STATUS AND THREATS

To catch each Tiger Prawn seed, collectors destroy 161 juveniles of other prawns, 7 fishes, 30 crabs, 1 mollusc & 8 unidentified meroplanktons

While many crustacean species occur in large numbers, however, there are species which are much rarer. Hilton-Taylor (2000) enlisted 479 species of crustaceans as extinct, 57 as critically endangered, and 77 as endangered. In the Red List published by IUCN in 2008, 89 species of crabs and copepods are included from India as nearly threatened, vulnerable, least concerned, and data deficient. Of these, two species, *Sartoriana spinigera* (Wood-Mason 1871) and *Spiralothelphusa hydrodromus* (Herbst 1794), are known to occur in the Indian Sundarbans. Both the species are however very common in this part of the country.

Main threats to crustacean components are destruction of habitat and pollution. Destruction and alteration of habitats for human settlement, agriculture, and intensive aquacultural practices without appropriate planning have resulted in the loss of faunal diversity in the recent past. Encroachment of mangrove areas for setting up industries and construction of jetties have resulted in large-scale destruction of mangrove forests. The other threats to crustacean diversity are from over-exploitation and collection of undersized specimens as well as large-scale exploitation of prawn seeds. Over-exploitation is also likely to have an adverse effect on the population of commercially important species. Improper planning in setting up tourist resorts in coastal areas may lead to a 'threat' to the mangroves and other estuarine ecosystems. Poor management and sewage disposal can bring about irreparable damage to the mangroves, which may even lead to the disappearance of mangrove biota.

In the Sundarbans, natural mangrove habitats have reportedly declined considerably due to reclamation for various developmental purposes like aquaculture and agriculture. The semi-intensive and modified intensive shrimp culture in the brackish-water *bheries* of the Sundarbans is leading to large inflow of organic and inorganic pollutants. Besides, there are also natural threats like soil erosion, recurrence of floods and storms, and changes in salinity in the estuarine ecosystem that pose a threat to faunal diversity.

Reclamation, pollution from semi-intensive and modified intensive shrimp culture as well as changes in salinity in the estuarine ecosystem poses threat.

The unabated pollution of rivers, creeks, and ponds coupled with large-scale reclamation of land for human settlement and industrial development and also use of insecticides in agricultural fields are especially posing serious threats to aquatic crustacean fauna. In addition, large-scale removal of juveniles and berried females by fishing trawlers and use of fine-mesh nets during 'Bagda' seed collections also affect the crustacean population, leading to the loss of biodiversity. According to a report, to catch 1 tiger prawn seed in the Sundarbans, collectors destroyed juveniles of 161 other prawns, 7 fishes, 30 crabs, 1 mollusc, and 8 unidentified meroplanktons (Das and Nandi 1999). Often many species are harvested indiscriminately without knowing the effects of over-exploitation on the species and the ecosystem.

Due to continuous growth of coastal population, pressures of the environment from land-based to marine-based human activities have increased manifold. As a result, coastal and marine living resources and their habitats are being lost or damaged in ways that are diminishing biodiversity, including crustacean biodiversity. The dependency on the ecosystem, however, can be brought down substantially by way of encouragement to alternate means of livelihood such as paddy-cum-fish culture, paddy-cum-prawn culture, apiary, duckery, mussel culture, and so on.

ANNEXURE

Systematic list of species occurring in Sundarbans

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
	Subhylum CRUSTACEA Brünnich, 1772			
	Class BRANCHIOPODA Latreille, 1817			
	Order CONCHOSTRACA Sars, 1867			
	Family **CYCLESTHERIIDAE** Sars, 1899			
1.	*Cyclestheria* sp.	FW	PL	Sundarban (Anonymous, 1987)
	Class BRANCHIOPODA Latreille, 1817			
	Subclass DIPLOSTRACA Gerstaecker, 1866			
	Superorder CLADOCERA Latreille, 1829			
	Order ANOMOPODA Stebbing, 1902			
	Family **BOSMINIDAE** Baird, 1845			
2	*Bosminopsis* sp.	FW	PL	Sundarbans (Mandal & Nandi, 1989)
	Family **DAPHNIIDAE** Straus, 1820			
3	*Ceriodaphnia cornuta* Sars, 1825	BW	PL	Port Canning (Annandale, 1907)
	Order ONYCHOPODA Sars, 1865			
	Family **PODONIDAE** Mordukhai-Boltovskoi, 1968			
4.	*Evadne* sp.	BW	PL	Mandirtala (Anonymous, 1987)
	Subclass SARCOSTRACA Tasch, 1969			
	Order ANOSTRACA Sars, 1867			
	Family **ARTEMIIDAE** Grochowski, 1896			
5.	*Artemia salina* (Linnaeus, 1758)	BW	PL	Sundarbans (Mandal & Nandi, 1989)
	Class MAXILLOPODA Dahl, 1956			
	Subclass CIRRIPEDIA Burmeister, 1834			
	Order THORACICA Darwin, 1854			
	Superfamily LEPADOMORPHA Pilsbry, 1916			
	Family **LEPADIDAE** Darwin, 1852			
6.	*Lepas antifera* Linnaeus, 1767	BW/ CW	SE	Sundarbans (Mandal & Nandi, 1989)
7.	*Conchoderma hunteri* (Owen, 1830)	BW/ CW	SE	Sundarbans (Mandal & Nandi, 1989)
	Family **POECILASMATIDAE** Annandale, 1909			
8.	*Octolasmis cor* (Aurivillius, 1892)	BW/ CW/	PA	Sundarbans (Nilsson-Cantell, 1938)
9.	*Octolasmis orthogonia* (Darwin, 1851)	BW/ CW	PA	Sundarbans (Mandal & Nandi, 1989)
10.	*Octolasmis warwickii* Gray, 1825	BW/ CW	PA	Sundarbans (Mandal & Nandi, 1989)
	Superfamily CHTHAMALOIDEA Darwin, 1854			
	Family **CHTHAMALIDAE** Darwin, 1854			

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
11.	*Eurapia withersi* (Pilsbry, 1916)	BW/ CW	SE	Port Canning (Nilsson-Cantell, 1938)
12.	*Chthamalus malayensis* Pilsbry, 1916	BW/ CW	SE	Port Canning (Annandale, 1906); Sundarbans (Mandal & Nandi, 1989)
	Superfamily BALANOIDEA Leach, 1817			
	Family **ARCHAEOBALANIDAE** Newmann and Ross, 1976			
13.	*Chirona amaryllis* (Darwin, 1854)	BW/ CW	SE	Port Canning (Nilsson-Cantell, 1938)
	Family **BALANIDAE** Leach, 1817			
14.	*Amphibalanus cirratus* Darwin, 1854	BW/ CW	SE	Sandheads (Nilsson-Cantell, 1938)
15.	*Amphibalanus variegatus (* Darwin, 1854)	BW/ CW	SE	Port Canning (Nilsson-Cantell, 1938)
16.	*Balanus patellaris* (Spengler, 1780)	BW/ CW	SE	Canning (Annandale, 1906)
	Family **MEGABALANIDAE**			
17.	*Megabalanus tintinnabulum* (Linnaeus, 1758)	BW/ CW	SE	Sandheads (Nilsson-Cantell, 1938)
	Superfamily CORONULOIDEA Lesch, 1817			
	Family **CHELONIBIIDAE** Pilsbry, 1916			
18.	*Chelonibia testudinaria* (Linnaeus, 1758)	BW/ CW	SE	Sundarbans (Mandal & Nandi, 1989)
	Order RHIZOCEPHALA F. Müller, 1862			
	Family **SACCULINIDAE** Lilljeborg, 1861			
19.	*Sacculina carcini* Thompson, 1836	CW	PA	Mouth of the River Hugli (Annandale, 1911)
	Subclass COPEPODA H. Milne Edwards, 1840			
	Order CALANOIDA Sars, 1903			
	Superfamily CENTROPAGOIDEA Giesbrecht, 1892			
	Family **ACARTIIDAE** Sars, 1903			
20.	*Acartia (Odontacartia) centrura* Giesbrecht, 1889	BW/CW	PL	Hugli-Matla estuary (Khan, 1995)
21.	*Acartia (Odontacartia) erythraea* Giesbrecht, 1889	BW/CW	PL	Hugli-Matla estuary (Khan, 1995)
22.	*Acartia (Odontacartia) spinicauda* Giesbrecht, 1889	BW	PL	Chemaguri (Anonymous, 1987)
23.	*Acartiella keralensis* Wellershaus, 1969	BW/CW	PL	Kachuberia (Anonymous, 1987)
24.	*Acartiella major* Sewell, 1919	BW	PL	Gazikhali (Roy, 1998)
25.	*Acartiella sewelli* Steuer, 1934	FW/BW	PL	Kachuberia (Anonymous, 1987)
26.	*Acartiella tortaniformis* (Sewell, 1919)	BW	PL	Bidya River, Pirkhali, Sundarban (Roy, 1998)
	Family **CANDACIIDAE** Giesbrecht, 1892			

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
27.	*Candacia bradyi* A. Scott, 1902	BW/CW	PL	South Sagar (Anonymous, 1987)
	Family **CENTROPAGIDAE** Giesbrecht, 1892			
28.	*Centropages alcocki* Sewell, 1912	BW	PL	Hugli-Matla estuary (Khan, 1995)
29.	*Centropages dorsispinatus* Thompson and Scott, 1903	BW/CW	PL	South Sagar, Mandirtala, Mooriganga (Anonymous, 1987)
30.	*Centropages furcatus* Dana, 1849	BW	PL	South Sagar (Anonymous, 1987)
	Family **DIAPTOMIDAE** Baird, 1850			
31.	*Heliodiaptomus (Heliodiaptomus) viduus,* (Gurney, 1916)	FW/BW	PL	Hugli-Matla estuary (Khan, 1995)
32.	*Heliodiaptomus (Indodiaptomus) cinctus* (Gurney, 1907)	BW	PL	Hugli-Matla estuary (Khan, 1995)
33.	*Heliodiaptomus (Indodiaptomus) contortus* (Gurney, 1907)	BW	PL	Hugli-Matla estuary (Khan, 1995)
34.	*Neodiaptomus schmackeri* (Poppe and Richard, 1892)	FW/BW	PL	Hugli-Matla estuary (Khan, 1995); Kachuberia, Mandirtala (Anonymous, 1987)
35.	*Phyllodiaptomus blanci* (De Guerne and Richard, 1896)	FW	PL	Hugli-Matla estuary (Khan, 1995)
	Family **PONTELLIDAE** Dana, 1853			
36.	*Calanopia elliptica* (Dana, 1849)	BW/CW	PL	Hugli-Matla estuary (Khan, 1995)
37.	*Labidocera acuta* Dana, 1849	BW/CW	PL	Hugli-Matla estuary (Khan, 1995)
38.	*Labidocera euchaeta* Giesbrecht, 1889	BW	PL	Chemaguri, Mandirtala (Anonymous, 1987)
39.	*Labidocera minutum* Giesbrecht, 1889	BW/CW	PL	South Sagar (Anonymous, 1987)
40.	*Labidocera pavo* Giesbrecht, 1889	BW	PL	Bidyadhari river and Kachia Khal (Roy, 1998)
41.	*Labidocera pectinata* Thompson & A. Scott, 1903	BW/CW	PL	Hugli-Matla estuary (Khan, 1995)
42.	*Pontella andersoni* Sewell, 1912	BW/CW	PL	Chemaguri, South Sagar (Anonymous, 1987)
43.	*Pontellopsis herdmani* Thompson & A. Scott., 1903	BW/CW	PL	South Sagar (Anonymous, 1987)
	Family **PSEUDODIAPTOMIDAE** Sars, 1902			
44.	*Pseudodiaptomus aurivilli* Cleve, 1901	BW/CW	PL	Kachuberia, Chemaguri (Anonymous, 1987)
45.	*Pseudodiaptomus binghami* Sewell, 1912	BW	PL	Kachuberia (Anonymous, 1987); Gazikhali (Roy, 1998)
46.	*Pseudodiaptomus daughlishi* Sewell, 1932	BW	PL	Mandirtala, South Sagar (Anonymous, 1987)
47.	*Pseudodiaptomus hickmani* Sewell, 1912	BW/CW	PL	Mandirtala, South Sagar (Anonymous, 1987)
48.	*Pseudodiaptomus lobipes* Gurney, 1907	BW	PL	Gazikhali (Roy, 1998)
49-.	*Pseudodiaptomus masoni* Sewell, 1932	BW/CW	PL	Mandirtala, South Sagar (Anonymous, 1987)
50.	*Pseudodiaptomus tollingeri* Sewell, 1919	FW/BW	PL	Mandirtala, Chemaguri (Anonymous, 1987); Pirkhali, Gazikhali (Roy, 1998)
51.	*Schmackeria annandalei* (Sewell, 1912)	BW	PL	Kachuberia, Chemaguri, South Sagar, Mooriganga (Anonymous, 1987)

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
52.	*Schmackeria serricaudatus* (T. Scott, 1894)	BW	PL	Hugli-Matla estuary (Khan, 1995)
	Family **TEMORIDAE** Giesbrecht, 1892			
53.	*Temora discaudata* Giesbrecht, 1889	BW/CW	PL	Chemaguri, South Sagar (Anonymous, 1987)
54.	*Temora turbinata* (Dana, 1849)	BW/CW	PL	Chemaguri, South Sagar (Anonymous, 1987)
	Family **TORTANIDAE** Sars, 1902			
55.	*Tortanus forcipatus* (Giesbrecht, 1889)	BW/CW	PL	Chemaguri, South Sagar (Anonymous, 1987)
56.	*Tortanus gracilis* Brady, 1883	BW/CW	PL	Chemaguri (Anonymous, 1987)
	Superfamily CLAUSOCALANOIDEA Giesbrecht, 1892			
	Family **EUCHAETIDAE** Giesbrecht, 1892			
57.	*Euchaeta concinna* Dana, 1849	BW/CW	PL	South Sagar, Mandirtala (Anonymous, 1987)
58.	*Euchaeta marina* (Prestandrea, 1833)	BW/CW	PL	Moorganga, Chemaguri, South Sagar (Anonymous, 1987)
59.	*Euchaeta tenuis* Esterly, 1906	BW/CW	PL	South Sagar (Anonymous, 1987)
60.	*Euchaeta wolfendeni* A. Scott, 1909	BW/CW	PL	Mooriganga, South Sagar (Anonymous, 1987)
	Superfamily EUCALANOIDEA Giesbrecht, 1892			
	Family **EUCALANIDAE** Giesbrecht, 1892			
61.	*Eucalanus elongatus* (Dana, 1848)	BW/CW	PL	South Sagar, Chemaguri (Anonymous, 1987)
62.	*Eucalanus subcrassus* Giesbrecht, 1888	BW/CW	PL	South Sagar (Anonymous, 1987)
	Superfamily MEGACALANOIDEA Sewell, 1947			
	Family **CALANIDAE** Dana, 1849			
63.	*Acrocalanus inermis* Sewell, 1912	BW/CW	PL	Sundarbans (Khan, 1995)
64.	*Acrocalanus similis* Sewell, 1914	BW/CW	PL	Sundarbans (Khan, 1995)
65.	*Canthocalanus pauper* (Giesbrecht, 1888)	BW/CW	PL	South Sagar (Anonymous, 1987)
66.	*Undinula darwini* (Lubbock, 1860)	BW/CW	PL	South Sagar, Chemaguri (Anonymous, 1987)
	Family **PARACALANIDAE** Giesbrecht, 1892			
67.	*Paracalanus dubia* Sewell, 1912	BW/CW	PL	Sundarbans (Khan, 1995)
68.	*Paracalanus parvus* (Claus, 1863)	BW/CW	PL	Sundarbans (Khan, 1995)
	Order HARPACTICOIDA Sars, 1903			
	Superfamily TACHIDIOIDEA (pro Tachidiidi - morpha Lang, 1948)			
	Family **CLYTEMNESTRIDAE** Scott, 1909			
69.	*Clytemnestra scutellata* Dana, 1849	BW	PL	Chemaguri, South Sagar (Anonymous, 1987)
	Family **HARPACTICIDAE** Dana, 1846			
70.	*Harpacticus* sp.	BW	PL	Sundarbans (Mandal & Nandi, 1989)
	Family **TACHIDIIDAE** Sars, 1909			

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
71.	*Tachidius (Tachidius) disciples* Giesbrecht, 1881	BW	PL	Kahcuberia (Anonymous, 1987)
	Infraorder PODOGENNONTA Lang, 1948			
	Superfamily CLETODOIDEA (pro Cletodidimor - pha Lang, 1948)			
	Family **CLETODIDAE** T. Scott, 1904			
72.	*Enhydrosoma vervoorti* Fiers, 1987	BW	MEB	Sagar Island (Fiers, 1987
73.	*Nitocra lacustris lacustris* (Schmankevitsch, 1875)	BW	MEB	Sagar Island (Fiers, 1987)
	Family **LAOPHONTIDAE** T. Scott, 1904			
74.	*Laophonte* sp.	BW/CW	MEB	South Sagar, Chemaguri, Mooriganga (Anonymous, 1987)
	Superfamily THALESTROIDEA (pro Thalestridi - morpha Lang, 1948)			
	Superfamily			
	Family **MIRACIIDAE** Dana, 1846			
75.	*Cladorostrata brevipoda* Shen and Tai, 1963	BW/CW	PL	Chemaguri (Anonymous, 1987)
76.	*Macrosetella gracilis* (Dana, 1848)	BW/CW	PL	Chemaguri, South Sagar (Anonymous, 1987)
77.	*Microsetella rosea* (Dana, 1849)	BW/CW	PL	South Sagar (Anonymous, 1987)
	Family **EUTERPINIDAE** Brian, 1921			
78.	*Euterpina acutifrons* (Dana, 1849)	BW/CW	PL	Kachuberia, South Sagar, Mooriganga (Anonymous, 1987)
	Order CYCLOPOIDA Burmeister, 1834			
	Family **CYCLOPIDAE** Rafines ue, 1815			
79.	*Halicyclops tenuispina* Sewell, 1924	BW	PL	Kachuberia (Anonymous, 1987)
80.	*Megacyclops viridis* (Jurine, 1820) = *Cyclops viridis* Jurine, 1820	FW	PL	Hugli-Matla estuary (Khan, 1995)
81.	*Mesocyclops hyalinus* (Rehberg, 1880)	FW/BW	PL	Hugli-Matla estuary (Khan, 1995)
82.	*Mesocyclops leuckarti* (Claus, 1939)	FW/BW	PL	Gazikhali (Roy, 1998)
	Family **OITHONIDAE** Dana, 1853			
83.	*Oithona brevicornis* Giesbrecht	BW	PL	Piali River (Khan, 1995)
	Order POECILOSTOMATOIDA Thorell, 1859			
	Family **CLAUSIDIIDAE** Giesbrecht, 1895			
84.	*Saphirella indica* Sewell, 1924	BW/CW	PL	Kachuberia, Chemaguri (Anonymous, 1987)
	Family **CORYCAEIDAE** Dana, 1852			
85.	*Corycaeus agilis* Dana, 1849	BW/CW	PL	South Sagar (Anonymous, 1987)
86.	*Corycaeus catus* F. Dahl, 1894	BW/CW	PL	South Sagar (Anonymous, 1987)
87.	*Corycaeus danae* Giesbrecht, 1891	BW/CW	PL	Mandirtala, Chemaguri (Anonymous, 1987)
	Family **ERGASILIDAE** Nordmann			

