampurensis*; 92. *Trachycardium angulatum* (Lamarck, 1819); 93. *Laevicardium australis* (Sowerby); 94. *Plagiocardium pseudolatum* (Vosku & Unverwagt); 95. *Solen kemp* (Preston); 96. *Solen brevis*; 97. *Siliqua radiate*; 98. *Siliqua winteriana* (Dunker, 1852); 99. *Pharella javanica* (Lamarck, 1818); 100. *Glaucanome sculpta*; 101. *Glaucanome virens* (Linnaeus, 1767); 102. *Bernea candida* (Linnaeus, 1758); 103. *Pholas orientalis* (Gmelin, 1791); 104. *Laternula truncate* (Lamarck, 1818); 105. *Laternula anatine* & 106. *Placuna placenta* (Linnaeus, 1758))

Number of occurrences of different species:
The occurrence and relative occurrence of different species is presented in Figs. 6 & 7. The maximum occurrence for the species like *Amaea (Acrilla) acunimata*, *Saccostrea cucullata*, *Mactra cuneata*, *Mertrix meretrix*, *Mercia opima*, *Bernea candida* and most of the species reported form the region were from a single occurrence during the entire sampling period.

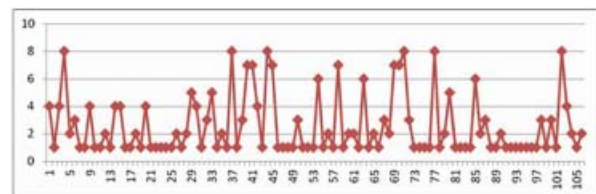


Fig. 6. Occurrences of different species.

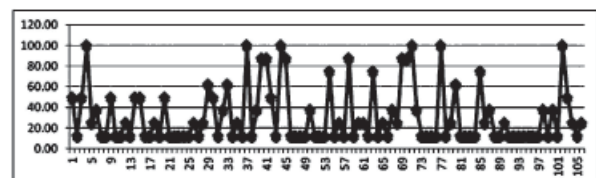


Fig. 7. Percentage occurrence of different species.

(Species name: 1. *Umbonium vestiarium* (Linnaeus, 1758); 2. *Nerita (Ritena) grayana* (Recluz, 1843); 3. *Telescopium telescopium* (Montfort,); 4. *Amaea (Acrilla) acunimata* (Sowerby, 1844); 5. *Natica tigrina* (Roeding, 1798); 6.

Polinices (Glossaulox) didyma (Roeding); 7. *Polinices trigona*; 8. *Sinum laevigatum*; 9. *Turritella attenuata* (Reeve, 1849); 10. *Turritella columnaris*; 11. *Lamellaria (Corvicella) indica* (Leach); 12. *Bursa (Bufonaria) rana*; 13. *Gyrinum natator*; 14. *Thais blanfordi* (Melvill, 1893); 15. *Thais lacera* (Born, 1778); 16. *Cronia konkanensis* (Melvill, 1893); 17. *Murex tribulus* (Linnaeus, 1758); 18. *Nassarius (Hima) stolatus* (Gmelin, 1791); 19. *Nassarius drsatus*; 20. *Amalda ampla* (Gmelin, 1791); 21. *Olivancilaria globosa*; 22. *Oliva olive*; 23. *Agaronia nebulosa*; 24. *Melo melo* (Solander, 1786); 25. *Turicula javana*; 26. *Pugilina (Hemifusus) cochlidium* (Linnaeus, 1758); 27. *Archectionica perspective* (Linnaeus, 1758); 28. *Anadara granosa* (Linnaeus, 1758); 29. *Anadara antiquata* (Linnaeus, 1758); 30. *Scapharca inaequalvis* (Bruguiere, 1789); 31. *Scapharca indica* (Gmelin, 1791); 32. *Scapharca cornea*; 33. *Perna viridis* (Linnaeus, 1758); 34. *Modiolus undulates* (Dunker); 35. *Modiolus striatulus*; 36. *Atrina bicolor*; 37. *Saccostrea cucullata* (Born, 1778); 38. *Crassostrea cuttackensis* (Newton & Smith); 39. *Crassostrea graphoides*; 40. *Macra luzonica* (Reeve, 1854); 41. *Macra mera* (Reeve); 42. *Macra violacea* (Gmelin, 1791); 43. *Macra stultum* (Linnaeus, 1758); 44. *Macra cuneata* (Gmelin, 1791); 45. *Macra dissimilis* (Reeve, 1854); 46. *Macra parkensiana* (Hadley, 1902); 47. *Macra echatina* (Holten, 1802); 48. *Macra echinata*; 49. *Macra symmetrica*; 50. *Roetella pulchella*; 51. *Roeta peliculla*; 52. *Spisula (Standella) annandalei*; 53. *Tellina angulosa* (Gmelin, 1791); 54. *Tellina (Tellinids) opalina*; 55. *Tellina (Homalina) myaeformis* (Sowerby); 56. *Tellina timorensis*; 57. *Tellina sinuate*; 58. *Macoma blairensis*; 59. *Macoma (Psammocoma) truncate*; 60. *Macoma birmanica*; 61. *Macoma truncate*; 62. *Macoma candida* (Lamarck, 1818); 63. *Apolymetis edentula*; 64. *Arcopagia remis* (Linnaeus); 65. *Donax pulchellus*; 66. *Donax incrnatus* (Gmelin, 1791); 67. *Donax compressus*; 68. *Donax deltoids* (Lamarck, 1818); 69. *Donax scortum* (Linnaeus, 1758); 70. *Sanguinolaria (Soletellina) acuminata* (Deshays); 71. *Mertrix meretrix*; 72. *Meretrix casta*. 73. *Circe scripta*; 74. *Pitar affinis*; 75. *Pitar morhuansis*; 76. *Pitar textile*; 77. *Mercia opima* (Gmelin, 1791); 78. *Paphia schnelliana*; 79. *Paphia semirugata*; 80. *Paphia gallus*; 81. *Pahia malabrica*; 82. *Paphia alapailiones* (Roeding); 83. *Sunetta (Sunetta) scripta*; 84. *Sunetta (Sunetta) meroi*; 85. *Pelecyrora trigona* (Reeve); 86. *Tapes belcheri*; 87. *Dosinia bruguiere*; 88. *Katelesiya japonica*; 89. *Katelesiya mermorata*; 90. *Diplodonta semiaspera* (Philippi, 1836); 91. *Diplodonta berhampurensis*; 92. *Trachycardium angulatum* (Lamarck, 1819); 93. *Laevicardium australis* (Sowerby); 94. *Plagiocardium pseudolatum* (Vosku & Unverwagt); 95. *Solen kemp* (Preston); 96. *Solen brevis*; 97. *Siliqua radiata*; 98. *Siliqua winteriana* (Dunker, 1852); 99. *Pharella javanica* (Lamarck, 1818); 100. *Glaucanome sculpta*; 101. *Glaucanome virens* (Linnaeus, 1767); 102. *Berneia candida* (Linnaeus, 1758); 103. *Pholas orientalis* (Gmelin, 1791); 104. *Laternula truncate* (Lamarck, 1818); 105. *Laternula anatine* & 106. *Placuna placenta* (Linnaeus, 1758))