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
88.	*Ergasilus hamiltoni* Southwell and Prashad, 1918	BW	PA	Gosaba (Southwell and Prashad, 1918)
	Family **ONCAEIDAE** Giesbrecht, 1892			
89.	*Oncaea venusta* Philippi, 1843	BW/CW	PL	Chemaguri (Anonymous, 1987)
	Order SIPHINOSTOMATOIDA Thorell, 1859			
	Family **LERNANTHROPIDAE** Kabata, 1979			
90.	*Lernanthropus chrysophrys* Shishido, 1898	BW	PA	Port Canning (Tripathi, 1962a)
91.	*Lernanthropus pami* Tripathi, 1962	BW/CW	PA	Hugli estuary (Tripathi, 1962a)
92.	*Mitrapus engraulis* (Tripathi, 1962)	BW/CW	PA	Hugli (Tripathi, 1962a)
	Family **LERNAEOPODIDAE** Olsson, 1869			
93.	*Clavellisa ilishae* Tripathi, 1962	BW/CW	PA	Hugli estuary (Tripathi, 1962b)
94.	*Clavellisa pellonae* Tripathi, 1962	BW/CW	PA	Hugli estuary (Tripathi, 1962b)
95.	*Clavellisa phasa* Tripathi, 1962	BW/CW	PA	Hugli-Matla (Tripathi, 1962b)
	Subclass BRANCHIURA Thorell, 1864			
	Order ARGULOIDA Rafines ue, 1815			
	Family **ARGULIDAE** Leach, 1819			
96.	*Argulus siamensis* Wilson, 1926	BW	PA	Sundarbans (Mandal and Nandi, 1989); Champahati (present record) Ram - akrishna, 1951
	Class OSTRACODA Latreille, 1806			
	Subclass MYODOCOPA Sars, 1866			
	Order MYODOCOPIDA Sars, 1866			
	Superfamily CYPRIDINOIDEA Baird, 1850			
	Family **PHILOMEDIDAE** Müller, 1906			
97.	*Philomedes* sp.	BW	PL	Chemaguri (Anonymous, 1987)
	Subclass PODOCOPA Müller, 1894			
	Order PODOCOPIDA Sars, 1866			
	Superfamily CYPRIDOIDEA Baird, 1845			
	Family **CYPRIDIDAE** Baird, 1845			
	Subfamily CYPRIDINAE Baird, 1845			
98.	*Cypris* sp.	FW	PL	Sundarbans (Mandal & Nandi, 1989)
	Class MALACOSTRACA Latreille, 1806			
	Subclass HOPLOCARIDA CALMAN, 1904			
	Superfamily SQUILLOIDEA Latreille, 1803			
	Family **HARPIOSQUILLIDAE** Manning, 1980			
99.	*Harpiosquilla annandalei* (Kemp, 1911)	CW	NB	Sundarbans (Mandal & Nandi, 1989); Sandheads (Ghosh, 1998)
100.	*Harpiosquilla harpax* (De Haan, 1844)	CW	NB	Sandheads (Ghosh, 1995)
101.	*Harpiosquilla raphidea* (Fabricius, 1798)	CW	NB	Mouth of River Hooghly and Ganges Delta (Kemp, 1913); Sundarbans (Man - dal & Nandi, 1989); Bakkhali, Fraser- gunj, Kakdwip; Ganga Sagar (Ghosh, 1995)
	Family **SQUILLIDAE** Latreille, 1803			

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
102.	*Alimopsis supplex* (Wood-Mason, 1875)	CW	NB	Jambudwip (Ghosh, 1995)
103.	*Carinosquilla multicarinata* (White, 1848)	CW	NB	Sundarban (Ghosh, 1995)
104.	*Clorida decorata* Wood-Mason, 1875	CW	NB	Sundarbans (Mandal & Nandi, 1989); Bakkhali and Frasergunj (Ghosh, 1995)
105.	*Clorida latreillei* Eydoux and Souleyat, 1841	CW	NB	Sandheads and Gangetic Delta (Kemp, 1913); Sundarbans (Mandal & Nandi, 1989); Jambudwip (Ghosh, 1998)
106.	*Cloridopsis bengalensis* (Tiwari and Biswas, 1952)	BW/CW	NB	Jhingakhali (Mandal & Nandi, 1989); Sajnakhali, Piali River and Jharkhali (Ghosh, 1998)
107.	*Cloridopsis immaculata* (Kemp, 1913)	BW/CW	NB	Canning, Sajnakhali, Jhingakhali; Choto Mollakhali, Gosaba and Raimangal River (Mandal & Nandi, 1989)
108.	*Cloridopsis scorpio* (Latreille, 1825)	CW	NB	Frasergunj (Ghosh, 1998)
109.	*Dictyosquilla foveolata* (Wood-Mason, 1895)	CW	NB	Sandheads (Ghosh, 1998)
110.	*Oratosquilla holoschista* (Kemp, 1911)	CW	NB	Sundarbans (Mandal & Nandi, 1989); Sandheads (Ghosh, 1998)
111.	*Oratosquilla inornata* (Tate, 1883)	CW	NB	Gangetic Delta (Kemp, 1913); Sandheads (Kemp, 1913; Ghosh, 1998; Sundarbans (Mandal & Nandi, 1989)
112.	*Oratosquilla interrupta* (Kemp, 1911)	CW	NB	Sundarbans (Mandal & Nandi, 1989); Bakkhali, Jambudwip and Ganga Sagar (Ghosh, 1998)
113.	*Oratosquilla nepa* (Latreille, 1825)	CW	NB	Sandheads and Gangetic Delta (Kemp, 1913); Sundarbans (Mandal & Nandi, 1989); Jambudwip (Ghosh, 1998)
114.	*Oratosquilla hindustanica* Manning, 1978	CW	NB	Hoogly Delta (Kemp, 1913); Sandheads (Kemp, 1913; Ghosh, 1998)
115.	*Oratosquilla woodmasoni* (Kemp, 1911)	CW	NB	Sandheads and Gangetic Delta (Kemp, 1913); Sundarbans (Mandal & Nandi, 1989); Sagar Is. (Ghosh, 1998)
116.	*Squilloides gilesi* (Kemp, 1911)	CW	NB	Sundarbans (Mandal & Nandi, 1989); Sandheads (Ghosh, 1998)
	Superfamily LYSIOSQUILLOIDEA Giesbrecht, 1910			
	Family **LYSIOSQUILLIDAE** Giesbrecht, 1910			
117.	*Lysiosquilla tredecimdentata* Holthuis, 1944	CW	NB	Sandheads (Ghosh, 1998)
	Family **NANNOSQUILLIDAE** Manning, 1980			
118.	*Acanthosquilla acanthocarpus* (Miers, 1880)	CW	NB	Sundarbans (Mandal & Nandi, 1989); Sandheads (Ghosh, 1998)
119.	*Acanthosquilla multifasciata* (Wood-Mason, 1895)	CW	NB	Sundarban (Ghosh, 1998)
	Subclass EUMALACOSTRACA Grobben, 1892			
	Superorder PERACARIDA Calman, 1904			
	Order MYSIDACEA Haworth, 1825			
	Family **MYSIDAE** Haworth, 1825			
120.	*Gastrosaccus muticus* W. Tattersall, 1932	BW	PL	Matla River, Gangetic delta (present record)

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
121.	*Mesopodopsis orientalis* (W. M. Tattersall, 1908)	BW	PL	Port Canning (Tattersall, 1908); Man - dirtala (Anonymous, 1987)
	Order AMPHIPODA Latreille, 1816			
	Suborder COROPHIOIDEA Leach, 1814			
	Family **AORIDAE** Walker, 1908			
122.	*Grandidierella megnae* (Giles, 1888)	BW	MAB	Port Canning (Stebbing, 1908)
123.	*Microdeutopus* sp.	BW	MAB	Sundarbans (Chaudhuri & Choudhury, 1994)
124.	Paraoroides unistylus	BW	MAB	Sagar Is. (Anonymous, 1987)
	Family **PHOTIDAE** Boeck, 1871			
125.	*Dodophotis digitata* (Barnard, 1935)	BW	MAB	Mandirtala, South Sagar (Anonymous, 1987)
126.	*Microphotis* sp.	BW	MAB	Sundabans (Anonymous, 1987)
	Suborder GAMMARIDEA Latreille, 1802			
	Family **AMPELISCIDAE** Costa, 1857			
127.	*Ampelisca pusilla* Sars, 1891	BW	MAB	Gangetic delta (Annandale, 1906)
128.	*Ampelisca zamboanza* Stebbing, 1888	BW	MAB	Sagar Is. (Anonymous, 1987)
129.	*Byblis* sp.	BW	MAB	Sundarbans (Anonymous, 1987)
	Family **GAMMARIDAE** Latreille, 1802			
130.	*Gammarus* sp.	BW	MAB	Sundarbans (Chaudhuri & Choudhury, 1994)
	Family **MERIDAE** Krapp-Schickel, 2008			
131.	*Quadrivisio bengalensis* Stebbing, 1907	BW	PL	Port Canning (Stebbing, 1907); Gangetic delta (Annandale, 1906)
	Order ISOPODA Latreille, 1817			
	Suborder PHREATOICIDEA Stebbing, 1893			
	Suborder CYMOTHOIDEA			
	Family **BOPYRIDAE** Rafines ue, 1815			
132.	*Bopyrus bimaculatus* Chopra, 1923	BW	PA	Gangetic delta and Matla River (Chopra, 1923); Sundarban (Mandal & Nandi, 1989)
133.	*Epipenaeon elegans* Chopra, 1923	BW	PA	Gangetic delta (Chopra, 1923); Sundarban (Mandal & Nandi, 1989)
134.	*Probopyrus abhoyai* (Chopra, 1923)	BW	PA	Sundarban (Mandal & Nandi, 1989)
135.	*Probopyrus alcocki* (Chopra, 1923)	BW	PA	Sundarban (Mandal & Nandi, 1989)
136.	*Probopyrus bengalensis* (Chopra, 1923)	BW	PA	Sundarban (Mandal & Nandi, 1989)
137.	*Probopyrus brachysoma* (Chopra, 1923)	BW	PA	Sundarban (Mandal & Nandi, 1989)
138.	*Probopyrus buitendijki* Horst, 1910	BW	PA	Sundarban (Mandal & Nandi, 1989)
139.	*Probopyrus demani* Weber, 1892	BW	PA	Sundarban (Mandal & Nandi, 1989)
140.	*Probopyrus gangeticus* (Chopra, 1923)	BW	PA	Gangetic delta (Chopra, 1923); Sundarban (Mandal & Nandi, 1989)
141.	*Probopyrus prashadi* (Chopra, 1923)	BW	PA	Gangetic delta (Chopra, 1923); Sundarban (Mandal & Nandi, 1989)
	Family **CIROLANIDAE** Dana, 1852			

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
142.	*Annina mannai* Schotte, 1994	FW	PL	Mouth of the Ganges (Schotte, 1994)
143.	*Cirolana parva* Hansen, 1890	BW	WB	Sundarbans (Chaudhuri and Choudhury, 1994)
144.	*Dolicholana elongata* (H. Milne Edwards, 1840)	CW	WB	Mouth of the Ganges (H. Milne Edwards, 1840)
	Family **CYMOTHOIDAE** Leach, 1814			
145.	*Cymothoa indica* Schioedt and Meinert	BW	PA	Port Canning (Ghatak, 1995)
146.	*Nerocila madrasensis* Ramakrishna and Ramaniah, 1978	BW	PA	Bakkhali (Ghatak, 1995)
147.	*Nerocila phaeopleura* Bleeker, 1857	BW	PA	Port Canning (Ghatak, 1995)
148.	*Nerocila trivittata* Milne Edwards	BW	PA	Port Canning (Ghatak, 1995)
	Suborder SPHAEROMATIDEA			
	Family **SPHAEROMATIDAE** Latreille, 1825			
149.	*Sphaeroma annandalei* Stebbing, 1911	CW	WB	Port Canning (Stebbing, 1911)
150.	*Sphaeroma triste* Heller, 1865	CW	WB	Hugli-Matla Estuary (Ghatak, 1995)
151.	*Exosphaeroma parva* Chilton, 1924	CW	WB	Bakkhali (Ghatak, 1995)
	Order CUMACEA Krøyer, 1846			
	Family **DIASTYLIDAE** Bate, 1856			
152.	*Paradiatylis* sp.	BW	PL	Chemaguri and Prentice Is. (Anonymous, 1987)
	Order DECAPODA Latreille, 1802			
	Suborder DENDROBRANCHIATA Bate, 1888			
	Superfamily PENAEOIDEA Rafines ue, 1815			
	Family **PENAEIDAE** Rafines ue, 1815			
153.	*Metapenaeus affinis* (H. Milne Edwards, 1837)	BW	NB	Canning, Kakdwip, , Gosaba, Raidighi, Sandeshkhali, Dhanchi and Sajnekhali (Reddy, 1995b)
154.	*Metapenaeus brevicornis* (H. Milne Edwards, 1837)	BW	NB	Sundarbans (Anonymous, 1987)
155.	*Metapenaeus dobsoni* (Miers, 1878)	BW	NB	Canning (Reddy, 1995b)
156.	*Metapenaeus lysianasa* (De Man, 1888)	BW	NB	Canning, Kakdwip, Namkhana, Sagar Is., Basanti, Netidhopani, Gosaba, Golabari, Haldibari, Sandeshkhali, Nazat, Raidighi, Marich Jhanpi, Arbesi, Panchamukhani, Sajnekhali, and Mayadwip (Reddy, 1995b)
157.	*Metapenaeus monoceros* (Fabricius, 1798)	BW	NB	Sundarbans (Anonymous, 1987)
158.	*Parapenaeopsis sculptilis* (Heller, 1862)	BW	NB	Kakdeip, Namkhana, Canning, Gosaba, Patharpratima, Jambu Is., Sagar Is., Basanti, Balasurai, Frasergunj, Netidhopani, Saimari, Jharkhali, Kultali, Sandeshkhali, Kalas and Bhangaduni Is. (Reddy, 1995b)
159.	*Parapenaeopsis stylifera* (H. Milne Edwards, 1837)	BW	NB	Gosaba, Goashaba, Netidhopani and Pratham Gheri (Reddy, 1995b)
160.	*Fenneropenaus indicus* H. Milne Edwards, 1837	BW	NB	Canning, Pratham Gheri, Namkhana, Patharptatima, Basanti, Goashaba, Netidhopani, Sandeshkhali, Arbesi, Marich Jhanpi, Panchamukhani, Gona Is., and Sajnekhali (Reddy, 1995b)

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
161.	*Fenneropenaus merguiensis* De Man, 1888	BW	NB	Gosaba, Namkhana, Goashaba, Dhanchi, Netidhopani, Arbesi, Sandehkhali, Marich Jhanpi and Bhangaduni Is. (Reddy, 1995b)
162.	*Fenneropenaus penicillatus* Alcock, 1905	BW	NB	Hingalguni, Chulkati and Bhangaduni Is. (Reddy, 1995b)
163.	*Marsupenaeus japonicus* Bate, 1888	BW	NB	Gosaba and Kalas (Reddy, 1995b)
164.	*Penaeus (Penaeus) monodon* (Fabricius, 1798)	BW	NB	Canning, Goashaba, Netidhopani, Dhanchi and Sandeshkhali (Reddy, 1995b)
165.	*Penaeus (Penaeus) semisulcatus* De Haan	BW	NB	Sundarbans (Chaudhuri & Choudhury, 1994)
	Superfamily SERGESTOIDEA Dana, 1852			
	Family **SERGESTIDAE** Dana, 1852			
166.	*Acetes erythraeus* Nobili, 1905	BW	NB	Haliday Is. and Sajnekhali (Reddy, 1995b)
167.	*Acetes indicus* H. Milne Edwards, 1837	BW	NB	Basanti, Namkhana, Pathatpratima, Canning, Gosaba, Sudhanykhali and Goashaba (Reddy, 1995b)
	Family **LUCIFERIDAE** De Haan, 1849			
168.	*Lucifer hanseni* Nobili, 1905	BW	PL	Chemaguri (Anonymous, 1987)
	Suborder PLEOCYEMATA Burkenroad, 1963			
	Infraorder CARIDEA Dana, 1852			
	Superfamily ATYOIDEA De Haan, 1849			
	Family **ATYIDAE** De Haan, 1849			
169.	*Caridina nilotica bengalensis* De Man, 1908	FW	NB	Port Canning, De Man, 1908
	Superfamily PALAEMONOIDEA Rafines ue, 1815			
	Family **PALAEMONIDAE** Rafines ue, 1815			
170.	*Exopalaemon styliferus* (H. Milne Edwards, 1840	FW	NB	Gangetic delta (Kemp, 1917a); Kakd - wip, Chhayer Gheri, Sagar Is., Canning, Namkhana, Basanti, Hingalgunj, Jambu Is., Kultali, Netidhopani, Sandeshkhali, Arbesi and Marich Jhanpi (Reddy, 1995)
171.	*Nematopalaemon tenuipes* (Henderson, 1893)	BW	NB	Gangetic delta (Kemp, 1917a); Sundar - bans (Chaudhuri & Choudhury, 1994)
172.	*Macrobrachium equidens* (Dana, 1852)	BW	NB	Kakdwip, Namkhana, Patharpratima, Gosaba, Canning, Sudhanyakhali, Net - idhopani, Sandeshkhali and Raidighi (Reddy, 1995b)
173.	*Macrobrachium javanicum* (Heller, 1862)	FW	NB	Confluence of Matla and Bidya Rivers (Reddy, 1995b)
174.	*Macrobrachium lamarrei* (H. Milne Edwards, 1844)	FW	NB	Port Canning (De Man, 1908); Kakdwip and Patharpratima (Reddy, 1995b)
175.	*Macrobrachium malcomsonii* (H. Milne Ed- wards, 1844)	BW	NB	Sundarbans (Anonymous, 1987)
176.	*Macrobrachium mirabile* (Kemp, 1917)	BW	NB	Port Canning, Sandheads (Kemp, 1914, 1917a); Kakdwip (Reddy, 1995b)
177.	*Macrobrachium rosenbergii* (De Man, 1879)	FW/BW	NB	Kakdwip, Chulkati and Marich Jhanpi (Reddy, 1995b)

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
178.	*Macrobrachium rude* (Heller, 1862)	FW/BW	NB	Basanti and Marich Jhanpi (Reddy, 1995b)
179.	*Macrobrachium scabriculum* (Heller, 1862)	BW	NB	Sundarbans (Mandal & Nandi, 1989)
	Superfamily ALPHEOIDEA Rafines ue, 1815			
	Family **ALPHEIDAE** Rafines ue, 1815			
180.	*Alpheus crassimanus* Heller, 1862	BW	NB	Sundarbans (Anonymous, 1987)
181.	*Alpheus edwardsii* Audouin, 1827	BW	NB	Sandheads (present record)
182.	*Alpheus paludicola* Kemp, 1915	BW	NB	Sundarbans (Anonymous, 1987)
	Family **HIPPOLYTIDAE** Dana, 1852			
183.	*Exhippolysmata ensirostris* (Kemp, 1914)	CW	NB	Chhayer Gheri (Reddy, 1995b); Sandheads (present record)
184.	*Saron marmoratus* (Olivier, 1811)	BW	NB	Port Canning (Kemp, 1914)
	Superfamily CRANGONOIDEA Haworth, 1825			
	Family **CRANGONIDAE** Haworth, 1825			
185.	*Pontocaris pennata* Bate, 1888	CW	NB	Gangetic delta (Kemp, 1916); Sandheads (present record)
	Infraorder GEBIIDEA De Saint Laurent, 1979			
	Family **THALASSINIDAE** Latreille, 1831			
186.	*Thalassina anomala* (Herbst, 1804)	BW	MAB	Sundarbans (Anonymous, 1987)
	Infraorder PALINURA Latreille, 1803			
	Superorder PALINUROIDEA Latreille, 1803			
	Family **PALINURIDAE** Latreille, 1803			
187.	*Panulirus homarus* (Linnaeus, 1758)	CW	NB	Sundarbans (Anonymous, 1987)
188.	*Panulirus polyphagus* (Herbst, 1793)	CW	NB	Sundarbans (Anonymous, 1987)
	Infraorder ANOMURA H. Milne Edwards, 1832			
	Superfamily COENOBITIDEA Dana, 1851			
	Family **COENOBITIDAE** Dana, 1851			
189.	*Coenobita cavipes* Stimpson, 1859	BW	NB	Arbesi; Chhota Hardi; Bhangaduni Is.; Baghmara and Mechua Khal (Reddy, 1995a)
	Family **DIOGENIDAE** Ortmann, 1892			
190.	*Clibanarius clibanarius* (Herbst, 1791)	CW	NB	Sandheads (Reddy, 1995a)
191.	*Clibanarius infraspinatus* Hilgendorf, 1869	BW	NB	Bakkhali (Reddy, 1995a)
192.	*Clibanarius olivaceus* Henderson, 1915	BW	NB	Sagar Is., Chhoto Mollakhali and Gosaba (Reddy, 1995a)
193.	*Clibanarius padavensis* De Man, 1888	BW	NB	Port Canning, Sajnekhali, Sagar Is., Bak - khali, Arbesi, Kedo Block, Jhingakhali, Bhangaduni Is., Baghmara, Parghumti, Chhoto Mollakhali, Gosaba and Bhangon-Khalighat (Reddy, 1995)
194.	*Diogenes avarus* Heller, 1865	BW	NB	Bakkhali and Sagar Is (Reddy, 1995a)
195.	*Diogenes costatus* Henderson, 1893	CW	NB	Sandheads (Reddy, 1995a)
196.	*Diogenes custos* (Fabricius, 1798)	CW	NB	Sandheads (Reddy, 1995a)
197.	*Diogenes diogenes* (Herbst, 1791)	CW	NB	Sandheads (Reddy, 1995a)

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198.	*Diogenes investigatoris* Alcock, 1905	BW	NB	Bakkhali and Sagar Is (Reddy, 1995a)
199.	*Diogenes planimanus* Henderson, 1893	CW	NB	Sandheads (Reddy, 1995a)
200.	*Dardanus hessi* (Miers, 1884)	CW	NB	Sandheads (Reddy, 1995a)
	Superfamily PAGUROIDEA Latreille, 1803			
	Family **PAGURIDAE** Latreille, 1803			
201.	*Profundorum spiriger* Alcock, 1905	CW	NB	Sandheads (Reddy, 1995a)
	Section PODOTREMATA Guinot, 1977			
	Superfamily DROMIOIDEA De Haan, 1833			
	Family **DROMIIDAE** De Haan, 1833			
202.	*Conchoecetus artificiosus* (Fabricius, 1798)	CW	MAB	Hugli delta (Alcock;1899); Sandheads (Chopra, 1934a)
	Superfamily RANINOIDEA De Haan, 1839			
	Family **RANINIDAE** De Haan, 1839			
203.	*Raninoides personatus* Henderson, 1888	CW	MAB	Sandheads (Deb, 1998)
	Section EUBRACHYURA Saint Laurent, 1980			
	Subsection HETEROTREMATA Guinot, 1977			
	Superfamily AETHROIDEA Dana, 1851			
	Family **AETHRIDAE** Dana, 1851			
204.	*Drachiella morum* (Alcock, 1896)	CW	MAB	Sandheads (Chopra, 1934a)
	Superfamily CALAPPOIDEA De Haan, 1833			
	Family **CALAPPIDAE** De Haan, 1833			
205.	*Calappa lophos* (Herbst, 1790)	CW	MAB	Ganges delta (Alcock, 1896); Sandheads (Chopra,1933)
206.	*Calappa pustulosa* Alcock, 1896	CW	MAB	Sandheads (Chopra, 1933)
	Family **MATUTIDAE** De Haan, 1835			
207.	*Ashtoret lunaris* (Forskål, 1775)	BW/CW	NB	Sundarbans (Alcock, 1896); Sandheads (Chopra, 1933); Sagar Island (Chakraborty *et al*., 1986); Gazikhali, Patibunia, Bhangaduni Is.,Kakdwip, Frasergunj, Canning, Salt-Gheri, Hatkhali, Chhoto Seara, Sambunagar, Sarupkhali, Atapur, Kalinagar, Moina char and Bagna (present record)
208.	*Matuta planipes* Fabricius, 1798	BW/CW	NB	Sandheads (Chopra, 1933); Jambu Is.,Namkhana, Ukil Bazar, Thumkati, Purandar; Mainachar and Frasergunj, Kishorimohanpur – char, Sitagunge and Salt Gheri(present record)
209.	*Matuta victor* (Fabricius, 1781)	BW/CW	NB	Ganges delta (Alcock, 1896)
	Superfamily CORYSTOIDEA Samouelle, 1819			
	Family **CORYSTIDAE** Samouelle, 1819			
210.	*Jonas indica* (Chopra, 1935)	CW	MAB	Sandheads (Chopra, 1935)
	Superfamily DORIPPOIDEA MacLeay, 1838			
	Family **DORIPPIDAE** MacLeay, 1838			
211.	*Dorippe quadridens* (Fabricius, 1793)	CW	MAB	Sandheads (Chopra, 1933)

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
212.	*Dorippoides facchino* (Herbst, 1785)	CW	MAB	Sandheads (Chopra, 1933);
213.	*Neodorippe callida* (Fabricius, 1798)	CW	MAB	Sandheads (Dev Roy & Nandi, 2001)
	Family **ETHUSIDAE** Guinot, 1977			
214.	*Ethusa indica* Alcock, 1894	CW	MAB	Gangetic delta (Alcock, 1896)
	Superfamily ERIPHIOIDEA Macleay, 1838			
	Family **MENIPPIDAE** Ortmann, 1893			
215.	*Menippe rumphii* (Fabricius, 1798)	CW	MAB	Sandheads (Deb, 1998)
216.	*Myomenippe hardwickii* (Gray, 1831)	BW/CW	MAB	Sandheads (Chopra, 1935); Saimari, Parsamari and Chara-Ba-Dweep; (present record)
	Superfamily GECARCINUCOIDEA Rathbun, 1904			
	Family **PARATHELPHUSIDAE** Alcock, 1909			
217.	*Sartoriana spinigera* (Wood-Mason, 1871)	FW/BW	MAB	Sundarban (Nandi & Pramanik, 1994)
218.	*Spiralothelphusa hydrodromus* (Herbst, 1794)	FW/BW	MAB	Sundarban (Nandi & Pramanik, 1994)
	Superfamily GONEPLACOIDEA MacLeay, 1838			
	Family **SCALOPIDIIDAE** Stevcic, 2005			
219.	*Scalopidia spinosipes* Stimpson, 1858	CW	MAB	Sandheads (Chopra, 1935)
	Superfamily LEUCOSIOIDEA Samouelle, 1819			
	Family **IPHICULIDAE** Alcock, 1896			
220.	*Iphiculus spongiosus* Adams and White, 1848	CW	MAB	Sandheads (Chopra, 1933)
221.	*Pariphiculus mariannae* (Herklot, 1852)	CW	MAB	Sandheads (Chopra, 1933)
	Family **LEUCOSIIDAE** Samouelle, 1819			
	Subfamily EBALIINAE Stimpson, 1871			
222.	*Arcania erinaceus* (Fabricius, 1793)	CW	MAB	Sandheads (Chopra, 1933)
223.	*Arcania septemspinosa* (Fabricius, 1787)	CW	MAB	Gangetic delta (Alcock, 1896); Sandheads (Chopra, 1933)
224.	*Ixa cylindrus* (Fabricius, 1787)	CW	MAB	Sandheads (Chopra, 1933)
225.	*Ixa inermis* Leach, 1817	CW	MAB	Sandheads (Chopra, 1933)
226.	*Myra elegans* Bell, 1855	CW	MAB	Sandheads (Chopra, 1933)
227.	*Myra fugax* (Fabricius, 1798)	CW	MAB	Gangetic delta (Chopra, 1933)
228.	*Philyra globus* (Fabricius, 1775)	CW	MAB	Sandheads (Alcock, 1896; Chopra, 1933)
	Subfamily LEUCOSIINAE Samouelle, 1819			
229.	**Euclosia rotundifrons* Chopra, 1933	CW	MAB	Sandheads (Chopra, 1933)
230.	*Seulocia rhomboidalis* De Haan, 184	CW	MAB	Sandheads (Chopra, 1933)
231.	*Leucosia craniolaris* (Linnaeus, 1758)	CW	MAB	Sandheads (Alcock, 1896)
	Superfamily MAJOIDEA Samouelle, 1819			
	Family **EPIALTIDAE** MacLeay, 1838			
	Subfamily PISINAE Dana, 1851			
232.	*Doclea armata* De Haan, 1839	CW	MAB	Sandheads (Alcock, 1895; Chopra, 1933)
233.	*Doclea canalifera* Stimpson, 1857	CW	MAB	Sandheads (Alcock, 1895)
234.	*Doclea muricata* (Fabricius, 1787)	CW	MAB	Sandheads (Chopra, 1935)

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
235.	*Doclea ovis* (Fabricius, 1787)	CW	MAB	Sandheads (Chopra, 1935)
236.	*Doclea rissonii* Leach, 1815	CW	MAB	Sandheads (Alcock, 1895; Chopra, 1935)
237.	*Hyastenus diacanthus* (De Haan, 1839)	CW	MAB	Sandheads (Chopra, 1935)
238.	*Phalangipus longipes* (Linnaeus, 1758)	CW	MAB	Sandheads (Chopra, 1935)
	Family **HYMENOSOMATIDAE** MacLeay, 1838			
239.	*Neorhynchoplax inachoides* (Alcock, 1900)	BW	MAB	Port Canning (Alcock, 1900)
240.	*Neorhynchoplax nasalis* (Kemp, 1911)	BW	MAB	Bidyadhari River and Chingrighata (Kemp, 1917b)
241.	*Neorhynchoplax woodmasoni* (Alcock, 1900)	BW	MAB	Port Canning (Alcock, 1900)
242.	*Trigonoplax unguiformis* (De Haan, 1839)	BW	MAB	Sundarbans (Mandal & Misra, 1985)
	Superfamily PARTHENOPOIDEA MacLeay, 1838			
	Family **PARTHENOPIDAE** MacLeay, 1838			
	Subfamily DALDORFIINAE Ng and Rodriguez, 1986			
243.	*Cryptopodia angulata* H. Milne Edwards and Lucas, 1841	CW	MAB	Sandheads (Chopra, 1935)
	Subfamily PARTHENOPINAE MacLeay, 1838			
244.	*Enoplolambrus pransor* (Herbst, 1796)	CW	MAB	Sundarban (Deb, 1998)
	Superfamily PILUMNOIDEA Samouelle, 1819			
	Family **GALENIDAE** Alcock, 1898			
	Subfamily GALENINAE Alcock, 1898			
245.	*Galene bispinosa* (Herbst, 1783)	CW	MAB	Sandheads (Chopra, 1935)
	Subfamily HALIMEDINAE Alcock, 1898			
246.	*Halimede fragifer* De Haan, 1835	CW	MAB	Sandheads
247.	*Halimede tyche* (Herbst, 1801)	CW	MAB	Sandheads (Chopra, 1935)
	Family **PILUMNIDAE** Samouelle, 1819			
	Subfamily PARAPANOPINAE Stevcic, 2005			
248.	*Parapanope euagora* De Man, 1895	CW	MAB	Sandheads (Deb, 1995)
	Subfamily PILUMNINAE Samouelle, 1819			
249.	*Eurycarcinus bengalensis* Deb, 1998	BW	MAB	Canning, Gosaba, Jharkhali, Baghmara and Champatala (Deb, 1995) ; Chamta Block (Deb, 1998)
250.	*Eurycarcinus natalensis* (Krauss, 1843)	BW	MAB	Canning, Basanti and Sajnakhali (Deb, 1995); Sagar, Lothian & Prentice Islands (Chakraborty *et al*., 1986); Haldibari, Gona Is., Chhotahardi, Fatikpur and Keorasuti (present record)
251.	*Eurycarcinus orientalis* A. Milne Edwards, 1867	BW	MAB	Haldibari, Gona Is., Chhotahardi and confluence of Bidya and Matla rivers (present record)
252.	*Heteropanope glabra* Stimpson, 1858	BW	MAB	Jharkhali, Bakkhali, Sagar Islands and Canning (Deb, 1995, 1998)
253.	*Heteropanope neolaevis* Deb, 1998	BW	MAB	Kachuberia (Deb, 1998)
254.	*Heteropilumnus ciliatus* (Stimpson, 1858)	BW	MAB	Sundarban (Deb, 1995)

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	Subfamily RHIZOPINAE Stimpson, 1858			
255.	*Typhlocarcinus nudus* Stimpson, 1858	BW	MAB	Sandheads (Alcock, 1900)
	Superfamily PORTUNOIDEA Rafines ue, 1815			
	Family **PORTUNIDAE** Rafines ue, 1815			
	Subfamily CAPHYRINAE Paul'son, 1875			
256.	*Lissocarcinus arkati* Kemp, 1923	CW	NB	Sandheads (Kemp, 1923)
	Subfamily PORTUNINAE Rafines ue, 1815			
257.	*Portunus (Lupocycloporus) gracilimanus* (Stimpson, 1858)	CW	NB	Sandheads
258.	*Portunus (Monomia) gladiator* Fabricius, 1758	CW	NB	Sundarbans (Alcock, 1899); Sandheads and Matla River (Bhadra, 1995)
259.	*Portunus (Portunus) pelagicus* (Linnaeus, 1758)	CW	NB	Sandheads and Port Canning; (Chakraborty *et al*., 1986)
260.	*Portunus (Portunus) pubescens* (Dana, 1852)	CW	NB	Sagar Is. (Bhadra, 1995)
261.	*Portunus (Portunus) sanguinolentus* (Herbst, 1790)	CW	NB	Sandheads
262.	*Portunus (Xiphonectes) hastatoides* Fabricius, 1798	CW	NB	Sandheads (Bhadra, 1998)
263.	*Portunus (Xiphonectes) pulchricristatus* (Gordon, 1931)	CW	NB	
264.	*Scylla serrata* (Forskål, 1775)	BW	NB	Port Canning (Annandale, 1906); Sagar, Lothian, Prentice & Jambu Is - lands (Chakraborty *et al*., 1986); Basanti, Gosaba, Bakkhali, Chhoto Mollakhali, Baghmara; Bhangaduni Is., Chhotahardi, Nikarikhal, Hatkhali, Gobinokati, Kalitala, Pakhiraloi, Sunda - rkhali and Jharkhali (present record)
265.	*Scylla tranquebarica* (Fabricius, 1798)	BW	NB	Basanti, Gosaba, Chhoto Mollakhal (present record)
	Subfamily THALAMITINAE Paul'son, 1875			
266.	*Charybdis (Charybdis) affinis* Dana, 1852	CW	NB	Bakkhali (Bhadra, 1998)
267.	*Charybdis (Charybdis) callianassa* (Herbst,	CW	NB	Sandheads (Bhadra, 1998)
268.	*Charybdis (Charybdis) feriatus* (Linnaeus, 1758)	CW	NB	Sandheads and Port Canning (Chakraborty *et al*., 1986); Bakkhali and Jharkhali (Bhadra, 1995); Jambu Is. (present record)
269.	*Charybdis (Charybdis) helleri* (A. Milne Edwards, 1867)	CW	NB	Sandheads and Gosaba (Bhadra, 1998); Dabbu, Prentice Is.,Gazikhali; Purandar and Ajmalmari (present record)
270.	*Charybdis (Charybdis) miles* (De Haan, 1852)	CW	NB	Sandheads (Bhadra, 1995)
271.	*Charybdis (Charybdis) orientalis* Dana, 1852	BW	NB	Sundarbans (Mandal & Misra, 1985); Gosaba (Bhadra, 1995)

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272.	*Charybdis (Charybdis) rostrata* (A. Milne Edwards, 1861)	BW/CW	NB	Sandheads (Bhadra, 1998); Ganga Sagar, Piali River, Frasergunj, Matla River, Bakkhali,Gosaba and Sagar Is. (Bhadra, 1995); Dabbu, Nazat, Bakkhali, Thumkati, Sapkhali, Phuldubi, Namkhana, Bagna, Mainachar, Kultali, Thumkati, Gosaba, Sardarpara and Chhoto Mollakhali (present record)
273.	*Charybdis (Charybdis) variegata* (Fabricius, 1798)	CW	NB	Sandheads (Bhadra, 1998)
274.	*Charybdis (Goniohellenus) truncata* (Fabricius, 1798)	CW	NB	Sandheads (Alcock, 1899)
275.	*Charybdis (Goniohellenus) vadorum* Alcock, 1899	CW	NB	Sandheads (Chopra, 1935; Bhadra, 1998)
276.	*Thalamita crenata* (Latreille, 1829)	BW	NB	Dhanchi (Dev Roy and Nandi, 2001)
	Superfamily XANTHOIDEA MacLeay, 1838			
	Family **XANTHIDAE** MacLeay, 1838			
	Subfamily XANTHINAE MacLeay, 1838			
277.	*Liagore erythematica* Guinot, 1971	CW	MAB	Sandheads (Kemp, 1923; Guinot, 1971)
278.	*Orphanoxanthus microps* (Alcock and Anderson, 1894)	CW	MAB	Bay of Bengal around West Bengal coast (Deb, 1998)
	Superfamily GRAPSOIDEA MacLeay, 1838			
	Family **GRAPSIDAE** MacLeay, 1838			
279.	*Metopograpsus latifrons* (White, 1874)	BW	MAB	Bhangaduni Is. (Ghosh, 1995); Sagar, Prentice & Lothian Islands (Chakraborty *et al*., 1986)
280.	*Metopograpsus messor* (Forskål, 1775)	BW	MAB	Canning (Mandal & Misra, 1985); Sagar Is. (Ghosh, 1995); Sagar, Prentice & Lothian Islands (Chakraborty *et al*., 1986); Achipur, Raychak, Bhangonkhali Ghat, Gosaba, Gobindapur, Himchakhali, Nikarighat, Belekhali, Sonakhali, Jharkhali, Saimari and Marichjhapi (present record)
281.	*Pachygrapsus porpinquus* De Man, 1908	BW	MAB	Canning (De Man, 1908; Annandale, 1907); Kakdwip (Ghosh, 1995)
	Family **SESARMIDAE** Dana, 1851			
282.	*Clistocoeloma merguiense* De Man, 1888	BW	MAB	Sagar Is. (Ghosh, 1995)
283.	*Episesarma mederi* (H. Milne Edwards, 1853)	BW	MAB	Jhingakhali, Canning (Mandal & Misra, 1985); Sagar, Lothian, Prentice & Jambu Islands (Chakraborty *et al*., 1986); Chamta Block (Ghosh, 1995); Golabari, Chaltamunikhal, Patharprotima, Frasergunj, Netidhopani, Bidya River Bank, Tooshkhali, Jharkhali, Marichjhapi and Sajnakhali (present record)
284.	*Muradium tetragonum* (Fabricius, 1798)	BW	MAB	Sundarban (Ghosh, 1995); Bhagabatpur and Ukiler haat (present record)
285.	*Parasesarma pictum* (De Haan, 1835)	BW	MAB	Sagar Is. (Chakraborty *et al*., 1986)
286.	*Parasesarma plicatum* (Fabricius, 1798)	BW	MAB	Matla River; Uttarbhag (Ghosh, 1995)

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
287.	*Perisesarma bidens* (De Haan, 1835)	BW	MAB	Bakkhali, Kakdwip, Bidya river, Achipur, Nurpur, Diamond Harbour, Uttarbhag, Gosaba, Bhangaduni Is., Baghmara, Sajnakhal, Jhingakhali and Marichjhapi (Ghosh, 1995); Sagar, Lothian & Prentice Islands (Chakraborty *et al*., 1986)
288.	*Sesarmops impressum* (H. Milne Edwards, 1837)	BW	MAB	Jhingakhali (Mandal & Misra, 1985)
289.	*Sesarmops intermedium* (De Haan, 1835)	BW	MAB	Nurpur (Ghosh, 1998)
290.	*Sesarmoides longipes* (Krauss, 1843)	BW	MAB	Bhangonkhali Ghat (Ghosh, 1995); Sagar Is. (Chakraborty *et al*., 1986)
291.	*Sesarmoides kraussi* (De Man, 1888)	BW	MAB	Nurpur (Ghosh, 1995, 1998)
292.	*Pseudosesarma edwardsi* (De Man, 1887)	BW	MAB	Falta, Majherchar, Babugungehat and Ballykhal (Ghosh, 1995); Achipur, Nurpur, Kakdwip, Bakkhali, Gosaba, Bidya River, Bhangaduni Is., Baghmara, Sajnakhali, Jhingakhali, Sagar, Lothian & Prentice Islands
293.	*Neosarmatium smithi* (H. Milne Edwards, 1853)	BW	MAB	Baghmara Khal (Ghosh, 1995)
294.	*Metasesarma rousseauxii* h. Milne Edwards, 1853	BW	MAB	Sandheads (Ghosh, 1995)
	Family **VARUNIDAE** Alcock, 1900			
	Subfamily CYCLOGRAPSINAE H. Milne Ed - wards, 1853			
295.	*Metaplax crenulata* (Gerstecker, 1856)	BW	MAB	Sundarbans (Alcock, 1900); Prentice & Lothian Islands (Chakraborty *et al*., 1986); Canning (Ghosh, 1995); Fraser- gunj, Patibunia, Haldibari, Jhingakhali, Kishorimohanpur, Chamta Block, Sajnakhali and Bhangaduni Is. (Ghosh, 1998)
296.	*Metaplax dentipes* (Heller, 1865)	BW	MAB	Port Canning (Annandale, 1906; De Man, 1908); Jhingakhali (Man - dal & Misra, 1985); Canning, Ba- santi, Achipur,Nurpur; Kakdwip, Bhangonkhali Ghat, Belekhali and Marichjhapi (Ghosh, 1998)
297.	*Metaplax distincta* H. Milne Edwards, 1852	BW	MAB	Jhingakhali (Mandal & Misra, 1985); Kakdwip (Ghosh, 1995)
298.	*Metaplax indica* H. Milne Edwards, 1852	BW	MAB	Prentice & Lothian Islands (Chakraborty *et al*., 1986); Achipur (Ghosh, 1998)
299.	*Metaplax intermedia* De Man, 1888	BW	MAB	Jhingakhali (Mandal & Misra, 1985); Sagar, Lothian, Prentice & Jambu Islands (Chakraborty *et al*., 1986); Nurpur, Jharkhali and Chota Mollakhali (Ghosh, 1995); Canning, Basanti, Go - saba, Sajnakhali, and Kakdwip (Ghosh, 1998)
	Subfamily VARUNINAE H. Milne Edwards, 1853			
300.	*Ptychognathus dentatus* De Man, 1892	BW	MAB	Falta (Ghosh, 1995); Falta, Nurpur, Dia - mond Harbour, Bakkhali and Uttarbhag (Ghosh, 1998)