Abundance of different species: The abundance of different species is presented in Fig. 8. The species like *Umbonium vestiarius*, *Crassostrea graphoides*, *Macra stultum* were the most abundant species in the region followed by *Thais blanfordi*, *Macra cuneata*, *Berneia candida*, *Macra luzonica*. Most of the species were having single occurrence with single incidence during the entire sampling.

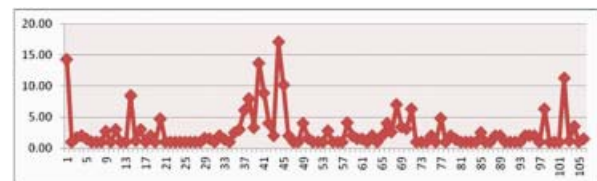


Fig. 8. Abundance of different species

(Species name: 1. *Umbonium vestiarius* (Linnaeus, 1758); 2. *Nerita (Ritena) grayana* (Recluz, 1843); 3. *Telescopium telescopium* (Montfort,); 4. *Amaea (Acrilla) acuminata* (Sowerby, 1844); 5. *Natica tigrina* (Roeding, 1798); 6. *Polinices (Glossaulox) didyma* (Roeding); 7. *Polinices trigona*; 8. *Sinum laevigatum*; 9. *Turritella attenuata* (Reeve, 1849); 10. *Turritella columnaris*; 11. *Lamellaria (Corvicella) indica* (Leach); 12. *Bursa (Bufonaria) rana*; 13. *Gyrinum natator*; 14. *Thais blanfordi* (Melvill, 1893); 15. *Thais lacera* (Born, 1778); 16. *Cronia konkanensis* (Melvill, 1893); 17. *Murex tribulus* (Linnaeus, 1758); 18. *Nassarius (Hima) stolatus* (Gmelin, 1791); 19. *Nassarius drsatus*; 20. *Amalda ampla* (Gmelin, 1791); 21. *Olivancilaria globosa*; 22. *Oliva olive*; 23. *Agaronia nebulosa*; 24. *Melo melo* (Solander, 1786); 25. *Turicula javana*; 26. *Pugilina (Hemifusus) cochlidium* (Linnaeus, 1758); 27. *Archectionica perspective* (Linnaeus, 1758); 28. *Anadara granosa* (Linnaeus, 1758); 29. *Anadara antiquata* (Linnaeus, 1758); 30. *Scapharca inaequalvis* (Bruguiere, 1789); 31. *Scapharca indica* (Gmelin, 1791); 32. *Scapharca cornea*; 33. *Perna viridis* (Linnaeus, 1758); 34. *Modiolus undulates* (Dunker); 35. *Modiolus striatulus*; 36. *Atrina bicolor*; 37. *Saccostrea cucullata* (Born, 1778); 38. *Crassostrea cuttackensis* (Newton & Smith); 39. *Crassostrea graphoides*; 40. *Macra luzonica* (Reeve, 1854); 41. *Macra mera* (Reeve); 42. *Macra violacea* (Gmelin, 1791); 43. *Macra stultum* (Linnaeus, 1758); 44. *Macra cuneata* (Gmelin, 1791); 45. *Macra dissimilis* (Reeve, 1854); 46. *Macra parkensiana* (Hadley, 1902); 47. *Macra echatina* (Holten, 1802); 48. *Macra echinata*; 49. *Macra symmetrica*; 50. *Roetella pulchella*; 51. *Roeta peliculla*; 52. *Spisula (Standella) annandalei*; 53. *Tellina angulosa* (Gmelin, 1791); 54. *Tellina (Tellinids) opalina*; 55. *Tellina (Homalina) myaeformis* (Sowerby); 56. *Tellina timorensis*; 57. *Tellina sinuate*; 58. *Macoma blairensis*; 59. *Macoma (Psammocoma) truncate*; 60. *Macoma birmanica*; 61. *Macoma truncate*; 62. *Macoma candida* (Lamarck, 1818); 63. *Apolymetis edentula*; 64. *Arcopagia remis* (Linnaeus); 65. *Donax pulchellus*; 66. *Donax incrnatus* (Gmelin, 1791); 67. *Donax compressus*; 68. *Donax deltoids* (Lamarck, 1818); 69. *Donax scortum*