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
301.	*Ptychognathus onyx* Alcock, 1900	BW	MAB	Nurpur and Falta (Ghosh, 1998)
302.	*Pyxidognathus fluviatilis* Alcock, 1900	BW	MAB	Sundarban (Ghosh, 1995)
303.	*Varuna litterata* (Fabricius, 1798)	FW/BW/CW	NB	Port Canning (Annandale, 1907; De Man, 1908); Sagar Island (Chakraborty *et al*., 1986); Jhingakhali and Canning (Mandal & Misra, 1985); Kachuberia, Namkhana, Kakdwip, Sapkhali, Bortala, Frasergunj, Lothian Is., Mandirtala, Sajnakhali, Gosaba,Chadalkhali, Sand - eshkhali, Kalinagar, Belakhali, Hatkhali, Bagna,Charamayadwip,Narantala, Gho - shpur and Gogeshgunj (present record)
	Superfamily OCYPODOIDEA Rafines ue, 1815			
	Family **DOTILLIDAE** Stimpson, 1858			
304.	*Dotilla blanfordi* Alcock, 1900	BW	MAB	Sagar Is., Lower Long & Prentice Islands (Chakraborty *et al*., 1986); Kak- dwip (Bairagi, 1995)
305.	*Dotilla intermedia* De Man, 1888	BW	MAB	Sagar Is. (Bairagi, 1995)
306.	*Dotillopsis brevitarsis* (De Man, 1888)	BW	MAB	Jharkhali and Canning (Mandal & Misra, 1985); Sagar, Prentice, Jambu and Lothian Islands (Chakraborty *et al*., 1986); Gosaba and Canning (Bairagi, 1995); Kakdwip (Deb, 1998); Namkha - na, Jhingakhali and Pargumti (present record)
307.	*Ilyoplax gangeticus* (Kemp, 1919)	BW	MAB	Port Canning (Chakraborty *et al*., 1986); Gosaba and Chhotomollakhali (Bairagi, 1995)
308.	*Ilyoplax stapletoni* (De Man, 1908)	BW	MAB	Port Canning (De Man, 1908; Annan - dale, 1909); Nurpur (Bairagi, 1995)
309.	*Scopimera globosa* De Haan, 1835	BW	MAB	Sundarban (Mandal & Misra, 1985; Deb, 1998); Sundarban Tiger Reserve Area (Bairagi, 1995)
310.	*Scopimera investigatoris* Alcock, 1900	BW	MAB	Sundarban Tiger Reserve Area (Bairagi, 1995)
311.	*Scopimera proxima* Kemp, 1919	BW	MAB	Sundarban (Deb, 1998)
	Family **MACROPHTHALMIDAE** Dana, 1851			
312.	*Macrophthalmus (Macrophthalmus) brevis* (Herbst, 1804)	BW	MAB	Harinbari; Sagar Is. (Bairagi, 1995)
313.	*Macrophthalmus (Macrophthalmus) crassipes* H. Milne Edwards, 1834	BW	MAB	Jharkhali (Bairagi, 1995)
314.	*Macrophthalmus (Macrophthalmus) transver - sus* (Latreille, 1817)	CW	MAB	Sandheads (Deb, 1998)
315.	*Macrophthalmus (Mareotis) depressus* Rüppell, 1830	BW	MAB	Gosaba; Sonakhali (Bairagi, 1995)
316.	*Macrophthalmus (Mareotis) pacificus* 1851	BW	MAB	Gosaba (Bairagi, 1995)
317.	*Macrophthalmus (Mareotis) teschi* Kemp, 1919	BW	MAB	Pargumti, Jharkhali and Gosaba (Bairagi, 1995); Port Canning (Deb, 1998); Sagar Is. (Chakraborty *et al*., 1986); Pargumti; Jharkhali; Gosaba (present record)

Sl. No.	Group and Species	Habitat	F. G.*	Locality & References
318.	*Macrophthalmus (Mareotis) tomentosus* Souleyet, 1841	BW	MAB	Sundarban (Dev Roy & Nandi, 2001)
319.	*Macrophthalmus (Paramareotis) erato* De Man, 1888	BW	MAB	Bakkhali; Sagar Is. (Bairagi, 1995)
320.	*Macrophthalmus (Venitus) dentipes* Lucas in Guérin-Méneville, 1838	BW	MAB	Jhingakhali (Mandal & Misra, 1985); Sagar Is. (Chakraborty *et al*., 1986)
	Family **OCYPODIDAE** Rafines ue, 1815			
	Subfamily OCYPODINAE Rafines ue, 1815			
321.	*Ocypode ceratophthalma* (Pallas, 1772)	BW	MAB	Sagar & Lower Long Islands (Chakraborty *et al*., 1986)
322.	*Ocypode macrocera* H. Milne Edwards, 1837	BW	MAB	Sagar Is, Lower Long Is & Lothian Is.; Bakkhali (Chakraborty *et al*., 1986); Jharkhali and Namkhana (Bairagi, 1995); Bhangaduni Is., Frasergunj, Hali - day Is., Jambu Is.and Kakdwip (present record)
323.	*Ocypode platytarsis* H. Milne Edwards, 1852	BW	MAB	Sundarban (Deb, 1998)
	Subfamily UCINAE Dana, 1851			
324.	*Uca dussumieri* (H. Milne Edwards, 1852)	BW	MAB	Sagar, Prentice and Lothian Islands (Chakraborty *et al*., 1986); Namkhana, Bakkhali and Jharkhali
325.	*Uca rosea* (Tweedie, 1937)	BW	MAB	Canning and Jhingakhali (Mandal & Misra, 1985); Sagar, Prentice, Lower Long, Lothian & Jambu Islands (Chakraborty *et al*., 1986); Jharkhali (Bairagi, 1995); Sajnakhali , Gosaba and Port Canning (present record)
326.	*Uca vocans* (Linnaeus, 1758)	BW	MAB	Sajnakhali; Sagar Is. (Chakraborty *et al*., 1986)
327.	*Uca lactea* (De Haan, 1835)	BW	MAB	Sagar Is and Lothian Is. (Chakraborty *et al*., 1986); Bakkhali (Bairagi, 1995); Saimari (present record)
328.	*Uca triangularis* (A. Milne Edwards, 1873)	BW	MAB	Jhingakhali, Sagar, Prentice and Lothian Islands (Chakraborty *et al*., 1986); Jharkhali and Bakkhali (Bairagi, 1995)
	Superfamily PINNOTHEROIDEA De Haan, 1833			
	Family **PINNOTHERIDAE** De Haan, 1833			
	Subfamily PINNOTHERINAE De Haan, 1833			
329.	*Pinnotheres mactricola* Alcock, 1900	CW	PA	Sandheads (Alcock, 1900)

* Abbreviations used:

FG= Functional Guild FW=Fresh water EW= Estuarine water

BW= Brackish water CW= Coastal water PL= Pelagic/Planktonic

NB= Nektobenthos MAB= Macrobenhos MEB= Meiobenthos SEP=Sedentary Epibenthos

PA= Parasitic WB= Wood-borer

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2.11 ARANEAE

Spiders are among the most omnipresent and numerous predators in both natural and agricultural ecosystems, averaging 50,000 individuals per acre in vegetated areas (Zahl 1971).

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Mesothelae and Orthognatha consist of primitive spiders Labidognatha includes the more recent spiders

They are nature's master spinners of silken webs and are highly proficient predators (Wise 1993) and thereby, regulate insect populations. A quick glance at the biological diversity reveals that arthropods are the most diverse group of organisms. It has generated a very diverse group of arthropods and in particular, insects. Arthropods constitute 64.5 percent of the described species as compared to plants (14.3 percent), fungi (4.2 percent), and vertebrates (2.3 percent) (Global Biodiversity Assessment 1995). The arachnids constitute the second largest class (7 percent) of documented arthropods and it is estimated that 8.3 percent of arthropods are arachnids. Thus, arachnids rank second among arthropods. Currently, more than 39,000 species, 3,642 genera, and 111 families have been described. The order Araneae comprises three suborders: Mesothelae with one family of spiders the *Liphistiidae*; Mygalomorphae, the primitive spiders; and Araneomorphae, the modern spiders (Foelix 1996).

The class Arachnida comprises the orders Scorpiones (scorpions); Schizomida (schizomids) Amblypygi (tailless whip scorpions); Uropygi (uropygids or whip scorpions); Opiliones (opiliones, harvestmen, or daddy longlegs); Pseudoscorpiones (pseudo-scorpions or false scorpions); Palpigradi (palpigrades or micro whip scorpions); Solifugae (wind scorpions, sun spiders, or solifugids); Ricinulei (ricinuleids); Acari (mites and ticks); and Araneae (spiders).

Spiders belong to the class Arachnida of the phylum Arthropoda, animals that possess jointed appendages and a chitinous exoskeleton. The suborders Mesothelae and Orthognatha consist of primitive spiders, and the suborder Labidognatha includes the more recent spiders. The members of the class Arachnida are generally characterized by the two body regions, the cephalothorax having four pairs of segmented legs attached to it, and the abdomen. Unlike insects, arachnids do not have antennae.

Spiders can be clearly differentiated from other Arachnids by the presence of the pedicel, a narrow stalk that joins the cephalothorax (anterior body section) and the abdomen. In other arachnids, the two parts of the body are fused so that they appear as one. Spiders are unique as they possess spinnerets, situated near the hind end of the abdomen, which produce silk. Spiders range in size from the barely visible (Samoan moss spider, *Patu marplesi*, which measures only 0.017 inches) to many inches long, as in tropical mygalomorph spiders (the goliath tarantula, *Theraphosa blondihi*, with a body length of 3.5 inches and leg span of 11 inches).

It is known that spiders and insects have been able to spin silk for at least 380 million years. Orb-weaving spiders evolved about 120 million years ago and have developed silk for the specific purpose of trapping flying insects that are the spider's food source. Spider silk has tremendous economic value due to its extraordinary mechanical properties such as high tensile strength (stronger than steel), high extensibility comparable to rubber, and high capability and biodegradability of water uptake compared to wool (Sebastian et al. 2009).

OVERVIEW OF THE GROUP

1442
SPECIES RECORDED FROM INDIA

The distribution and diversity of spiders and their importance in ecosystem dynamics has drawn the attention of field workers in different parts of the world. Taylor (1999) provides a good and well-illustrated account of the diversity, beauty, and intricacies of spiders.

Platnick (2010) lists 41,719 spider species under 109 families and 3,802 genera globally. Tikader (1987) has listed 1,067 under 43 families. Siliwal et al. (2005) report 1,442 species belonging to 361 genera of 59 families from India. The predominant families are Lycosidae, Salticidae, Gnaphosidae, Thomisidae, and Araneidae.

Camaricus formosus

SYNOPTIC VIEW

Diversity

114
SPECIES FROM SUNDARBANS

Although there are several published records on the spiders of the Indian Sunderbans (Tikader 1980a, b; Majumder and Tikader 1991; Biswas and Biswas 1992; Biswas 1995), very little work has been done on spiders' ecology and the role they play in ecosystem dynamics. Majumder (2004) in his monumental works on the Sundarban spider reported 108 species in 36 genera under 13 families (see annexure), namely Araneidae, Clubionidae, Erisidae, Gnaphosidae, Hersilidae, Heteropodidae, Lycosidae, Oxyopidae, Salticidae, Tetragnathidae, Theridiidae, Thomisidae, and Uloboridae from the Indian Sunderbans. Among them, 3 species have been recorded in this region as new: *Oxyooes reddyi* sp. nov. (Family: Oxyopidae); *Marpissa dayapurensis* sp. nov.; and *M. lakshmikantapurensis* sp. nov. (Family: Salticidae). Thirty-eight species are new records from this area. Majumder (2005) had also described another 4 species from the Indian Sundarbans.

Out of the 361 genera recorded from the Indian region (Siliwal et al. 2005), 37 genera (table 1) are found in the Indian Sundarbans. Maximum generic diversity was found in Araneidae (11), Lycosidae (7), and Salticidae (4). The number of

genera recorded here is higher than that of other major Indian spider studies, for example, in the Andaman and Nicobar Islands—33 genera (Tikader 1977).

Species Richness and Functional Groups

Of about 1,442 species of spiders that are reported from India (Siliwal et al. 2005), 114 species have been recorded from 19 blocks of the Indian Sundarbans (figure 2). This number is very high when compared with other regions like the Andaman and Nicobar Islands—65 species (Tikader 1977). Guild structure analysis (figure 1) of spiders at the Indian Sundarbans reveals eight functional guilds, namely orb web weavers, ground runners, foliage runners, foliage hunters, stalkers, ambushers, scattered line weavers, and social spiders. Ground runners, orb web weavers, and stalkers were the dominant functional guilds representing 39 percent, 28 percent, and 22 percent, respectively, of the total spiders found in the Sundarbans.

3 species recorded in Sundarbans are new to science

38 species are new record from this area

Distribution Pattern

From 19 blocks of the Indian Sundarbans, 114 species have been recorded (figure 2). Maximum species diversity was found from Gosaba (56), Hingalgunj (35), Patharpratima (33), and Sandeshkhali (24). Table 2 represents the species distribution pattern with reference to the functional guilds available at these four places representing high species diversity.

Table 1: Total number of families, genera, species composition and functional guilds of spiders.

Sr. No.	Family	No. of Genera	No. of Species	Guild
1	Araneidae	11	30	Orb web weavers
2	Clubionidae	3	8	Foliage hunters
3	Eresidae	1	1	Social Spider
4	Gnaphosidae	2	2	Ground runners
5	Hersilidae	1	1	Foliage hunters
6	Heteropodidae	2	4	Foliage runners
7	Lycosidae	7	42	Ground runners
8	Oxyopidae	2	9	Stalkers
9	Salticidae	4	13	Stalkers
10	Tetragnatha	1	1	Orb web weavers
11	Thomisidae	1	1	Ambushers
12	Theridiidae	1	1	Scattered line weavers
13	Uloboridae	1	1	Orb web weavers
	Total	**37**	**114**	

Fig 1: Functional Guild Structure of Spiders

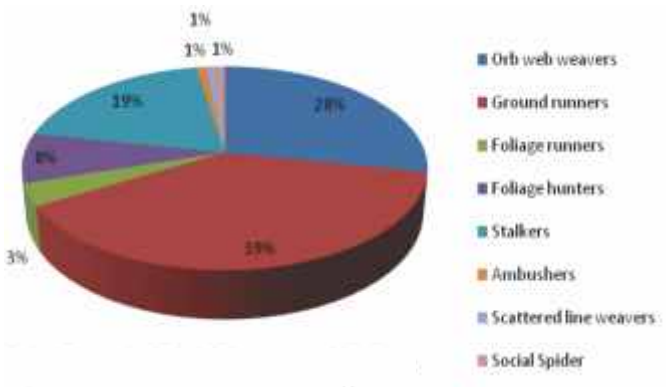


Fig 2: Distribution pattern of spiders in different blocks of Sunderban

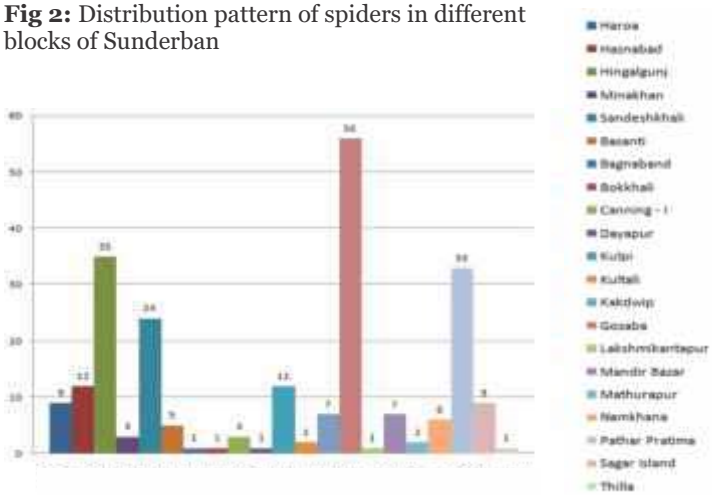


Table 2: Functional groups of spiders in 4 blocks of Indian Sundarbans.

Blocks	Functional groups					
	Orb web weavers	Foliage hunters	Foliage runners	Ground runners	Stalk-ers	Ambush-ers
Gosaba	+	+		+	+	+
Hingalgunj	+	+		+	+	
Patharpratima	+	+	+	+	+	+
Sandeshkhali	+			+		

Note: '+' means availability

Local Community Dependencies and Traditional Use

The healing of human ailments by using therapeutics based on medicines obtained from animals or ultimately derived from them is known as 'zootherapy' (Costa-Neto 2005). The use of animals for medicinal purposes is part of a body of traditional knowledge which is increasingly becoming more relevant to discussions on conservation biology, public health policies, and sustainable management of natural resources, biological prospection, and patents (Alves and Rosa 2005). Approximately 109 animals are reported in traditional medicine in different parts of India (Mahawar and Jaroli 2008).

Majumder and Dey (2005) reported drugs prepared from different species of spiders used successfully by the tribes at the Sundarbans as the remedy for various diseases. The Sundarbans hosts 81,000 tribal people. Fifty-seven medicinal applications have been reported from the Sundarbans, made from 14 species of spiders and 25 floral species (table 3).

The medicinal applications are used locally and some of them are taken orally for the cure of diseases. The applications are generally for the cure of toothache, paralysis of limbs, renal calculi, dysentery, burns, obesity, nasal obstruction, and so on.

Argiope pulchella

Table 3: Dependencies of Tribes on Aranae and flora for their ethnomedicinal usage.

Sr. No.	Name of Aranae Species	Name of the Flora	Local Name of the flora	Name of Tribe
1	*Argiope pulchella*	*Cynodon dactylon*	Durba *	S
		Blumea odorata	Kuksima	M
		Boerhaavia diffusa	Punarnaba *	O
		Acalypha indica	Muktajhuri	S
2	*Nephilia maculata*	*Ocimum sanctum*	Tulasi	O
		Nyctanthes arbor-tristis	Shephalika *	M
		Trichosanthes dioica	Patal	M
3	*Neoscona mukerjei*	*Luffa amara*	Titpolla *	S, M & O
		Hygrophilla spinosa	Kulekhara *	M
		Ocimum caryophyllatum	Dulai Tulasi	O
4	*Cyrtohora cicatrosa*	*Gentiana chirata*	Chirata	O
		Solanum lycopersicum	Tomato	S
		Hydrocotyle asiatica	Thankuni *	M

Sr. No.	Name of Aranae Species	Name of the Flora	Local Name of the flora	Name of Tribe
5	*Cheriacanthium mela-nostoma*	*Ficus bengalensis*	Bot *	M
		Achyranthes aspera	Apamarga	S
		Azadirachta indica	Nim *	O
6	*Cheriacanthium mela-nostoma*	*Calotropis gigantea*	Akanda *	S
		Nyctanthes arbor-tristis	Shephalika	M
		Azadirachta indica	Nim	M
7	*Pardosa birmanica*	*Musa sepientum*	Banana *	M & S
		Calotropis gigantea	Akanda	M
		Terminalia chrbula	Haritaki *	S
8	*Lycosa choudhuryi*	*Abroma radix*	Olat kambal root *	S
		Azadirachta indica	Nim	O
		Hygrophilla spinosa	Kulekhara	S
9	*Heteropoda venatoria*	*Azadirachta indica*	Nim	S
		Clerodendron infortunatum	Bhat *	S
		Boerhaavia diffusa	Punarnaba	M
		Hydrocotyle asiatica	Thankuni	O
10	*Spariolenus tigris*	*Musa sepientum*	Banana	M
		Cynodon dactylon	Durba	M
		Ficus bengalensis	Bot	M
		Hygrophilla spinosa	Kulekhara	S
		Tinospora cordifolia	Gulancha	M
11	*Phidippus bengalensis*	*Calotropis gigantea*	Akanda	O
		Terminalia chrbula	Haritaki	M
		Rauwolfia serpentina	Chandra	S
		Nyctanthes arbor-tristis	Shephalika	O
12	*Marpissa bengalensis*	*Abroma radix*	Olat kambal root	S
		Clerodendron infortunatum	Bhat	O
		Ocimum sanctum	Tulsi	S
		Nyctanthes arbor-tristis	Shephalika	S
13	*Crossoprhiza lyoni*	*Musa sepientum*	Banana	M
		Abroma radix	Olat kambal root	S
		Boerhaavia diffusa	Punarnaba	S
		Azadirachta indica	Nim	S
14	*Artema atlenta*	*Azadirachta indica*	Nim	M
		Solanum xanthocarpus	Kantikari	S
		Ficus religosa	Ashwattha	S
		Cynodon dactylon	Durba	O

Note:

- Name of the Tribe: S-Santhal; M-Munda; O-Oraon

- '*': multiple use of the flora with other Aranae species in different applications.
Source : (Majumder & Dey, 2005)

Ecological Importance and Need for Conservation

Spiders are among the oldest and most diverse groups of terrestrial organisms, with fossils dating back to the Devonian period. They stand out because of their ecological importance as the dominant predators of insects. Spiders are clearly an integral part of global biodiversity since they play many important roles in ecosystems as predators and sources of food for other creatures. Spiders are also used by ecologists in the form of conservation tools as ecological indicators of overall biodiversity in many terrestrial communities.

Large changes in moisture, such as those predicted by climate-change models, affect the sign of spider-induced cascades in the detrital web. Changes in rainfall affect ecosystem processes such as primary production and nutrient release from decomposing litter caused by the direct effects of altered rainfall on plants and primary decomposers. Change in rainfall also alters the trophic interactions, thus indirectly influencing ecosystem processes. In detritus-based food webs, predators have the potential to indirectly influence the amount of leaf litter through trophic interactions that affect the rates of decomposition. This chain of interactions as a trophic cascade is analogous to the classic cascade affecting living plants, thus altering net primary production. In the forest-floor food web, *Collembola* (Tomocerids and Entomobryids) affect litter disappearance directly by feeding on litter and indirectly through litter comminution, inoculation with microbes, and fungal grazing. Wandering spiders are clearly implicated as initiators of this trophic cascade. Lensing and Wise (2006) stated that in all trophic-cascade chains in forest leaf litter, it is primarily the Tomocerids or Entomobryids that increase in response to reduced densities of wandering spiders (Lycosidae). Decreased rainfall most likely changes the sign of the spider-initiated trophic cascade by altering the way in which these *Collembola* interact with fungi, a major resource of *Collembola* and an abundant primary decomposer in forest leaf litter.

Documenting spider diversity patterns in this mangrove ecosystem and given the impacts of climate change, the role spiders play in ecosystem dynamics can provide important information to justify the conservation of this unique ecosystem.

STATUS AND THREATS

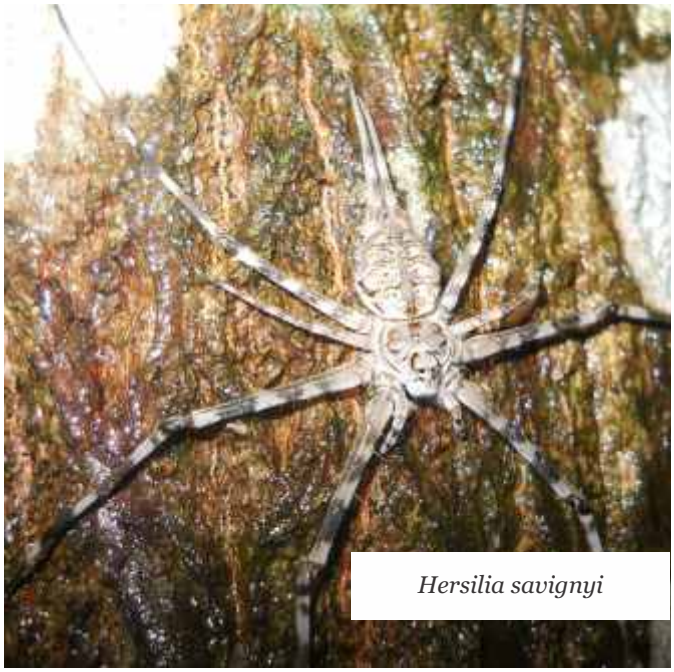
Sensitive to small changes in the habitat structure; including habitat complexity, litter depth and microclimate characteristics

Environmental factors are reported to affect species diversity (Rosenzweig 1995). The extensive leafy canopy of the mangrove forest provides a cool, stable, and shaded environment subjected to high humidity for faunal colonization (Sasekumar 1974; Ross and Underwood 1997). This is supported by Macnae (1968), who reported that mangroves are infested with mosquitoes and midges (often mistaken for sand flies), bees visiting mangrove flowers, and termite-infested deadwood together with cockroaches and beetles while canopy dwellers such as ants, spiders, and firefly aggregations take place during twilight. The canopy provides shelter for spider retreat, which would otherwise expose them to greater risk of desiccation.

The composition and properties of mangrove flora may affect the distribution and abundance of spiders analogous to faunal zonation, with possible dependent variables such as increasing distance from the seaward edge of the forest, height above low tidal level, orientation of the substratum, and biotic interaction such as competition or predatory relationships (Norma-Rashid 2009). Macnae (1968) stated that mangroves are limited to a few dominant groups and the widest zones in the mangroves are the forested area of *Bruguiera* which are separated from the sea by *Avicennia* or *Sonneratia* fringes. Here, the physical environment is potentially less severe due to the canopy of trees with extensive root growths and restricted movement of water (Ross and Underwood 1997). Maximum spider densities are found in such conditions in the middle zones of the mixed forest. In contrast, the open zones closest to the seaward edge have a harsh environment that is poor in fauna or flora. These areas with harsh environment do support a minimum spider community, especially the more hardy species of salticids, long-jawed, and web spiders (Berry 1972). Thus, there exists a clear spatial pattern of spiders in the mangrove forest.

A significant effect of habitat on the diversity of the spiders is evident from the eight functional guilds found in the Sundarbans. The web-building and foliage-running spiders rely on vegetation for some part of their lives, either for finding food,

Myrmarachne oreintalis



Hersilia savignyi

building retreats, or for web building. Studies have demonstrated that a correlation exists between the structural complexity of habitats and species diversity (Hawksworth and Kalin-Arroyo 1995). Diversity generally increases when a greater variety of habitat types are present (Ried and Miller 1989). Uetz et al. (1999) suggests that structurally more complex shrubs can support a more diverse spider community. Downie et al. (1999) and New (1999) have demonstrated that spiders are extremely sensitive to small changes in the habitat structure, including habitat complexity, litter depth, and microclimate characteristics. Spiders generally have humidity and temperature preferences that limit them to areas within the range of their 'physiological tolerances', which make them ideal candidates for land conservation studies (Riechert and Gillespie 1986). The structure of the vegetation is therefore expected to influence the diversity of spiders found in the Sundarbans.

Given the conservation and protection regime prevalent in India, spiders found in the Sundarbans do not find a place in the schedules of the Indian Wildlife (Protection) Act, 1972. This adds to the necessity of documenting the population diversity and relevant threats affecting their ecology and distribution.

ANNEXURE

List of Spiders reported from Indian Sundarbans and their economic importance

Family	Genera	Species Name	Common Name	Habitat	Economic Importance
Araneidae	*Araneus* Clerck	*Araneus mitifica* (Simon)	Orb-weaving spider	Mangrove & Semi-mangrove bushes	Controlling agent of various kind of harmful insect in crop field.
Araneidae	*Araneus* Clerck	*Araneus bitiberculata* (Walckenaer)	Orb-weaving spider	Mangrove & Semi-mangrove bushes	Predator of insect pest in the vegetable and flower garden.
Araneidae	*Araneus* Clerck	*Araneus anantnagensis* Tikader & Bal	Orb-weaving spider	Mangrove & Semi-mangrove bushes	Predator of insect pest in the vegetable and flower garden.
Araneidae	*Araneus* Clerck	*Araneus nympha* Simon	Orb-weaving spider	Mangrove & Semi-mangrove bushes	Controlling agent of various kind of harmful insect in crop field.
Araneidae	*Argiope* Audouin	*Argiope aemula* (Walckenaer)	Orb-weaving spider	Only Mangrove bushes	Controlling agent of various kind of harmful insect in crop field.
Araneidae	*Argiope* Audouin	*Argiope anasuja* Thorell	Signature Orb-weaving spider	Mangrove Herb & Small Trees	Predator of insect pest in the crop field.
Araneidae	*Argiope* Audouin	*Argiope arculata* Simon	Orb-weaving spider	True Mangrove and Semi-mangrove bushes	Predator of insect pest in the crop field.
Araneidae	*Argiope* Audouin	*Argiope kalimpongensis* Sinha	Orb-weaving spider	Mangrove & Semi-mangrove bushes & Small Trees	Controlling agent of insect pest in crop field.

Family	Genera	Species Name	Common Name	Habitat	Economic Importance
Araneidae	*Argiope* Audouin	*Argiope pulchella* Thorell	Orb-weaving spider	Mangrove & Semi mangrove forest	Medicinally Important
Araneidae	*Argiope* Audouin	*Argiope shillongensis* Sinha	Orb-weaving spider	Mangrove & Semi mangrove bushes	Medicinally Important
Araneidae	*Gasteracantha* Sundevall	*Gasteracantha hasseltii* C.L.Kochh	Orb-weaving spider	Mangrove & Semi mangrove bushes	Controlling agent of insect - pest in crop field.
Araneidae	*Neoscona* Simon	*Neoscona excelsus* (Simon)	Orb-weaving spider	Mangrove & Semi mangrove shurbs & bushes	Medicinally Important
Araneidae	*Neoscona* Simon	*Neoscona mukerjei* Tikader	Orb-weaving spider	Tall grasses, Mangrove & Semi mangrove bushes	Medicinally Important
Araneidae	*Neoscona* Simon	*Neoscona theis* (Walckenaer)	Orb-weaving spider	Mangrove & Semi mangrove areas	Medicinally Important
Araneidae	*Neoscona* Simon	*Neoscona shillongensis* Tikader & Bal	Orb-weaving spider	Mangrove & Semi mangrove bushes	Controlling agent of insect - pest in crop field.
Araneidae	*Neoscona* Simon	*Neoscona nautica* (L.Kocha)	Orb-weaving spider	Mangrove & Semi mangrove bushes	Controlling agent of insect - pest in crop field.
Araneidae	*Neoscona* Simon	*Neoscona pavida* (Simon)	Orb-weaving spider	Mangrove & Semi mangrove bushes	Predator of insect pest in the crop field.
Araneidae	*Neoscona* Simon	*Neoscona rumpfi* (Thorell)	Orb-weaving spider	Medium sized grass, mangrove and semi mangrove bushes and shrubs	Controlling agent of insect - pest in crop field.
Araneidae	*Neoscona* Simon	*Neoscona molemensis* Tikader & Bal	Orb-weaving spider	Mangrove & Semi mangrove bushes near paddy fields	Predator of insect pest in the crop field.
Araneidae	*Neoscona* Simon	*Neoscona elliptica* Tikader & Bal	Orb-weaving spider	Bushes & small trees	Medicinally Important
Araneidae	*Neoscona* Simon	*Neoscona lugubris* (Walckenaer)	Orb-weaving spider	Mangrove and Semi mangrove areas	Controlling agent of insect - pest in crop field.
Araneidae	*Larinia* Simon	*Larinia phtisica* (L. Koch)	Two tier orb-weaving spider	Mangrove and semi mangrove bushes and shrubs	Predator of insect pest in the crop field.

Family	Genera	Species Name	Common Name	Habitat	Economic Importance
Araneidae	*Parawixia* F.O.P. Cambridge	*Parawixia dehaanii* (Doleschall)	Orb-weaving spider	Mangrove forest	Predator of harmful insects in fruit garden
Araneidae	*Leucuage* White	*Leucuage decorata* (Blackwall)	Dome shaped Orb-weaving spider	Mangrove forest	Predator of harmful insects in the crop field.
Araneidae	*Leucuage* White	*Leucuage tessellata* (Thorell)	Dome shaped Orb-weaving spider	Bushes, shurb, herb of Mangrove and semi mangrove	Predator of harmful insects in the crop field.
Araneidae	Cyrtophora Simon	*Cyrtophora cicatrosa* (Stoliczka)	Dome shaped Orb-weaving spider	Mangrove and semi mangrove	Medicinally Important
Araneidae	Cyrtophora Simon	*Cyrtophora bidenta* Tikader	Dome shaped Orb-weaving spider	Mangrove and semi mangrove	Medicinally Important
Araneidae	Poltys Koch	*Poltys nagpurensis* Tikader	Orb-weaving spider	Mangrove and semi mangrove bushes	Predator of harmful insects
Araneidae	Zygeilla O.P. Cembrifge	*Zygeilla melanocrania* (Thorell)	Orb-weaving spider	Mangrove and semi mangrove	Predator of insects pest in fruit garden
Araneidae	*Singa* Koch	*Singa chota* Tikader	Orb-weaving spider	Mangrove and semi mangrove	Predator of harmful insects in the crop field.
Clubionidae	*Clubiona* Latreille	*Clubiona brassodes* Cambridge	Sac spider	Small tress or bushes & large grasses of mangrove & semi mangrove	Predator of harmful insects in the crop field.
Clubionidae	*Clubiona* Latreille	*Clubiona filicata* Cambridge	Sac spider	Shurb, herb or bushes near paddy field	Predator of harmful insects in the crop field.
Clubionidae	*Cheiracanthium* Koch	*Cheiracanthium trivialis* Thorell	Sac spider	Shurb, herb or bushes of Mangrove and semi mangrove	Medicinally Important
Clubionidae	*Cheiracanthium* Koch	*Cheiracanthium melanostoma* Thorell	Sac spider	Trees & Mangrove and semi mangrove bushes	Medicinally Important
Clubionidae	*Cheiracanthium* Koch	*Cheiracanthium himalayensis* Gravely	Sac spider	Shurb, herb or bushes near paddy field & Mangrove bushes	Medicinally Important

Family	Genera	Species Name	Common Name	Habitat	Economic Importance
Clubionidae	*Cheiracanthium* Koch	*Cheiracanthium mysorensis* Tikader & Majumdar	Sac spider	Trees, herb, shurb & bushes of Mangrove	Medicinally Important
Clubionidae	Castianeira Keyserling	*Castianeira himalayensis* Gravely	Mutilated Wasp Spider	Soil litters of Mangrove & Semi-Mangrove	-
Clubionidae	Castianeira Keyserling	*Castianeira tinae* Patel & Patel	Mutilated Wasp Spider	Forest litters of Mangrove	-
Eresidae	Stegodyphus Simon	*Stegodyphus sarasinorum* Karsch	Collonial Spider	Mangrove and semi mangrove	Controlling agent of harmful insect
Gnaphosidae	*Poecilochora* Westing	*Poecilochora barmani* Tikader	Two clawed nocturnal hunting spider	Forest litters in Mangrove & Semi Mangrove	-
Gnaphosidae	*Scopodes* Chamberlin	*Scopodes kuljitae* Tikader	Two clawed nocturnal hunting spider	Decaying logs & Forest litters in Mangrove & Semi Mangrove	-
Hersilidae	*Hersilia* Audouin	*Hersilia savignyi* Lucas	Arboreal Spider	Trunk of large trees	-
Heteropodidae	Heteropoda Latreille	*Heteropoda sikkimensis*	Giant Crab Spider	Rolled up dried leaves	Medicinally Important
Heteropodidae	Heteropoda Latreille	*Heteropoda venatoria* (Linnaeus)	Giant Crab Spider	Bushes of Mangrove and Semi Mangrove	Medicinally Important
Heteropodidae	*Sparіolenus* Simon	*Sparіolenus petricola* Gravely	Giant Crab Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Medicinally Important
Heteropodidae	*Sparіolenus* Simon	*Sparіolenus tigris* Simon	Giant Crab Spider	Walls of old houses	Medicinally Important
Lycosidae	*Arctosa* Koch	*Arctosa mulani* (Dyal)	Wolf spider	Wet litters of Mangrove and Semi Mangrove forest	Predator of insect pest
Lycosidae	*Arctosa* Koch	*Arctosa indicus* Tikader & Malhotra	Wolf spider	Pond, Stream and river bed of Sundarban	Predator of insect pest
Lycosidae	*Arctosa* Koch	*Arctosa himalayensis* Tikader & Malhotra	Wolf spider	Pond, Stream and river bed of Sundarban	Predator of insect pest
Lycosidae	*Arctosa* Koch	*Arctosa khudiensis* (Sinha)	Wolf spider	Moist forest litters	Predator of insect pest

Family	Genera	Species Name	Common Name	Habitat	Economic Importance
Lycosidae	*Arctosa* Koch	*Arctosa sandeshkhaliensis* Majumder	Wolf spider	Marshy lands: paddy fields	Predator of insect pest
Lycosidae	*Hippasa* Simon	*Hippasa greenalliae (*Blackwall)	Funnel Orb-weaving spider	Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Hippasa* Simon	*Hippasa holmerae* Thorell	Funnel Orb-weaving spider	Marshy lands & Moist grassy lands	Predator of insect pest
Lycosidae	*Hippasa* Simon	*Hippasa partita* (Cambridge)	Funnel Orb-weaving spider	Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Hippasa* Simon	*Hippasa olivacea* Thorell	Funnel Orb-weaving spider	Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Trochosa* Koch	*Trochosa punctipes* (Gravely)	Trap Door spider	Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Flanona* Simon	*Flonona puellula* Simon	Three clawed hunting spider	Open Vegetation	Predator of insect pest
Lycosidae	Ocyale Audouin	*Ocyale atalanta* Audouin	Three clawed hunting spider	Soil liters and foliage of Mangrove & Semi-Mangrove	Predator of insect pest
Lycosidae	Lycosa Latreille	*Lycosa chaperi* Simon	Wolf spider	Ground Dwellers & Forest litters of Mangrove & Semi-mangrove	Medicinally Important
Lycosidae	Lycosa Latreille	*Lycosa kempi* Gravely	Wolf spider	Pond, Stream and river bed of Sundarban	Predator of insect pest
Lycosidae	Lycosa Latreille	*Lycosa choudhuryi* Tikader & Malhotra	Wolf spider	Ground dwellers & Forest litters of Mangrove & Semi-mangrove	Medicinally Important
Lycosidae	Lycosa Latreille	*Lycosa poonaensis* Tikader & Malhotra	Wolf spider	Pond, Stream and river bed of Sundarban	Medicinally Important
Lycosidae	Lycosa Latreille	*Lycosa masteri* Pocock	Wolf spider	Ground dwellers of Mangrove & Semi-mangrove	Predator of insect pest