(Linnaeus, 1758); 70. *Sanguinolaria (Soletellina) acuminata* (Deshays); 71. *Meretrix meretrix*; 72. *Meretrix casta*. 73. *Circe scripta*; 74. *Pitar affinis*; 75. *Pitar morhuensis*; 76. *Pitar textile*; 77. *Mercia opima* (Gmelin, 1791); 78. *Paphia schnelliana*; 79. *Paphia semirugata*; 80. *Paphia gallus*; 81. *Paphia malabrica*; 82. *Paphia alapailiones* (Roeding); 83. *Sunetta (Sunetta) scripta*; 84. *Sunetta (Sunetta) meroi*; 85. *Pelecyrora trigona* (Reeve); 86. *Tapes belcheri*; 87. *Dosinia bruguiera*; 88. *Katelesiya japonica*; 89. *Katelesiya marmorata*; 90. *Diplodonta semiaspera* (Philippi, 1836); 91. *Diplodonta berthampurensis*; 92. *Trachycardium angulatum* (Lamarck, 1819); 93. *Laevicardium australis* (Sowerby); 94. *Plagiocardium pseudolatum* (Vosku & Unverwagt); 95. *Solen kempii* (Preston); 96. *Solen brevis*; 97. *Siliqua radiata*; 98. *Siliqua winteriana* (Dunker, 1852); 99. *Pharella javanica* (Lamarck, 1818); 100. *Glaucanome sculpta*; 101. *Glaucanome virens* (Linnaeus, 1767); 102. *Berneia candida* (Linnaeus, 1758); 103. *Pholas orientalis* (Gmelin, 1791); 104. *Laternula truncata* (Lamarck, 1818); 105. *Laternula anatine* & 106. *Placuna placenta* (Linnaeus, 1758))

Monthly variation in species diversity: The monthly variation in species diversity for two different years during the study is shown in Fig. 9. The monthly variation of species diversity in the sampling area suggested that the maximum species diversity was recorded during the post-monsoon and winter months (October-January) which highlights the recruitment and settlement of many species during the period and the minimum during the early summer months (March-April).

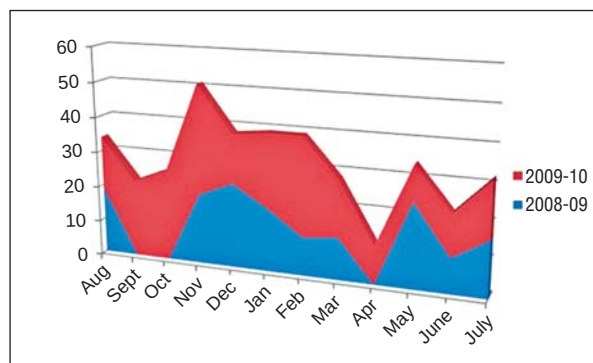


Fig. 9. Monthly variation in species diversity

DISCUSSION

The population studies of benthic invertebrates shows that the high species diversity at Udaipur and Talsari provides suitable substratum for macrobenthic invertebrate population. The habitat in these localities comprised of estuary with continuous flow of fresh water and regular tidal rhythm of inflow and outflow of water. It also shows that Talsari had little impact of

anthropogenic activities as compare to Udaipur. None of the species showed abundant distribution in Mohana because of increasing fishing activities in the area. The lower species record and maximum number of species under abundant distribution at Shankarpur shows that the locality favors the species which preferred the sandy beach habitat. Old Digha with low species diversity shows many species in sparse distribution which may be due to increasing anthropogenic activity in the area. This location showed only two species with moderate distribution which was due to construction of wall and cement boulder around coast provided suitable substratum of the settlement of rock oyster. The earlier study by Ramakrishna *et al.* (2003) described 55 species of marine bivalves under the comprehensive study on marine invertebrates along Digha coast.

The relationship between energy budgets, habitat structure, physiological parameters and population diversity has been investigated most extensively in marine bivalves by several workers (Hoarding, 1949; Kuenzler, 1961; Hancock, 1965; Dame, 1972; Dare, 1976; Rodhouse, 1979; Bayne *et al.*, 1983; Lee, 1985; Huang *et al.*, 1985; Cheung, 1991; 1993). Nevertheless, structural complexity of the environment has often been considered an important determinant of biotic diversity and the assumption that increased habitat complexity provides more ways for feeding strategies to differ has been a common thread running through many studies (Smith, 1972). This study of natural population of *Meretrix* sp., *Paphia* sp., *Donax* sp., *Macra* sp., *Saccostrea* sp. & *Macoma* sp. at five study localities reveals several points of interest with respect to sustainability of the species in the different geographically separate areas as well as impact of different levels of anthropogenic activities in the area.

As a common tropical and sub tropical marine bivalves, high densities of these species occur in the zone of inter tidal and sub tidal regions of coastal water, estuaries and backwaters on the coast of India (Subba Rao *et al.*, 1991). High population density of marine bivalves in Shankarpur and Talsari in summer (May) was partly maintained by a heavy recruitment occurred in winter. This is supported by the reproductive

events of gonadal cycles in case of *Saccostrea cucullata* (Born) (Yennawar, 1997). Besides the dominance of these species over other inter tidal bivalves reported in these localities, can possibly be attributed to a higher tolerance to environmental stress like atmospheric exposure, fluctuation in salinity due to influx of fresh water, pressure induced by pollution, etc. and particularly in Mohana & Talsari pollution effects like fishing boat discharge, sewage and land drain.