Family	Genera	Species Name	Common Name	Habitat	Economic Importance
Lycosidae	*Lycosa* Latreille	*Lycosa mackenjei* Gravely	Wolf spider	Wet litters of Mangrove and Semi Mangrove forest	Predator of insect pest
Lycosidae	*Lycosa* Latreille	*Lycosa mahabaleshwarensis* Tikader & Malhotra	Wolf spider	Wet grassy land of Mangrove and Semi Mangrove forest	Predator of insect pest
Lycosidae	*Lycosa* Latreille	*Lycosa himalayaensis* Gravely	Wolf spider	Ground dwellers of Mangrove & Semimangrove	Medicinally Important
Lycosidae	*Lycosa* Latreille	*Lycosa pictula* Pocock	Wolf spider	Wet litters of Mangrove and Semi Mangrove forest	Predator of insect pest
Lycosidae	*Lycosa* Latreille	*Lycosa tista* Tikader	Wolf spider	Wet litters of Mangrove and Semi Mangrove forest	Predator of insect pest
Lycosidae	*Lycosa* Latreille	*Lycosa shillongensis* Tikader & Malhotra	Wolf spider	Ground dwellers of Mangrove & Semimangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa annandalei* (Gravely)	Wolf spider	Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa birmanica* Simon	Wolf spider	Pond, Stream and river bed of Mangrove and semi mangrove	Medicinally Important
Lycosidae	*Pardosa* Koch	*Pardosa burasatiensis* Tikader & Malhotra	Wolf spider	Ground dwellers of Mangrove & Semimangrove	Medicinally Important
Lycosidae	*Pardosa* Koch	*Pardosa chambaensis* Tikader & Malhotra	Wolf spider	Wet litters of Mangrove and Semi Mangrove forest	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa heterophthalmus* Simon	Wolf spider	Wet litters of Mangrove and Semi Mangrove forest	Medicinally Important

Family	Genera	Species Name	Common Name	Habitat	Economic Importance
Lycosidae	*Pardosa* Koch	*Pardosa kupupa* (Tikader)	Wolf spider	Pond, Stream and river bed of Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa leucopalpis* Gravely	Wolf spider	Ground dwellers of Mangrove & Semi-mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa minutus* Tikader & Malhotra	Wolf spider	Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa oakleyi* Gravely	Wolf spider	Pond, Stream and river bed of Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa rhenockensis* (Tikader)	Wolf spider	Pond, Stream and river bed of Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa songosa* Tikader & Malhotra	Wolf spider	Wet litters of Mangrove and semi mangrove forest	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa shyamae* Tikader	Wolf spider	Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa sumatrana* (Thorell)	Wolf spider	Mangrove and semi mangrove	Medicinally Important
Lycosidae	*Pardosa* Koch	*Pardosa alii* Tikader	Wolf spider	Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa mysorensis* (Tikader & Malhotra)	Wolf spider	Mangrove and semi mangrove	Medicinally Important
Lycosidae	*Pardosa* Koch	*Pardosa sutherlandi* (Gravely)	Wolf spider	Ground dwellers of Mangrove & Semi-mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa amkhasensis* Tikader & Malhotra	Wolf spider	Mangrove and semi mangrove	Predator of insect pest
Lycosidae	*Pardosa* Koch	*Pardosa suchismitae* Majumder	Wolf spider	Pond, Stream and river bed of Mangrove and semi mangrove	Predator of insect pest

Family	Genera	Species Name	Common Name	Habitat	Economic Importance
Lycosidae	*Pardosa* Koch	*Pardosa debolinae* Majumder	Wolf spider	Pond, Stream and river bed of Mangrove and semi mangrove	Predator of insect pest
Oxyopidae	*Oxyopes* Latreille	*Oxyopes sakuntalae* Tikader	Lynx Spider	Mangrove and semi mangrove	Predator of insect pest
Oxyopidae	*Oxyopes* Latreille	*Oxyopes shweta* Tikader	Lynx Spider	Mangrove and semi mangrove	Predator of insect pest
Oxyopidae	*Oxyopes* Latreille	*Oxyopes sitae* Tikader	Lynx Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Predator of insect pest
Oxyopidae	*Oxyopes* Latreille	*Oxyopes redyii* Majumder	Lynx Spider	Pond, Stream and river bed of Mangrove and semi mangrove	Predator of insect pest
Oxyopidae	*Oxyopes* Latreille	*Oxyopes ratnae* Tikader	Lynx Spider	Shurb, herb or bushes near ponds & rivers	Predator of insect pest
Oxyopidae	*Oxyopes* Latreille	*Oxyopes sunandae* Tikader	Lynx Spider	Shurb, herb or bushes near ponds & rivers	Predator of insect pest
Oxyopidae	*Oxyopes* Latreille	*Oxyopes sikkimensis* Tikader	Lynx Spider	Bushes of Mangrove and Semi Mangrove	Predator of insect pest
Oxyopidae	*Oxyopes* Latreille	*Oxyopes pandae* Tikader	Lynx Spider	Bushes of Mangrove and Semi Mangrove	Predator of insect pest
Oxyopidae	*Peucetia* Thorell	*Peucetia latikae* Tikader	Lynx Spider	Mangrove and semi mangrove	Predator of insect pest
Salticidae	*Marpissa* Kochh	*Marpissa calcuttaensis* Tikader	Jumping Spider	Shurb, herb or bushes of Mangrove and semi mangrove	Predator of insect pest
Salticidae	*Marpissa* Kochh	*Marpissa bengalensis* Tikader	Jumping Spider	Arboreal & Ground Dwellers	Medicinally Important
Salticidae	*Marpissa* Kochh	*Marpissa decorata* Tikader	Jumping Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Medicinally Important
Salticidae	*Marpissa* Kochh	*Marpissa dhakuriensis* Tikader	Jumping Spider	Bushes near the paddy field	Predator of insect pest

Family	Genera	Species Name	Common Name	Habitat	Economic Importance
Salticidae	*Marpissa* Kochh	*Marpissa dyapurensis* Majumder	Jumping Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Predator of insect pest
Salticidae	*Marpissa* Kochh	*Marpissa lakshmikantapurensis* Majumder	Jumping Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Predator of insect pest
Salticidae	*Marpissa* Kochh	*Marpissa andamanensis* Tikader	Jumping Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Predator of insect pest
Salticidae	*Marpissa* Kochh	*Marpissa gangasagerensis* Majumder	Jumping Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Predator of insect pest
Salticidae	*Phidippus* Koch	*Phidippus* bengalensis Tikader	Jumping Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Medicinally Important
Salticidae	*Phidippus* Koch	*Phidippus pateli* Tikader	Jumping Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Medicinally Important
Salticidae	*Phidippus* Koch	*Phidippus indicus* Tikader	Jumping Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Medicinally Important
Salticidae	*Plexippus* Kochh	*Plexippus paykulii*	Jumping Spider	Foliage of Bushes in Mangrove and Semi Mangrove	Predator of insect pest
Salticidae	*Myrmarachne* Mac Leay	*Myrmarachne orientalis* Tikader	Ant Spider	Ground dwellers of Mangrove & Semi-mangrove	Predator of insect pest
Tetragnatha	*Tetragnatha* Latreille	*Tetragnatha anadamanensis* Latreille	Long jawed spider	Shurb, herb or bushes near ponds & rivers	Predator of insect pest
Thomisidae	*Camaricus* Thorell	*Camaricus formosus* Thorell	Crab Spider	Ground dwellers of Mangrove & Semi-mangrove	Predator of insect pest
Theridiidae	*Theridion* Walckenaer	*Theridiidae* indica Tikader	Irregular orb-weaving spider	Ground dwellers of Mangrove & Semi-mangrove	Predator of insect pest
Uloboridae	*Uloborus* Latrille	*Uloborus danolius* Tikader	Triangular Orb-weaving spider	Shurb, herb or bushes near ponds & rivers	Predator of insect pest

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2.12 ACARINA

Phylum Arthopoda also includes a group of animals which, unlike insects or myriapoda, have neither antennae nor mandibles. These animals comprise the group known as Chelicerata, of which the largest group is the class Arachnida.

ASOK KANTI SANYAL
Acarologist

Highest population densities and species richness of free-living mites occur in the organic strata of soils

The class Arachnida was named by Chevalier De Lamark in 1815, splitting the Linnaeus heterogeneous group Insecta into three classes. Lamark's class Arachnida included scorpions, spiders, and mites together with the Myriapoda and Thysanura. At present, the living members of Arachnida are grouped into nine subclasses, namely Scorpionida, Pedipalpida, Microthelyphonida, Solifugae, Ricinulei, Opiliones, Pseudoscorpionida, Acari, and Araneae. The subclasses Microthelyiphonida and Ricinulei are not recorded so far from India. The earliest record of arachnids from India was made as far back as 1758, when Linnaeus described ticks from India.

The arachnids are characterized by a number of features like two divisions of body—cephalothorax or prosoma and abdomen or opisthosoma—and absence of antenna. Arachnids have four pairs of legs each having seven segments and have eight simple eyes. One of the striking characteristic features of Arachnida is the absence of true jaws. Sexes are separate and remarkable sexual dimorphism is found in some cases.

The subclass Acarina comprising ticks and mites was first recorded in India by Peal (1868) through the discovery of the red-spider mite on tea in Assam. The size of mites ranges from 1.5 mm to 16 mm and ticks vary in size from 1.7 mm to 12.7 mm. Engorged individual ticks may attain 20–30 mm. Ticks differ from mites by the presence of hypostome with retrose teeth and the sensory setal field, Haller's organ on the tarsus-I of the leg. Most of the acarines are oviparous. Almost all mites complete several generations in a year. The ticks usually have a generation of several months and some may have an annual life cycle.

Many acarine groups have evolved far beyond the primitive habit of predation. Some are exclusively phytophagous and others have a parasitic relationship with invertebrate and vertebrate animals. Many acarine species are beneficial to human society as predators and decomposers.

Both the acarine groups, ticks and mites, live in diverse environments, including severe desert and tundra situations, mountain tops, deep soil layer, wetlands, subterranean caves, hot springs, and ocean floors. They live in almost every terrestrial, marine, and freshwater habitat. The highest population densities and species richness of free-living mites occur in the organic strata of soils where they form the numerically dominant component of the arthropod macrofauna and may contribute up to 7 percent of the total weight of the invertebrate fauna. The role of acarines is significant because of their manifold beneficial as well as harmful effects on agriculture, medical and veterinary sciences, public health, poultry, and apiaries.

Ticks are more capable of transmitting pathogens to man and domesticated animals than any other group of bloodsucking arthropods. Many of these agents cause zoonoses, that is, diseases that are transmitted from animal to man under natural conditions. Pathogens transmitted include viruses, spirochaetes, rickettsiae, anaplasmas, bacteria, piroplasmas, and filariae. There are a number of routes like saliva, regurgitation, coxal fluid, and faeces through which pathogens are transmitted from ticks to their vertebrate hosts.

Many family members of mites infest stored grains and other stored products. They are serious pests of crops and also act as vectors of viral diseases. They live as ectoparasites of man and domestic animals and suck blood from the host body or feed on the tissue material. They cause severe mange in cattle, dogs, cats, pigs, and horses. Oribatid mites act as vectors of anoplocephaline cestodes in cattle and cause various helminth diseases. The tiny creatures are also responsible for various human diseases such as scabies, tumors, nodules, thickening of the skin and other allergic dermatitis, loss of hair, anemia, pneumonia, scrub typhus, and respiratory allergies, including bronchial asthma and rhinitis to man.

Many species of mites are beneficial mainly for their ecological services. A number of species are efficient predators of plant-feeding mites and also of harmful soil nematodes. Some are used as biotic agents for control of the housefly and other insect and plant pests. The soil mites also facilitate the process of decomposition and humification of organic matter, resulting in increase of soil fertility and ultimately soil formation. Decomposition of litter occurs through physical and chemical changes. The presence of the soil fauna is necessary for the establishment of vigorous populations of these microorganisms. Mites are one of these soil fauna and live as detritivore in soil. They disintegrate plant and animal tissue and provide suitable substrate for invasion by microflora. They selectively decompose and chemically change litter, mix the organic matter thoroughly, transform plant residues into humic substances, and form a complex aggregate of organic matter with the mineral part of soil.

OVERVIEW OF THE GROUP

The fossil evidence of Arachnida in general or of the Acari in particular indicates that a major adaptive breakthrough occurred in Acari during the late Mesozoic and early Cenozoic era. Most of the acarologists opine that the Acari evolved from some primitive arachnid stock and branched into two separate entities as Acariformes and Parasitiformes. The enormous diversity in morphology, habit, and distribution in Acarina attracted the attention of Linnaeus (1758) and thousands of workers in the world. The existence of mites was referred to as early as 850 B.C. by Homer. The first consolidated list of mites was given in the book *Systema Naturae* by Linnaeus (1758). Alfred et al. (1998) presented a detailed account of the status of Acarina in India compared with the world.

Though no attempt has been made by anyone to estimate the total number of species from the world, it is presumed that the total acarine species known from the world is not less than 30,000 (Krantz 1978). Halliday et al. (2000) recorded 48,200 species of acari in the world, of which ticks share around 900 species. The total number of acarine species known so far from India is estimated as 2,186, distributed over 643 genera and 207 families (Alfred et al. 1998). Nearly 45 percent of the species known so far from India are described as new to science. The major families known from India include more than 20 species. Some of them are very rich in the number of species, for example, Ixodidae (107), Eriophyidae (270), Phytoseiidae (140), Tetranychidae (100), Tenuipalpidae (75), Scheloribatidae (50), and Gulumnidae (42).

SYNOPTIC VIEW

Diversity

45%
OF THE SPECIES SO FAR KNOWN FROM INDIA ARE DESCRIBED AS NEW TO SCIENCE

The work on Indian Acarina was initiated by Linnaeus (1758) and later by Peal (1868). The study of ticks in the Sundarbans was first attempted by Sharif (1928). While studying the collection of tick specimens present in the Indian Museum, he reported only two species. After a gap of about 60 years, Basu (1989) made a good collection of ticks from domestic cattle and buffalo in the Sundarbans and those were identified into two species. Nandi and De (1984) reported a case of tick infestation in humans. Thus, altogether four species under three genera, namely *Haemaphysalis, Hyalomma,* and *Rhipicephalus*, under one family Ixodidae are known from the Sundarbans. There is no record of argasid ticks from the area (see annexure). No new taxa of ticks was described from the area. This very poor representation was only due to lack of serious studies on ticks in the Sundarbans. No generic diversity in ticks was observed in the Sundarbans.

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ACARINE SPECIES KNOWN FROM INDIA

The number of genera recorded here is very low when considering the generic diversity of ticks in Gujarat (in general) - 7 genera (Sanyal and De 2004) and the Andaman and Nicobar Islands - 28 genera (De and Sanyal 1984).

Out of the 643 genera recorded from India (Alfred et al. 1998), 67 genera (table 1 and annexure) are found in the Indian Sundarbans. Maximum generic diversity was recorded in Phytoseiidae (7), Tetranychidae (6), Eriophyidae (5), and Tydeidae (4). As much more studies were undertaken in the Sundarbans than the other mangrove regions in India like Gujarat and the Andaman and Nicobar Islands, the number of genera is higher than that of Gujarat - 14 (Gupta 1985) and the Andaman and Nicobar Islands - 25 (Sanyal, forthcoming).

Table 1 : Diversity (Families, genera and species) of Acarina in Indian Sundarbans

Sl. No.	Family	No. of genera	No. of species
	METASTIGMATA		
1	Ixodidae	3	4
	CRYPTOSTIGMATA		
2	Hypochthoniidae	1	1
3	Mesoplophoridae	1	1
4	Cosmochthoniidae	2	2
5	Haplochthoniidae	1	1
6	Phthiracaridae	2	2
7	Euphthiracaridae	1	1
8	Lohmaniidae	2	2
9	Epilohmanniidae	1	1
10	Trhyhypochthoniidae	1	1
11	Malaconothridae	1	1
12	Basilobelbidae	1	1
13	Carabodidae	1	1
14	Tectocepheidae	1	1
15	Otocepheidae	1	2
16	Oppiidae	3	6
17	Chaunoproctidae	1	1
18	Xylobatidae	1	1
19	Haplozetidae	3	3
20	Scheloribatidae	2	6
21	Austrachipteridae	2	2
22	Galumnidae	1	3
	PROSTIGMATA		
23	Tetranychidae	6	18
24	Tenuipalpidae	3	7
25	Eriophyidae	5	8
26	Tarsonemidae	1	1
27	Stigmaeidae	1	2
28	Bdellidae	2	2
29	Tydeidae	4	7
30	Cunaxidae	1	3
31	Eupodidae	1	1
32	Cheyletidae	1	1
33	Erythraeidae	1	1
	MESOSTIGMATA		
34	Phytoseiidae	7	22
35	Ascidae	2	2
36	Rhodacaridae	1	1
37	Uropodidae	1	1

Species Richness and Functional Groups

Of the 2,186 acarine species known from India (Alfred et al. 1998), 121 species have been recorded from eight blocks of the Indian Sundarbans. This number is very high when compared to the number of mite species in Gujarat - 25 (Gupta 1992; Sanyal and Basak 2004) and the Andaman and Nicobar Islands - 45 (Gupta 1992). Though there is no definite functional group in ticks and mites, the acarine species in the Sundarbans may be divided into three major groups such as animal parasites, plant inhabiting forms, and soil dwelling forms, comprising 3.3 percent, 61.2 percent, and 35.5 percent, respectively, of the total acarines found in the Sundarbans.

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SPECIES FROM INDIAN SUNDARBANS

Distribution Pattern

Of the 121 species known from eight blocks of the Indian Sundarbans, maximum species diversity was recorded from Sagar (56). The other major blocks in order of species richness were Namkhana (43), Pirkhali (28), Kakdwip (26), Canning (20), Gosaba (18), Patharpratima (8), and Basanti (4).

Local Community Dependency and Traditional Use

As ticks and mites are mostly harmful to humans and animals, livelihood of the local community is not directly dependent upon the acarines. They are, however, indirectly affected by acarine fauna due to their parasitic and pest habits which cause financial and health problems to the local community and domestic animals.

Ecological Importance and Need for Conservation

Mites, especially the soil-inhabiting forms, are of great ecological significance. They constitute an integral part of the ecosystem as pest, predator, and decomposer and an active constituent of nutrient cycling in the ecological system. The unique habitat of the Sundarbans, having mangrove vegetation and partly shaded areas, exerts a direct and indirect influence on the distribution and abundance of soil- and plant-inhabiting mites (Macfadyen 1952) through its effect on soil cavity size, litter formation, and soil moisture. There might be a moderate correlation between plant community and mite population in the sense that the intensity of vegetation might directly or indirectly influence the faunal makeup. The analysis of the studies done so far in the Sundarbans clearly showed that the specimens were mostly collected from the middle zones in the forested areas where the physical environment was potentially less harsh due to tall trees, with a well-developed canopy and well-settled root system which checks frequent inundation.

Soil inhabiting forms are of great ecological significance

Rainfall, soil temperature, moisture, and organic carbon were found to be positively correlated with the mite population and affect the trophic cascade in the detrital web. All the energy entering the soil community ultimately dispersed as heat energy due to the metabolic activities of soil organisms, including mites which constitute the bulk of the soil arthropod community. This heat is not cycled but the inorganic nutrients continually circulate through the plant or soil system.

The litter, together with the faeces and corpses of animals living above the soil surface, forms the energy base on which the mites operate along with other detritivorous animals and microfloral decomposers in the soil. The feeding activities of soil organisms and mites chemically degrade the energy-rich plant debris, resulting in liberation of energy and nutrients which cycle.

Mites play an important role in nutrient cycling in the soil ecosystem. The bulk of the atmospheric carbon which enters the soil through vegetation is assimilated into the bodies of detritivores and decomposers. This assimilated carbon travels through the soil community and is ultimately released to the atmospheric pool. The cycling nitrogen, phosphorous, and sulphur and more important nutrients of the plant or soil system emphasize the considerable importance of bacteria and fungi. The activities of soil fauna are of secondary importance.

The plant-inhabiting mites, particularly the predators, play a vital role in maintaining ecological balance through their habit of predation on the mites of plant pests. The above discussion clearly indicates that mites are the most important ecological component, needing proper conservation for sustenance of life in the Sundarban mangrove ecosystem. Formulation of strategies for conservation of some taxa is a priority. Conservation can be successfully carried out through management of the habitat of the beneficial acarina and judicious and restricted use of poisonous chemicals.

Economically important mites are indeed an important resource in management of mite pests and soil. The rational and meaningful exploitation of these mites needs mass culture and release of the mites in fields as biological control agents to act as decomposers.