In the present study, population density of marine benthic groups was comparatively more at Talsari & Mohana. Qasim *et al.* (1972) observed that in an estuarine environments where changes in salinity are very large, maximum abundance of many organisms occur at exceptionally low salinities. In Digha, though the oysters inhabit in sub tidal region thereby remain submerged even in low tide hours, the water is mostly turbid. Due to such environment there is possible effect on the number of gametes formed, released and also survival of new recruits (Yennawar, 1997). Such situation may be attributed to enhanced by pure, eutrophic, environmental conditions prevailing in monsoon which gave great decrease in the population density in case of *Donax* sp. at all the localities. The decrease of population was considerably less in the other location in respect to seasons which reveals suitability of the habitats.

Difference between populations at different locations may represent the response to different levels of stress. Lee (1985) attributed the reproductive strategy adopted by *P. viridis* in Victoria Harbor, Hong Kong to the need for the population to maximize adult survival and successful production of offspring by ensuring that a considerable number of larvae successfully settle as new recruits to the parent population over a restricted period limited by pollution stress. The differences in the densities can be accounted to the greater number of younger individuals settled and grown. Such differences of the reproductive success is common in species that use an indirect mode of reproduction and several biotic and abiotic factors can be responsible.

Spatial and temporal variability of the beginning of the shell-growing season of *Macoma balthica*

had been documented by study of Beukema *et al.* (1985) and Vincent *et al.* (1987). Both suggested that the temperature was principal factor controlling the onset of shell growth. Further, in the view of density and size distribution of the marine bivalves, the differences in the start of the growing season observed between younger and older generations can probably be related to the presence or absence of reproductive activity and to energy allocation (Harvey and Vincent, 1989). In the study of *M. balthica* at St. Lawrence estuary, Canada, temperature and food conditions were favorable for growth. In those individuals which had not built up sexual products during the period would begin to grow earlier than those which had invested energy in reproduction (Harvey and Vincent, 1989). The differences in the population densities at different locations under the present study can also probably be related to the presence or absence of reproductive activity and to energy allocation.

Growth trajectories of shell and soft tissue in marine bivalves have already been compared but presence of three distinguishable phases of growth has never been observed (Beukema *et al.*, 1985; Craunford *et al.*, 1985). It is pertinent to mention here that Hilbish (1986) showed that rates of growth preceded the growth of soft tissue. However, Peterson and Fegley (1986) found that there was little tendency for *Mercenaria mercenaria* to grow simultaneously in shell volume, somatic mass and gonadal mass. Uncoupled growth patterns of shell and soft tissue seem to be a general phenomenon in marine bivalve populations (Hilbish, 1986; Peterson & Fegley, 1986). Mechanisms by which shell and soft tissue growth may be uncoupled are (1) different growth rates of both components, (2) loss of weight due to spawning, and (3) loss of tissue weight due to periods of negative energy balance. In the study on condition index conducted on *S. cucullata* from Kalbadevi estuary in summer at both localities focused the above mechanisms (Yennawar, 1997). In the present study, the population shows startled growth and variations in distribution in different locations because of elevation pollution levels and exploitation by local fishermen.

Table 2. Distribution of macro benthic fauna in different study locations.

Sl. No.		Talsari	Udaipur	Digha	Mohana	Shankarpur
	Phylum: CNIDARIA					
	Class: ANTHOZOA					
	Order: ACTINIARIA					
	Family: ACTINIIDAE					
1	<i>Paracondylactis indicus</i> (Dave, 1957)		√			
	Family: HALIACTIIDAE					
2	<i>Pelocoetes exul</i> (Annandale, 1915)			√		
3	<i>Pelocoetes</i> sp.		√			√
	Order: PENNATULACEA					
	Family: VERTILLIDAE					
4	<i>Cavernularia elegans</i> (Herklots, 1858)		√			
5	<i>Cavernularia malabrica</i> (Flower, 1894)		√			
	Family: VIRGULARIDAE					
6	<i>Virgularia</i> sp.		√		√	
	Class: HYDROZOA					
	Family: PORPITIDAE					
7	<i>Porpita porpita</i> (Linnaeus, 1758)		√			
	Phylum: ANNELIDA					
	Class: POLYCHAETA					
	Family: ONUPHIDAE					
8	<i>Dioptra cuprea</i> (Bosc, 1802)	√			√	√
	Family: AMPHINOMIIDAE					
9	<i>Chloeia parva</i> Baird, 1868	√			√	√
10	<i>Nereis chilkanis</i> Southern, 1921		√			
11	<i>Perinereis nunntia</i> (Saviguy in Lamarck, 1818)		√			
	Phylum: BRACHIOPODA					
	Class: LINGULATA					
	Family: LINGULIDAE					
12	<i>Lingula anatina</i> (Lamarck, 1801)		√		√	
	Phylum: ARTHROPODA					
	Class: CRUSTACEA					
	SUB Class: CIRRIPIEDIA					
	Order: THORACICA					
	Family: BALANIDAE					
13	<i>Balanus amphitrite</i> (Darwin, 1854)	√	√	√		√
	Family: CHTHAMALIDAE					
14	<i>Chthalamus stellatus</i> (Poli, 1795)		√	√		

Table 2. contd.