THREATS

However, the question of threat arises in the case of economically important species, particularly predatory and soil-inhabiting mites. Pollution coupled with habitat degradation kills the soil mites, thus gradually transforming nutrient-enriched soil to wasteland. Further, excessive and indiscriminate use of chemical pesticides and fertilizers, wrong agricultural practices, and introduction of alien species cause the loss of predatory mites and mites of economic importance.

1. *Haemaphysalis bispinosa* 2. and 3. *Rhipicephalus haemaphysaloides* 4. *Scheloriates albialatus*
5. *Dolicheremaeus bengalensis*

ANNEXURE

List of Acarine species described and recorded from Indian Sundarbans

	Family	Genus	Species name	Host / Habitat	Economic Importance	Distribution
METASTIGMATA	Ixodidae	*Haemaphysalis* Koch	*H. indica* Warburton	Mongoose	Ectoparasitic	Alampur village, Raiganj
		Haemaphysalis Koch	*H. bispinosa* Neumann	Cattle	Ectoparasitic	Basanti Village
		Hyalomma Koch	H. *anatolicum* Koch	Cattle	Ectoparasitic	Canning, Kakdwip
		Rhipicephalus Koch	*R. haemaphysaloides* Supino	Unknown	Ectoparasitic	Basanti
CRYPTOSTIGMATA	Hypochthoniidae	*Hypochthonius* Koch	*Hypochthonius* sp.	Soil and litter	Decomposer	Bakkhali, Frazerganj
	Mesoplophoridae	*Mesoplophora* Berlese	*M. pectinata* Mahunka	Soil and litter	Decomposer	Namkhana, Sagar Island, Bakkhali
	Cosmochthoniidae	*Cosmochthonius* Berlese	*C. bengalensis* Chakrabarti *et. al.*	Soil and litter	Decomposer	Frazerganj, Kakdwip, Namkhana
		Phyllozetes Gordeeva	*P. heterotrichus* Sanyal and Bhaduri	Soil and litter	Decomposer	Sagar Island, Frazerganj, Namkhana
	Haplochthoniidae	*Haplochthonius* Willmann	*H. intermedius* Chakrabarti *et. al.*	Soil and litter	Decomposer	Kakdwip, Bakkhali, Canning
	Phthiracaridae	*Atropacarus* Ewing	*A.(Hoplophorella) scapellata* (Aoki)	Soil and litter	Decomposer	Sagar Island, Frazerganj, Kakdwip, Canning
		Atropacarus Ewing	*A.(Hoplophorella) sundarbanensis* Sanyal and Bhaduri	Soil and litter	Decomposer	Sagar Island, Bakkhali, Namkhana
	Euphthiracaridae	*Rhysotritia* Markel and Meyer	*R. ardua* var. *otahitensis* Hammer	Soil and litter	Decomposer	Kakdwip, Sagar Island, Bakkhali
	Lohmaniidae	*Cryptacarus* Grandjean	*C.tuberculatus* Csiszar	Soil and litter	Decomposer	Sagar Island, Frazerganj
		Haplacarus Wallwork	*H. foliates bengalensis* Bhattacharya *et al.*	Soil and litter	Decomposer	Bakkhali, Kakdwip
	Epilohmanniidae	*Epilohmannia* Berlese	*E. pallida pacifica* Aoki	Soil and litter	Decomposer	Sagar Island, Frazerganj, Namkhana

Family	Genus	Species name	Host / Habitat	Economic Importance	Distribution
Trhypochthoniidae	*Allonothrus* Hammen	*A.indicus* Bhaduri and Raychaudhuri	Soil and litter	Decomposer	Namkhana, Frazerganj
Malaconothridae	*Malaconothrus* Berlese	*M. geminus* Hammer	Soil and litter	Decomposer	Namkhana
Basilobelbidae	*Basilobelba* Balogh	*B. indica* Bhaduri *et al.*	Soil and litter	Decomposer	Frazerganj, Kakdwip
Carabodidae	*Carabodes* Koch	*C. peniculatus* Hammer	Soil and litter	Decomposer	Sagar Island, Kakdwip, Frazergunj
Tectocepheidae	*Tectocepheus* Berlese	*T. velatus velatus* (Michael)	Soil and litter	Decomposer	Frazergunj, Sagar Island, Canning
Otocepheidae	*Dolicheremaeus* Jacot	*D. bengalensis* Sanyal	Soil and litter	Decomposer	Namkhana
		D. coronarius Chakrabarti *et al.*	Soil and litter	Decomposer	Kakdwip, Sagar Island
Oppiidae	*Brachioppia* Hammer	*B. ananthakrishni* Sanyal and Bhaduri	Soil and litter	Decomposer	Kakdwip
	Multioppia Hammer	*M. simplitricha* Sanyal and Bhaduri	Soil and litter	Decomposer	Kakdwip, Frazergunj, Namkhana
	Oppia Koch	*O. orientalis* Sanyal and Bhaduri	Soil and litter	Decomposer	Bakkhali
		O. ramisetosa Sanyal and Bhaduri	Soil and litter	Decomposer	Kakdwip
		O. yodai Aoki	Soil and litter	Decomposer	Bakkhali, Namkhana, Canning
		Oppia sp.	Soil and litter	Decomposer	Canning
Chaunoproctidae	*Chaunoproctus* Pearce	*C. abalai* Bhaduri *et al.*	Soil and litter	Decomposer	Kakdwip, Frazergunj
Xylobatidae	*Xylobates* Jacot	*X. seminudus*	Soil and litter	Decomposer	Sagar Island, Bakkhali
Haplozetidae	*Haplozetes* Willmann	*Haplozetes* sp.	Soil and litter	Decomposer	Kakdwip, Frazergunj, Sagar Isalnd, Canning
	Lauritzenia Hammer	*L. longipluma* Hammer	Soil and litter	Decomposer	Frazergunj
	Rostrozetes Sellnick	*R. foveolatus* Sellnick	Soil and litter	Decomposer	Canning
Scheloribatidae	*Euscheloribates* Kunst	*E.samsinaki* Kunst	Soil and litter	Decomposer	Namkhana
	Scheloribates Berlese	*S. albialatus* Hammer	Soil and litter	Decomposer	Canning
		S. bhadurii Sanyal	Soil and litter	Decomposer	Namkhana, Sagar Island

	Family	Genus	Species name	Host / Habitat	Economic Importance	Distribution
			S. indicus Sanyal	Soil and litter	Decomposer	Namkhana
			S. natalensis Hammer	Soil and litter	Decomposer	Sagar Island, Frazergunj, Bakkhali, Canning
			S. rakhali Sanyal	Soil and litter	Decomposer	Frazergunj, Sagar Island, Kakdwip
	Austrachipteriidae	*Lamellobates* Hammer	*L. palustris* Hammer	Soil and litter	Decomposer	Sagar Island, Kakdwip, Canning
		Paralamellobates Bhaduri and Raychaudhuri	*P. bengalensis* Bhaduri and Raychaudhuri	Soil and litter	Decomposer	Sagar Island, Namkhana
	Galumnidae	*Galumna* von Heyden	*G. crenata* Deb and Raychaudhuri	Soil and litter	Decomposer	Namkhana, Bakkhali
			G. flabellifera orientalis Aoki	Soil and litter	Decomposer	Kakdwip, Namkhana, Frazergunj
			Galumna sp.	Soil and litter	Decomposer	Canning
PROSTIGMATA	Tetranychidae	*Eutetranychus* Oudemans	*E. orientalis* (Klein)	Plant	Pest	Kakdwip, Sagar Island
		Eotetranychus Oudemans	*E. hicoriae* McGregor)	Plant	Pest	Sagar Island
			Eotetranychus sp.	Plant	Pest	Bakkhali
		Oligonychus Berlese	*O. magniferus* (Rahman and Sapra)	Plant	Pest	Bakkhali, Lothian Island
			Oligonychus sp.	Plant	Pest	Sudhanyakhali
			O. indicus (Hirst)	Plant	Pest	Sagar Island, Chemaguri, Gosaba
			O. oryzae (Hirst)	Plant	Pest	Chandanpiri
			O. sacchari (McGregor)	Plant	Pest	Bhagabatpur
		Panonychus Yokoyama	*P. citri* (McGreger)	Plant	Pest	Gosaba
		*Schizotetranych*us Tragardh	*S. baltazari* Rimando	Plant	Pest	Kakdwip
	Tetranychidae	*Schizotetranychus* Tragardh	*S. hindustanicus* (Hirst)	Plant	Pest	Sagar Island
			Schizotetranychus sp.	Plant	Pest	Sajnakhali, Sagar Island

Family	Genus	Species name	Host / Habitat	Economic Importance	Distribution
	Tetranychus Dufour	*T. neocalidonicus* Andre	Plant	Pest	Sagar Island
		T. urticae Koch	Plant	Pest	Bakkhali, Sagar Island
		T. fijiensis Hirst	Plant	Pest	Sagar Island Lothian Island
		T. ludeni Zacher	Plant	Pest	
		T. macfarlanei Baker and Pritchard	Plant	Pest	Lothian Island
		Tetranychus sp.	Plant	Pest	Sajnakhali, Sagar Island
Tenuipalpidae	*Brevipalpus* Donnadieu	*B. essigi* Baker	Plant	Pest	Sagar Island, Gosaba
		B. phoenicis (Geij.)	Plant	Pest	Sagar Island
		B. rugolosus Chaudhuri *et al.*	Plant	Pest	Sajnakhali, Gosaba
	Raoiella Hirst	*R. indica* Hirst	Plant	Pest	Sajnakhali
	Tenuipalpus Donnadieu	*T. micheli* Lawrence	Plant	Pest	Sajnakhali
		T. perrieis Chaudhuri *et al.*	Plant	Pest	Bhagabatpur
		Tenuipalpus sp.	Plant	Pest	Sagar Island
Eriophyidae	*Aceria* Keifer	*A. litchi* (Keifer)	Plant	Pest	Sajnakhali
		A. guerreronis	Plant	Pest	Gosaba
		A. saccharini Wang	Plant	Pest	Gosaba
	Phyllocoptes Nalepa	*P. oleivora* (Ashmead)	Plant	Pest	Gosaba
	Aculops Keifer	*A. abutiloni* Mondal and Chakrabarti	Plant	Pest	Sajnakhali
		A. excoecaria Mondal and Chakrabarti	Plant	Pest	Sajnakhali
	Bakeriella Chakrabarti and Mondal	*B ocimis* Chakrabarti and Mondal	Plant	Pest	Kakdwip
	Tegolophus Keifer	*T. spondialfus* Mondal and Chakrabarti	Plant	Pest	Kakdwip
Tarsonemidae	*Polyphagotarsonemus*	*P. latus* Banks	Plant	Pest	Sajnakhali

	Family	Genus	Species name	Host / Habitat	Economic Importance	Distribution
	Stigmaeidae	*Agistemus* Summers	*A.fleschneri* Summers	Plant	Pest	Kakdwip
			A.industani Gaonzalez Rodriguez	Plant	Pest	Sagar Island
	Bdellidae	*Bdella* Latreille	*B.maldahensis* Gupta	Plant	Pest	Sagar Island, Lothian Island, Chemaguri
		Bdellodes Oudemans	*B.(Hoploscirus)* sp.	Plant	Pest	Sajnakhali
	Tydeidae	*Paraprone-matus* Baker	*Paraprone-matus* sp.	Plant	Pest	Sagar Island, Chandanpiri
		Pronematus Canestrini	*P. fleschneri* Baker	Plant	Pest	Sagar Island
			Pronematus sp.	Plant	Pest	Sajankhali, Chandanpiri
		Paralorryia Baker	*P. fodder* Gupta	Plant	Pest	Gosaba
		Tydeus Koch	*T. gossabaensis* Gupta	Plant	Pest	Gosaba
			T. cumini Gupta	Plant	Pest	Gosaba
			Tydeus sp.	Plant	Pest	Sagar Island, Canning
	Cunaxidae	*Cunaxa* Von Heyden	*C.cynodonae* Gupta and Ghosh	Plant	Pest	Sajnakhali
			C. setirostris (Hermann)	Plant	Pest	Gosaba, Sagar Island, Lothian Island
			Cunaxa sp.	Plant	Pest	Canning
	Upodidae	*Eupodes* Koch	*E.sigmoidensis* Strandtmann and Goff	Plant	Pest	Sagar Island
	Cheylelidae	*Cheletogenes* Oudemans	*C.ornatus* (Canestrini and Fanzago)	Plant	Pest	Sajnakhali
	Erythraeidae	*Sphaerolophus* Berlese	*S. gigas* Khat	Plant	Pest	Sajnakhali
MESOSTIGMATA	*Phytoseiidae* Berlese	*Amblyseius* Berlese	*A.largoensis* (Muma)	Plant	Pest	Sajnakhali, Sagar Island, Gosaba, Kakdwip, Chemaguri, Bhagabat-pur
			A. alstoniae Gupta	Plant	Pest	Basanti, Sagar Island, Bhagabatpur
			A. coccineae Gupta	Plant	Pest	Kakdwip, Sagr Island, Namkhana
			A. finlandicus (Ondemans)	Plant	Pest	Namkhana, Gosaba, Kakdwip

Family	Genus	Species name	Host / Habitat	Economic Importance	Distribution
		A. ovalis Evans	Plant	Pest	Kakdwip, Sagar Island, Namkhana, Chandanpiri
		A. pruni Gupta	Plant	Pest	Gosaba, Sagar Island
		A. fallacies Garman	Plant	Pest	Sagar Island,Bhagabatpur, Chandanpiri
		A. multidentatus (Swirski and Shechter)	Plant	Pest	Gosaba, Sagar Island, Sajnakhali, Gosaba
		A. paspalivorus (De Leon)	Plant	Pest	Basanti
	Indoseiulus Ehara	*I. ricini* (Ghai and Menon)	Plant	Pest	Sajnakhali
Blattisocidae	*Blattisocius* Keegan	*B. keegani* Fox	Plant	Pest	Sajnakhali
	Iphiseius Berlese	*I. andamanicus* Gupta	Plant	Pest	Sajnakhali, Sudhanyakhali, Sagar Island, Lothian Island
	Phytoseius Ribaga	*P. kapuri* Gupta	Plant	Pest	Gosaba, Sagar Island, Chemanguri, Chandanpiri
		P. cornigera Wainstein	Plant	Pest	Sagar Island
		P. indicus Bhattacharyya	Plant	Pest	Sagar Island, Bhagabatpur
		P. macropilis (Banks)	Plant	Pest	Sagar Island
		Phytoseius sp.	Plant	Pest	Chemaguri
	Typhlodromus Scheuten	*T. communis* Gupta	Plant	Pest	Sagar Island, Bhagabatpur
		T. homalii Gupta	Plant	Pest	Sajnakhali
Ascidae	*Asca* von Heyden	*Asca* sp.	Soil and litter	Decomposer	Canning
	Lasioseius Berlese	*L. megregori* Chant *L. parberlesei* Bhattacharyya *L. reticulates* Bhattacharyya	Soil and litter	Decomposer	Canning
	Ololaelaps Berlese	*Ololaelaps* sp.	Soil and litter	Decomposer	Canning
	Proctolaelaps Berlese	*Proctolaelaps* sp.	Plant	Pest	Sajnakhali
Rhodacaridae	*Gamasiphis* Berlese	*Gamasiphis bengalensis* Bhattacharyya	Soil and litter	Decomposer	Canning
Uropodidae	*Uroobovella* Berlese	*U. villosella* Berlese	Soil and litter	Decomposer	Canning

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2.13 INSECTS

Insects comprise the largest number of species in the animal kingdom. A quick glance at the biological diversity reveals that arthropods, to which insects belong, are the most diverse group of organisms.

RATUL SAHA
Wildlife Biologist with specialization in Entomology

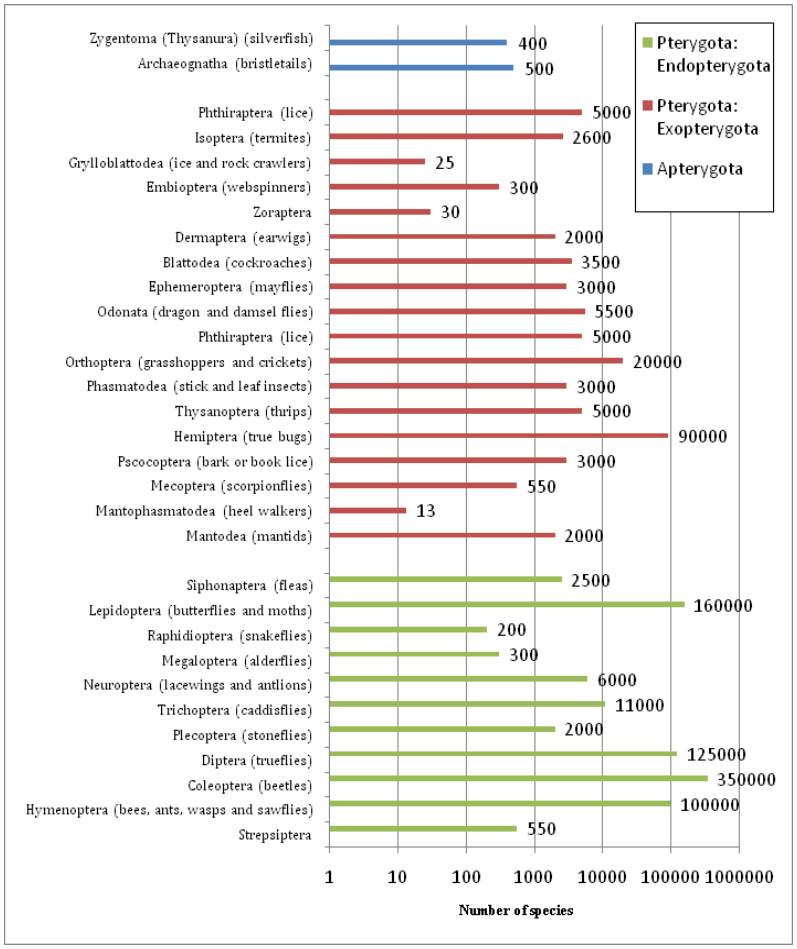
The Zoological Survey of India database (2007) lists 861696 and 61151 insect species in world & India respectively

The phylum Arthropoda contains roughly three-quarters of the species of animals on earth. The class Insecta alone accounts for about two-thirds of the animal species (Hammond 1992) and belongs within the superclass Hexapoda (true or six-legged insects) (Gullan and Cranston 2005).

The class Insecta comprises Aptery- gota (wingless insects): the Zygen-toma (silverfish), the Archaeog-natha (bristletails), and the Pterygote group (winged insects). This is in turn divided into the Exopterygota (also known as the Hemi-metabola), whose wings develop gradually through several nymphal instars, and the Endopterygota (also known as the Holometabola), which usually have a distinct larval stage separated from the adult by a pupa. Figure 1 summarizes the classification of insects and roughly indicates the number of species described so far from each order. With extensive survey in hitherto inaccessible areas, a large number of new species of insects are being described by scientists, especially from the humid, tropical forest areas of the Southern Hemisphere. Gaston and Hudson (1994) estimate that global insect species are likely to be around 10 million based on biogeographic patterns of diversity of well- or better-documented taxa. The Zoological Survey of India (2007) database lists 861,696 and 61,151 insect species in the world and India, respectively.

Asian giant honey bee (Apis dorsata)

Figure 1: Numbers of described species in world within the orders of insect. (From Gullan & Cranston, 2005.)



Source: Gullan and Cranston 2005

Insects have evolved a highly technologically efficient set of specialized body parts and appendages. The three basic sections (called tagmata) of an insect's body are admirably adapted for different purposes. The head specializes in sensory reception and food gathering, the thorax in locomotion, and the abdomen in digestion and reproduction. All but a minimum number of appendages have been lost when compared with ancestors, leaving a set of highly adapted mouth parts and a pair of immensely stable tripods, the legs (Gullan and Cranston 2005).

Insects are believed to constitute a significant portion of the fauna in many mangrove communities. They may be permanent residents of the mangroves or only transient visitors. In either case, they often play important roles in the ecology of the system and contribute to the unique character of these habitats (Kathiresan and Bingham 2001). Surveys of mangrove insects reveal complex assemblages of species filling a wide variety of niches. Many of the insects being temporary visitors and

representing a wide array of habitat types provide linkages between the mangroves and other environments (Ananda Rao et al. 1998). Mangroves provide a habitat that supports a number of insects at different trophic levels. These insects bear inputs into the mangrove ecosystem and play a vital role in pollination, as a food resource, in nutrient cycling in forests, and in other important dynamics of the ecosystem.