Sl. No.		Talsari	Udaipur	Digha	Mohana	Shankarpur
	Subclass: MALACOSTRACA					
	Order: STOMATOPODA					
	Family: SQUILLIDAE					
15	<i>Squilla nepa</i> Latreille, 1828	✓	✓	✓	✓	✓
	Order: DECAPODA					
	Family: PALINURIDAE					
16	<i>Panulirus polyphagus</i> (Herbst, 1793)	✓	✓	✓	✓	✓
17	<i>Panulirus ornatus</i> (Fabricius, 1798)	✓	✓	✓	✓	✓
	Family: MATUTIDAE					
18	<i>Matuta victor</i> (Fabricius, 1781)	✓	✓	✓	✓	✓
19	<i>Matuta planips</i> Fabricius, 1798	✓	✓	✓	✓	✓
	Family: PORTUNIDAE					
20	<i>Portunus pelagicus</i> (Linnaeus, 1758)	✓	✓			
21	<i>Portunus sanguinolentus</i> Herbst, 1868	✓	✓		✓	
22	<i>Charybdis feriata</i> (Linnaeus, 1758)	✓	✓	✓	✓	✓
23	<i>Charybdis granulata</i> (de Haan, 1833)	✓	✓		✓	✓
24	<i>Scylla serrata</i> (Forsk., 1775)	✓	✓		✓	✓
	Family: PAGUNIDAE					
25	<i>Diogenes custus</i> (Fabricius, 1798)	✓	✓			
26	<i>Diogenes miles</i> (Fabricius, 1787)	✓	✓		✓	
	Family: MAIIDAE					
27	<i>Doclea ovis</i> (Fabricius, 1787)		✓			
28	<i>Doclea canalifera</i> Stimpson, 1857		✓			
	Family: PARATHENOPIIDAE					
29	<i>Lambrush (Platylambrush) prensor</i> Herbst		✓			
	Family: OCYPODIDAE					
30	<i>Oceypoda macrocera</i> H. Milne-Edwards, 1852		✓			✓
31	<i>Uca triangularis</i> (A. Milne-Edwards, 1873)		✓			✓
	Class: MEROSTOMATA					
	Order: XIPHOSURIDA					
	Family: XIPHOSURIDAE					
32	<i>Tachypleus gigas</i> (Muller, 1785)	✓	✓			
33	<i>Carcinoscorpius rotundicauda</i> (Latreille, 1802)	✓	✓			
	Phylum: MOLLUSCA					
	Class: GASTROPODA					
	Order: ARCHAEOGASTROPODA					
	Family: TROCHIDAE					
34	<i>Umbonium vestiarium</i> (Linnaeus, 1758)	✓	✓	✓		✓
	Family: NERITIDAE					
35	<i>Nerita (Ritena) grayana</i> Recluz, 1843		✓			

Table 2. contd.

Sl. No.		Talsari	Udaipur	Digha	Mohana	Shankarpur
	Order: MESOGASTROPODA					
	Family: POTAMIDIDAE					
36	<i>Telescopium telescopium</i> (Linnaeus, 1758)	✓	✓		✓	✓
	Family: EPITONIIDAE					
37	<i>Amaea (Acrilla) acunimata</i> (Sowerby, 1844)	✓	✓	✓	✓	✓
	Family: NATICIDAE					
38	<i>Natica tigrina</i> (Roeding, 1798)	✓	✓			
39	<i>Polinices (Glossaulox) didyma</i> (Roeding, 1798)		✓	✓	✓	
40	<i>Polinices tumidus</i> (Swainson, 1840)	✓				
41	<i>Sinum neritoiderum</i> (Linnaeus, 1767)		✓			
	Family: TURRITELLIDAE					
42	<i>Turritella attenuata</i> Reeve, 1849	✓	✓	✓		✓
43	<i>Turritella columnaris</i> Kiener, 1843					✓
	Family: LAMELLARIIDAE					
44	<i>Lamellaria (Corvicella) indica</i> Leach, 1867	✓				✓
	Family: BURSIDAE					
45	<i>Bursa (Bufonaria) rana</i> (Linnaeus, 1758)			✓		✓
	Family: RENELLIDAE					
46	<i>Gyrium natator</i> (Roding, 1798)			✓		
	Order: NEOGASTROPODA					
	Family: MURICIDAE					
47	<i>Thais blanfordi</i> (Melvill, 1893)		✓	✓	✓	
48	<i>Thais lacera</i> (Born, 1778)	✓	✓	✓		
49	<i>Seminricinula konkanensis</i> (Melvill, 1893)				✓	
50	<i>Murex tribulus</i> (Linnaeus, 1758)		✓			
	Family: NASSARIDAE					
51	<i>Nassarius (Hima) stolatus</i> (Gmelin, 1791)	✓				
52	<i>Nassarius dorsatus</i> (Roeding, 1798)					✓
	Family: OLIVIDAE					
53	<i>Ancilla ampla</i> (Gmelin, 1791)	✓	✓		✓	✓
54	<i>Olivancilaria gibbosa</i> Born, 1778				✓	
55	<i>Oliva oliva</i> (Linnaeus, 1758)			✓		
56	<i>Agaronia nebulosa</i> (Lamarck, 1811)		✓			
	Family: VOLUTIDAE					
	SUB Family: CYMBIINAE					
57	<i>Melo melo</i> (Solander, 1786)		✓			
	Family: TURIIDAE					
	SUB Family: TURRICULINAE					
58	<i>Turricula javana</i> (Lamarck, 1816)					✓
	Family: MELONGENIDAE					
59	<i>Pugilina cochlidium</i> (Linnaeus, 1758)		✓			

Table 2. contd.

Sl. No.		Talsari	Udaipur	Digha	Mohana	Shankarpur
	SUB Class: HETEROBRANCHIA					
	SUPER Order: ALLOGASTROPODA					
	Family: ARCHECTONIDAE					
60	<i>Archectonica perspective</i> (Linnaeus, 1758)					√
	Class: BIVALVIA					
	Order: ARCOIDA					
	Family: ARCIDAE					
61	<i>Anadara granosa</i> (Linnaeus, 1758)				√	
62	<i>Anadara antiquata</i> (Linnaeus, 1758)	√	√	√	√	√
63	<i>Scapharca inaequivalvis</i> (Bruguiere, 1789)		√	√		√
64	<i>Anadara indica</i> (Gmelin, 1791)					√
65	<i>Scapharca cornea</i> (Reeve, 1844)	√	√	√		√
	Order: MYTILOIDA					
	Family: MYTILIDAE					
66	<i>Perna viridis</i> (Linnaeus, 1758)	√	√	√	√	√
67	<i>Modiolus undulates</i> (Dunker, 1856)		√			
68	<i>Modiolus striatulus</i> (Hanley, 1844)			√	√	
	Order: PTERIOMORPHA					
	Family: PINNIDAE					
69	<i>Pinna bicolor</i> Gmelin, 1791		√			
	Order: OSTEROIDA					
	Family: OSTREIDAE					
70	<i>Saccostrea cucullata</i> (Born, 1778)	√	√	√	√	√
71	<i>Crassostrea cuttackensis</i> (Newton & Smith, 1912)	√				√
72	<i>Crassostrea graphoides</i> (Scholtheim, 1813)			√	√	
	Order: VENEROIDA					
	Family: MACTRIDAE					
73	<i>Mactra luzonica</i> (Reeve, 1854)	√	√	√	√	√
74	<i>Mactra mera</i> (Reeve,)	√	√	√	√	√
75	<i>Mactra violacea</i> (Gmelin, 1791)	√	√	√		√
76	<i>Mactra stultum</i> (Linnaeus, 1758)		√			
77	<i>Mactra cuneata</i> (Gmelin, 1791)	√	√	√	√	√
78	<i>Mactra dissimilis</i> (Reeve, 1854)	√	√	√	√	√
79	<i>Mactra turgida</i> Gmelin, 1791	√				
80	<i>Mactra achatina</i> (Holten, 1802)	√				
81	<i>Standella nicobarica</i> Gmelin, 1790	√				
82	<i>Mactra symmetrica</i> Deshayes, 1853					√
83	<i>Roeta pulchella</i> (Reeve, 1850)		√	√		√
84	<i>Roeta peliculla</i> (Reeve, 1854)		√			

Table 2. contd.

Sl. No.		Talsari	Udaipur	Digha	Mohana	Shankarpur
85	<i>Spisula (Standella) annandalei</i>	✓				
	Family: TELLINIDAE					
86	<i>Tellina angulata</i> Chemitz		✓			
87	<i>Tellina (Tellinids) opalina</i> Chemitz, 1788	✓	✓	✓	✓	✓
88	<i>Tellina (Homalina) myaeformis</i> (Sowerby)	✓				
89	<i>Tellina timorensis</i> (Lamarck, 1818)	✓	✓			
90	<i>Strigilla splendid</i> (Anton)	✓				
91	<i>Macoma blairensis</i>	✓	✓	✓	✓	✓
92	<i>Macoma (Psammocoma) truncata</i> (Jonas)	✓				✓
93	<i>Macoma birmanica</i> Philippi, 1949	✓	✓			
94	<i>Macoma truncate</i>		✓			✓
95	<i>Macoma candida</i> (Lamarck, 1818)	✓				
96	<i>Apolymetis edentula</i> Spengler, 1782	✓	✓	✓	✓	✓
97	<i>Tellina remies</i> (Linnaeus, 1758)			✓		
	Family: DONACIDAE					
98	<i>Donax pulchellus</i> Hanley, 1843	✓				
99	<i>Donax incrnatus</i> Gmelin, 1791					✓
100	<i>Donax compressus</i> Lamarck, 1800			✓	✓	✓
101	<i>Donax deltoids</i> (Lamarck, 1818)	✓	✓	✓		✓
102	<i>Donax scortum</i> (Linnaeus, 1758)	✓	✓	✓	✓	✓
	Family: PSAMMOBIIDAE					
103	<i>Sanguinolaria acuminata</i> (Deshays)	✓	✓	✓		✓
	Family: VENERIDAE					
104	<i>Mertrix meretrix</i> (Linnaeus, 1758)	✓	✓	✓	✓	✓
105	<i>Meretrix casta</i> (Gmelin, 1791)			✓	✓	✓
106	<i>Circe scripta</i> (Linnaeus, 1758)				✓	
107	<i>Pitar albastrum</i> (Reeve, 1863)		✓			✓
108	<i>Pitar morhuansis</i> (Dall, 1902)		✓			
109	<i>Pitar textile</i> (Gmelin, 1791)	✓				
110	<i>Katelysia opima</i> (Gmelin, 1791)	✓	✓	✓	✓	✓
111	<i>Paphia textile</i> Gmelin, 1791					✓
112	<i>Paphia semirugata</i>			✓	✓	✓
113	<i>Paphia gallus</i> (Gmelin, 1791)	✓			✓	✓
114	<i>Paphia malabrica</i> (Chemnitz, 1782)	✓				
115	<i>Paphia alapailiones</i> Roeding				✓	
116	<i>Sunetta (Sunetta) scripta</i> (Linnaeus, 1758)		✓			
117	<i>Sunetta (Sunetta) meroi</i> (Linnaeus)		✓			
118	<i>Pelecyrora trigona</i> (Reeve, 1850)	✓	✓	✓	✓	✓
119	<i>Tapes belcheri</i> Sowerby, 1852	✓				✓
120	<i>Dosinia trigona</i> Schroter				✓	✓
121	<i>Katelesiya japonica</i> (Gmelin, 1791)		✓			✓

Table 2. contd.

Sl. No.		Talsari	Udaipur	Digha	Mohana	Shankarpur
122	<i>Katelesiya mermorata</i> (Lamarck, 1818)					√
	Family: UNGULINIDAE					
123	<i>Diplodonta bullata</i> (Dunker, 1865)					√
124	<i>Diplodonta berhampurensis</i> Preston					√
	Family: CARDIIDAE					
125	<i>Trachycardium asiaticum</i> Brugiera, 1794		√			
126	<i>Laevicardium apertom</i> (Brugiera)	√				
127	<i>Acanthocardia coronata</i> (Schroter, 1786)	√				
	Order: ADAPENDOTA					
	Family: SOLENIDAE					
128	<i>Solen kemp</i> (Preston, 1915)			√		
129	<i>Solen brevis</i> Gray, 1842					√
130	<i>Siliqua radiata</i> (Linnaeus, 1758)		√			
131	<i>Siliqua winteriana</i> (Dunker, 1852)	√	√	√	√	√
132	<i>Pharella javanica</i> (Lamarck, 1818)					√
	Family: GLAUCONOMIDAE					
133	<i>Glaucome sculpta</i> Sowerby, 1894		√	√	√	
134	<i>Glaucome virens</i> (Linnaeus, 1767)			√		
	Order: MYOIDA					
	Family: PHOLADIDAE					
135	<i>Berneia candida</i> (Linnaeus, 1758)	√	√	√	√	√
136	<i>Pholas orientalis</i> (Gmelin, 1791)			√	√	√
	Family: LATERNULIDAE					
137	<i>Laternula truncate</i> (Lamarck, 1818)	√	√			√
138	<i>Laternula anatina</i> (Linnaeus, 1758)					√
	Family: PLACUNIDAE					
139	<i>Placuna placenta</i> (Linnaeus, 1758)					√
	Phylum: ECHINODERMATA					
	Class: ASTEROIDEA					
	Order: PAXILLOSIDA					
	Family: ASTEROPECTINIDAE					
140	<i>Astropecten euracanthus</i> (Luetken, 1871)					√
141	<i>Astropecten indicus</i> (Doederlein, 1872)		√		√	√

CONCLUSION

The variation of population size of different species at different location in different seasons reflects the suitability of habitat, environ & pressure to the marine bivalves. Overall, Talsari, Udaipur & Shankarpur was observed to be most

suitable location of marine benthic population. However, Digha & Mohana was under pressure due to increasing tourism and other anthropogenic activities. The species diversity was recorded maximum during the months of October-January and minimum during March-April, which

suggested that the recruitment and settlement of the fauna are maximum during the post-monsoon to winter. The major dominant species are *Mactra cuneata* (Gmelin, 1791), *Mactra dissimilis* (Reeve, 1854), *Mactra luzonica* (Reeve, 1854), *Mactra mera* (Reeve), *Bernea candida* (Linnaeus, 1758) and majority of the species are distributed in the region but does not reflected its dominance throughout the sampling. The population shows

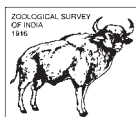
startled growth and variations in distribution in different locations because of elevation pollution levels and exploitation by local fishermen. Generally, the marine benthic invertebrates occur in areas of wide range of coastal zonation, some live where the salinity is high and many favors backwaters and estuaries where the flow of freshwater is regular and moderate salinities are prevail.

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Short Communication

A NOTE ON SEROW, *NEMORHAEDUS SUMATRAENSIS* (BECHSTEIN, 1799) IN DARJEELING DISTRICT, WEST BENGAL, INDIA

Darjeeling district lies in the northern part of west Bengal between 26°33' - 27°13' N and 88°2' - 88°56' E with a geographical area of 3148 km² approximately. The Darjeeling district falls on Sub- Himalayan region, extended over on elevation of 50 to 3800 m. About 20% of the total geographical areas is under good forest and 10% open forests.



Fig. 1. Serow (*Nemorhaedus sumatraensis*) at Senchal (West Range)

The survey of Darjeeling district was initiated to study the population trend of Serow (Fig-1). Serow belongs to order Artiodactyla under family Bovidae. It is somewhat larger than a goat in size and positioned intermediate between goat and antelopes (Alfred *et al.*, 2006). It is a hilly-forest dwelling antelope and found in the Himalayas both in eastern and western parts (Kathayat and Mathur, 2002). Serow is now a days confined in three reserve forests of this district viz. Senchal Wildlife Sanctuary; Neora valley National Park and Singalila National Park. The elevation of these

three forested areas ranges from 305 m to 2130 m, though Serow lives mainly at an elevation of 500 m 4000 m but it was sighted at lower elevation at Senchal.

Two field trips were carried out during 2011-2012 but the sighting of Serows presented here is based on 2012 survey when the entire accessible habitats of Serow was covered. No definite samplings technique were adopted as the study areas were hilly and Serow preferred to live under thick vegetation cover in gorges and undulating habitats. However, random sampling was made in the survey for locating the Serows, as it is an accepted standard method of assessing biotic diversity in a given area (Heywood & Watson, 1995). Mechanical aids that were used in the survey were binocular, digital camera and GPS.

Senchal Wildlife Sanctuary

The total area of thesanctuary is 38.60 km² and is situated between 457 and 793 m. A total of 6 Serows were recorded in this forest (T-1). Entire habitable area of this sanctuary was surveyed and a total of 9 observation was made. Indirect evidence of the species like pellets, skulls and different parts of body of the Serow was found in this sanctuary.

Neora Valley National Park

The geographical area of this park is about 88 km² and elevationis 305 m approximately. The park represents tropical, sub-tropical, temperate and sub temperate forests which is a great wealth of biodiversity of eastern Himalayas. Some of

the flora and fauna of this park has similarities with that of Palearctic region of the adjacent geographic zone. 5 Serows were recorded from this park with 9 observation (T-1). A number of times the habitable areas of Serow was surveyed in this park.

Sigalila National Park

It is situated in the higher elevation at about 2134 m spreading over 76.6 km². Only 4 Serows were noticed in this park in 5 observation. Though good vegetation cover and ideal habitats were present in this park, Serow population is very poor here.



Fig. 2. Survey party in search of Serow at Singalila National Park

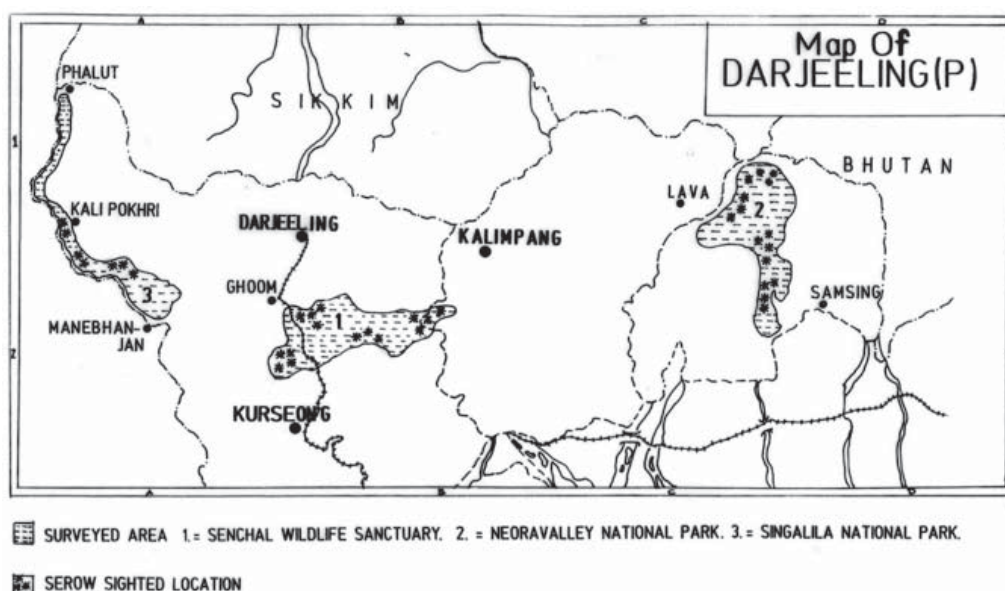


Table-1. Serows sighted in the Sanctuary and National Parks of Darjeeling district.

Sanctuary/ National park	Habitat	Latitude / Longitude	Individual animal sighted	Total Nos.of observation	
Neora Valley N. Park	Hilly terrain with vegetation	27°05' N 88° 42' E 27°07' N 88° 46' E 27°04' N 88° 42' E 27°07' N 88° 43' E	5	9	
Singalila N. Park	Hilly terrain with vegetation	27°02' N 88° 01' E 27°02' N 88° 04' E 27°01' N 88° 07' E 27°01' N 88° 03' E	4	5	
Senchal W.L. Sanctuary	Hilly terrain with vegetation	26°59.614' N 88° 18.166' E 26°59.598' N 88° 18.88 E 26°59.852' N 88° 18.212' E 26°59.538' N 88° 18.222' E 26°59.850' N 88° 18.261' E 26°59.542' N 88° 18.230' E	6	9	
Total			15	23	

CONCLUSION

A total of 110 hours were spent in field survey and 15 Serows were sighted. Indirect evidence like pellets that found in all the sanctuaries revealed that the number of Serows were more. Inaccessible terrain (Fig. 2) with thick vegetation cover made the sighting of animals difficult. Serows normally come out from the place of night stay in early morning and minimum disturbance cause their disappearance in steep slopes or in the thick vegetation. The habitat of all the surveyed areas have great similarity with that of steep hilly terrain but Singalila is higher than the other two forests. The Senchal Wildlife Sanctuary is more ideal habitat for the Serow in comparison to other forests. More number of Serow (6 Nos.) and large quantity of pellets at many places even carcasses suggest that Senchal Wildlife Sanctuary provides better food and shelter.

All the forests described in this report are highly infiltrated by the local people for collection

of firewood and forest produce. Tourist Bungalows are situated in the forests and tourist pressure is more throughout the year except rainy season. So, anthropogenic pressure is one of the main threats for Serow in these forests. Although Serows live in hilly forests but it also found in grassland in all these forests here. It likes to eat leaves and shoots but feeding on grass was noticed at number of times. Goral, a small antelope goat is occupying the same niche along with the Serow in these forests. Interspecific competition along with habitat loss, small grazing areas are the causes of population depletion of antelopes in these reserve forests.

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