Being dominated by trees, mangroves forests are similar to terrestrial forests in many ways, especially so for canopy fauna such as insects. Among the insects, ants play an important ecological role. They are important actors in ecosystem functioning due to their high abundance and the multitude of interactions they are engaged in. (Cannicci et al. 2008). It is evident from terrestrial studies that ants are able to protect plants against herbivores through their predatory and territorial behavior (Bronstein 1998).

OVERVIEW OF THE GROUP

711
SPECIES OF INSECTS FROM DIFFERENT MANGROVE ECOSYSTEM OF INDIA

Insects have been reported to have a significant impact on tree growth rate and form, survivorship, reproductive output, and forest ecology in virtually all forest ecosystems (Crawley 1989; Schowalter 1986). However, the impact of insects on mangroves has been considered of minor importance compared to other types of forests (Macnae 1968).

Mangrove insects and other terrestrial arthropods avoid harsh conditions of strong sunlight, high temperatures, and desiccation by emerging only at night or by living entirely within the plants. Wood-boring moths and beetles in *mangals* (mangroves) of Belize, South America have been reported to excavate tunnels through the mangroves. The tunnels then become habitat to more than 70 other species of ants, spiders, mites, moths, roaches, termites, and scorpions (Feller and Mathis 1997; Rützler and Feller 1996). A number of organisms (including isopods, amphipods, myriapods, and spiders in addition to insects) escape high temperatures and desiccation by living in the intertidal portions of the *mangals* (mangroves). During periods of high tide, these organisms retreat to air-filled cavities where they remain until they are again exposed by the falling water level (Murphy 1990a).

The global distribution of mangroves has been divided into two biogeographical hemispheres, the Indo-West Pacific and the Atlantic-East Pacific (Duke 1992). The former ranges from the east coast of Africa to Asia, Australia, and the western Pacific Islands, while the latter includes the eastern Pacific Islands, the coasts of the American continent, and the African west coast. Insect diversity in the mangroves of the Indo-West Pacific is thought to be higher than in the Atlantic-East Pacific as a result of higher plant diversity in the former although, to some extent, the dearth of insect species in the latter reflects gaps in our knowledge rather than low species diversity (Macintosh and Ashton 2002). Of about 711 species of insects reported from different mangrove ecosystems of India (Kathiresan and Rajendran 2005), 497 species of insects are reported from the Indian Sundarbans. This number is very high when compared with other mangroves of India (table 1) such as the Andaman and Nicobar Islands - 276, Pichavaram - 101, and Muthupet - 113.

Table 1: Total number of insect species in mangrove ecosystem of different regions.

Sr. no.	Name of the region	No. of Species	Reference
1	Indo Malaysia	500	Spadling *et. al.,* 1997
2	Australasia	72	Spadling *et. al.,* 1997
3	India *(all mangroves inclusive)*	711	Kathiresan *et. al.,* 2005
4	Sundarbans, India	497	Ghosh, 1992 – 2001
5	Andaman & Nicobar Islands, India	276	Veenakumari *et al.* (1997)
6	Pichavaram, India	101	Senthil and Varadharajan (1995)
7	Muthupet, India	113	Rahaman, (2002)

SYNOPTIC VIEW

Diversity

Although there are several published records on the insects of the Indian Sundarbans, little effort has been spent to make all those records available as a compendium. To add to this, very little work has been done on insect ecology and the role of insects in the Sundarbans mangrove ecosystem dynamics.

497 SPECIES IN 344 GENERA UNDER 107 FAMILIES IN SUNDARBANS

The present review of available records (Ghosh 1992–2001; Mitra and Mitra, 2009) reports 497 species in 344 genera under 107 families (table 2 and figure 2). The insects are classified into 15 orders (see annexure): Thysanura, Collembola, Isoptera, Dermaptera, Blataria, Odonata, Orthoptera, thysanoptera, Hemiptera, Homoptera, Lepidoptera, Neuroptera, Diptera, Coleoptera, and Hymenoptera. Maximum generic diversity was found in Orthoptera (36), Hemiptera (46), Lepidoptera (59), Diptera (52), Coleoptera (69), and Hymenoptera (28). The number of genera recorded in the Sundarbans is higher than that of other major Indian mangrove insect studies—the Pichavaram mangrove hosts 9 orders and 42 families (Senthil and Varadharajan 1995) and the Muthupet mangrove hosts 8 orders and 53 families (Rahaman 2002).

The maximum number of 100 species was found in the order Coleoptera, followed by Diptera - 93 species, Lepidoptera - 77 species, Hemiptera - 72 species, Orthoptera - 45 species, Hymenoptera - 45 species, and Odonata - 26 species. Among

Lady Bird Beetle(Coccinella sp.)

Pygmy dartlet (pygmaea)

them, *Mahathala ameria ameria* (Hewitson), family Lycaenidae (order Lepidoptera) is a single species recorded in India, from West Bengal. *Mixomicromus lampus* (Ghosh), family Hemerobiidae (order Lepidoptera) is new to science and *Mantispa femoralis* (Banks), family Mantispidae (order Neuroptera) is a new record from this area.

Honey bees produce significant quantities of honey from the mangroves of the Sundarbans and are an important food resource for humans. *Apis dorsata* and *Apis mellifera* are the honey bees that are reported from the Sundarbans (Naskar and Guhabakshi 1987). The dominant bee species (*Apis dorsata*) may travel hundreds of miles to forage in the mangrove forests during periods of peak blooming (March and July). They build honeycombs on several mangrove species but prefers *Excoecaria* (Krishnamurthy 1990). Twenty-two ant species are reported from here. *Camponotus, Leptogenys*, and *Diacamma* are the most common genera. The carpenter ant *Componotus* sp. and thief ant *Solenopsis* sp. found in the Sundarbans are reported to construct their nests preferably in rotten and decaying *Exoecaria* woods.

Beehive

Holes in the mangrove trees (particularly the *Avicennia* species) and crab burrows provide ideal sites for mosquito breeding (Thangam 1990). Mosquitoes are often incredibly numerous and the degree of abundance is exceptional (Macnae 1968); many act as vectors for diseases of vertebrates. Populations are often dense and species diversity can be high; 21 species of the Culicidae family (Diptera) are recorded from the Sundarbans area. Culicine mosquitoes are reported to find breeding places in pools at ground level, in water collecting at the bases of the leaves of *Nypa*, in rot holes in trees, and in the burrows of crabs. Macnae (1968) also reported that mosquitoes settle on the back of the head of the mudskipping goby; *Boleophthalmus sp*. *Anopheles sundaicus* breeds exclusively in brackish water of chlorinity 4.8–13 percent (Hodgkin 1956). The breeding pools are, as a rule, found at the limits of tidal rise, where the tide reaches once or twice per month. Rain and seepage water dilute the dammed-up seawater to a point that is suitable for the mosquito to breed

Feeding Guilds

Mixomicromus lampus Ghosh, Family Hemerobiidae (Order Lepidoptera) is new to science

Mangroves provide a habitat that supports a large number of insects at different trophic levels. The primary trophic groups are (a) herbivorous insects that feed on leaves and other plant parts, (b) saproxylic and saprophagous insects that feed on dead and decaying organic matter, and (c) parasitic and predatory insects that feed or prey on other animals.

Herbivorous insects. The Feeding Guild structure analysis (Southwood 1973) of insects in the Indian Sundarbans reveals herbivory as the dominant feeding guild represented by the orders Orthoptera, Hemiptera, Homoptera, Lepidoptera, Diptera, Coleoptera, and Hymenoptera. They feed in all stages

White Tiger - (Danaus melanippus)

Vespa sp. feeding on a caterpillar

while larval dipterans are gall farming, leaf mining, and flower and fruit boring insects (Murphy 1990b). Insects are reported to feed on a wide range of mangrove plant parts, including leaves, shoots, flowers, fruits, and stems. Butterflies are known to be host specific and a few species are entirely restricted to mangroves (Corbet and Pendlebury 1992). However, some butterfly species such as Burma Tree Nymph (*Idea agamarschana*) are recorded from the tidal creeks of the Sundarbans and are associated with flora of secondary growth.

Saproxylic and saprophagous insects. Saproxylic insects consist of termites and wood borers (usually the larvae of beetles or moths), which form a relatively characteristic assemblage in mangroves. The relative abundance of a limited number of tree species provides an abundant and stable food source for this group of insects. In the intertidal zone, periodic or continuous flooding makes mangroves uninhabitable for many termite species that forage from the ground. However, species that nest above the ground thrive in this habitat in the absence of competing fauna and in the presence of abundant food resources. Termite groups that readily colonize the mangrove habitat are *Coptotermes* (Kirton 1995), which are able to nest in moist wood with no ground contact, and species that build arboreal carton nests on tree trunks and branches, such as *Microcerotermes* spp. *Coccotrypes nepheli*, a scolytid beetle, is reported to be the primary wood-boring beetle in mangroves, including in the Sundarbans. The beetles feed on dead branches that have yet to dry completely and burrow under the bark or into the wood and culture fungi on which their brood feeds. However, some are seed or prop-root feeders (Ng and Sivasothi 2002), and others may cause the death of branches and trees through girdling and hollowing of stems and twigs. The dung beetle (Scarabidae) communities are excellent models to evaluate and to monitor the extent to which the changes in the vegetation alter the animal communities (Halffter and Favila 1993). *Onthophagus quadridentatus* (dung beetle) is also recorded from this area. Ground-dwelling saprophagous insects are also found in the Sundarbans, and many have specialized adaptations for survival in the intertidal zone. Springtails (Collembola) are diverse among the roots of mangrove plants and in the leaf litter that accumulates on the ground (Murphy 1965; Roque 2007), where they feed on a range of organic material, including detritus and fungi.

Parasitic and predatory insects.

A wide range of predatory and parasitic insects, with a great diversity of host and habit, occur in mangrove habitats. These include predatory larvae and adult insects that prey on other organisms, parasitoids that feed within a single host and eventually kill it, hyperparasitoids that parasitize parasitoids, and blood-sucking parasites of vertebrates. They occur throughout the mangroves, from the soil to the water surface and on mangrove plants, where they exert a restraining influence on populations of herbivorous and saprophagous organisms. Ants (Formicidae) are important predators in mangroves (Nagelkerken et al. 2008).

Many other predatory insects live and feed on the ground, sheltering under plant debris during high tides and emerging to feed on springtails, copepods, protozoa, and nematodes when the tides recede (Ng and Sivasothi 2002). In the Sundarbans, the more common predatory insects are hemipterans. On the water surface of mangrove tidal pools in Singapore, water skaters (Veliidae) are reported to prey on smaller insects that fall or land on the water (Ng and Sivasothi 2002). Female mosquitoes (Culicidae) and other small biting flies (Ceratopogonidae and Phlebotominae) that inhabit mangroves take a blood meal from vertebrate hosts, before reproduction. Biting midges breed in the mud in mangroves and mosquitoes breed in stagnant pools as well as rot holes in trees (Nagelkerken et al. 2008).

Local Community Dependencies and Traditional Use

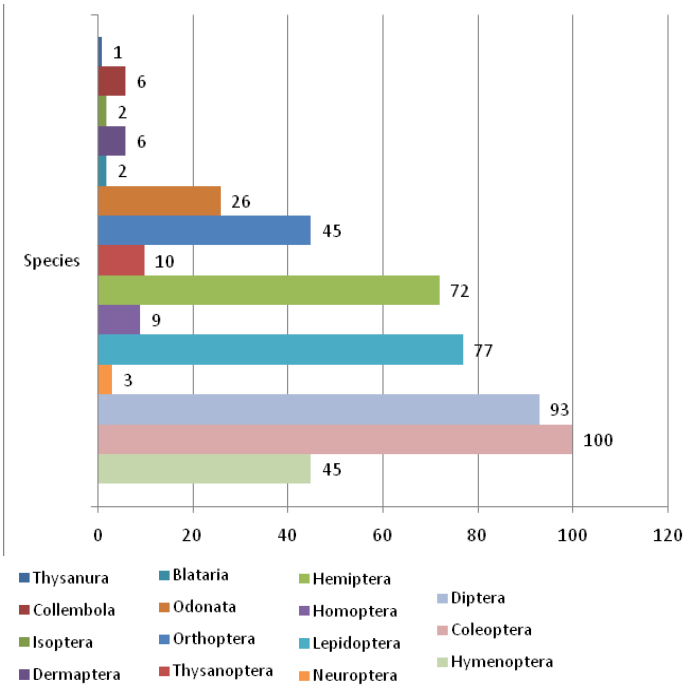
Natural honey from *Apis dorsata,* cultured (apiary) honey from *Apis indica*, and bee wax are among the Non Timber Forest Products (NTFP) collected by the local community from the Sundarbans. Singh et al. (2010) report that honey and wax

93 MEDICINAL APPLICATIONS FROM 24 INSECT SPECIES

Table 2: Total number of families, genera, species composition of Insects in Sundarbans

Sr. No.	Order	Family	Genus	Species
1	Thysanura	1	1	1
2	Collembola	2	3	6
3	Isoptera	2	2	2
4	Dermaptera	4	6	6
5	Blataria	1	1	2
6	Odonata	3	24	26
7	Orthoptera	8	36	45
8	Thysanoptera	2	6	10
9	Hemiptera	19	46	72
10	Homoptera	4	8	9
11	Lepidoptera	15	59	77
12	Neuroptera	3	3	3
13	Diptera	20	52	93
14	Coleoptera	17	69	100
15	Hymenoptera	6	28	45
	Total	**107**	**344**	**497**

Fig 2: Diversity of Insect species in Sundarbans.



collection from the forest is one of the livelihood activities of Sundarban dwellers even though it is not a high income-yielding activity. About 1,000 honey collectors are given permits from West Bengal Forest Development to collect honey at a fixed tariff per kg.

Majumder and Dey (2005) reported a drug prepared from different species of entomofauna by the tribes (Santhal, Oraon, and Munda) at the Sundarbans for the treatment of various diseases. Ninety-three medicinal applications made from 24 insect species have been reported from the Sundarbans. The insect species were Coleoptera (6 species), Hymenoptera (10 species), Hemiptera (4 species), Orthoptera (1 species), Diptera (2 species), and Odonata (1 species). The medicinal applications are used locally and the oral applications are for the cure of hydrophobia, nerve disability, hemoptysis, dysmeno-rrhoea, obesity, gallstone, and nasal obstruction.

Ecological Importance and Need for Conservation

Components of several biogeochemical cycles as well as mediators of energy transformation

Mangrove forests consists of tree species occurring in monoculture stands or a mixture of tree species. Very rarely, under storey plants exist and even the canopy of the existing trees has limited vertical stratification. This further simplifies the structural and floristic diversity of the mangrove ecosystem. Herbivore insects are widely accepted as playing a significant role in the ecology of forest ecosystems (Burrows 2003). Herbivore insects have a significant impact on tree growth and form, survivorship curve, reproductive output, and forest ecology (Crawley 1989; Schowalter 1986).

Insect herbivores can cause changes in nutrient cycles and nutrient availability in soils (Hunter 2001b); they deposit significant quantities of fecal material onto litter and soil. Nutrients returned to soils in insect cadavers are more easily decomposed than those in leaf litter (Schowalter 1986) and can stimulate the decomposition of litter during defoliator outbreaks (Seastedt and Crossley 1984; Swank et al. 1981). Insect defoliation changes the nutrient content of precipitation as it passes through plant canopies. Herbivory can change the quantity of leaf litter that falls from plant canopies to the soil and also affect the utilization of soil nutrients by the new community (Kielland et al. 1997). Herbivory may influence root exudates or interactions between roots and their symbionts (Bardgett et al. 1998), both of which are known to influence nutrient dynamics. Changes in soil microclimate, which result from insect herbivory, can alter the cycling of nutrients (Mulder 1999). Similarly, herbivore-induced changes in light availability may influence litter quality through effects on leaf chemistry (Hunter and Forkner 1999) or plant productivity and diversity (van der Wal et al. 2000).

Insects are important components of several biogeochemical cycles as well as mediators of energy transformation. Some of the carbon captured by plants is consumed by primary consumers such as insect herbivores and, in turn, by predators that eat herbivores. At each trophic level, carbon that was originally captured by plants is returned to the atmosphere by the respiration of organisms at that trophic level. Leaf shredding insects like Diptera select leaf litter tissue that has been colonized and partially decomposed (or 'conditioned') by fungi and bacteria (Cummins and Klug 1979). Shredders also ingest attached algae and bacteria along with litter tissue (Merritt and Cummins 1984), and it seems likely that they gain some of their energy and nutrient requirements from the microbes rather than the litter itself. The leaf shredders possess the ability to turn the coarse particulate organic matter (CPOM) of litter into fine particulate organic matter (FPOM) and dissolved organic matter (DOM) (Wallace et al. 1982). Most of the litter passes through their gut, emerging as fine particles or dissolved fractions in the faeces. FPOM and DOM are major sources of nutrition for gatherers; filter feeders (for example, blackfly larvae in the dipteran family Simulidae); and microbes in streams (Cummins et al. 1973; Short and Maslin 1977; Wotton 1994). Insect shredders also promote wood decomposition by scraping, gouging, and tunneling into the woody debris (twigs, branches, and stems) that fall into streams. Freshly gouged surfaces act as sites for microbial activity and subsequent decomposition (Anderson et al. 1984).

Insects play a major role in the carbon cycle during the decomposition process. Blowflies and flesh flies (Diptera: Calliphoridae and Sarcophagidae, respectively) are well-known insect decomposers whose larvae often feed within carrion or excrement. The gut symbionts of various termite groups include both flagellate protozoans (Yoshimura et al. 1993) and bacteria (Basaglia et al. 1992). As an aside, it has been reported that some spirochetes that live symbiotically in termite guts are able to fix atmospheric nitrogen and may contribute this nitrogen to termite nutrition (Lilburn et al. 2001). Large amounts of ammonia (NH_3) build up in the nests of certain termite species, possibly to levels 300 times higher than in the surrounding soil (Ji and Brune 2006). One crucial feature of termites relevant to the carbon cycle is the occurrence of anaerobic microsites in termite guts. Termites therefore have the potential to recycle significant amounts of carbon to the atmosphere in two gaseous forms.

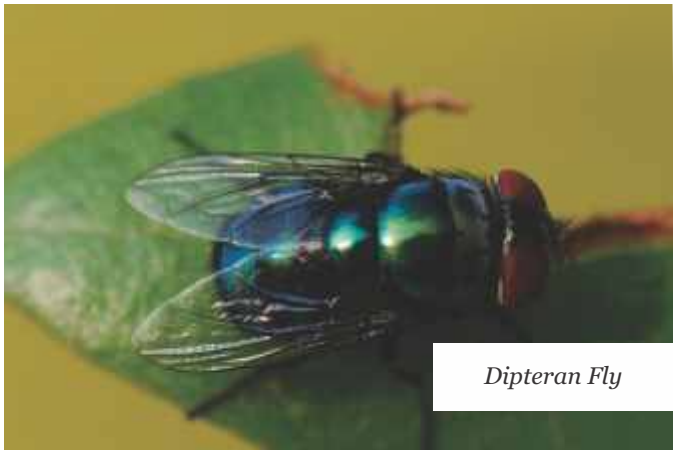
Besides wind, birds, and, in some instances, bats, insects also play a major role in pollination in most mangrove species. In the absence of bats, hawkmoths become the primary night-time pollinators of *Sonneratia* (Hockey and de Baar 1991). Two lycaenid butterflies are reported to be important in the

Honey collection

pollination of mangroves in Brisbane, Australia, where their abundance is directly correlated with the abundance of mangrove flowers (Hill 1992). Bees are also reported to regularly visit and pollinate species of *Avicennia, Acanthus, Excoecaria, Rhizophora, Scyphiphora*, and *Xylocarpus*. Some wasps and flies are highly dependent on mangroves for nesting and are particularly important pollinators of *Bruguiera* sp., *Ceriops decandra*, *Kandelia candel*, and *Lumnitzera racemosa* (Tomlinson 1986).

STATUS AND THREATS

Given the conservation and protection regime prevalent in India, of the total insect fauna recorded in the Sundarbans, only 4 insect species (Lepidoptera) (table 3) has been included in the Indian Wildlife (Protection) Act, 1972.



Dipteran Fly

Table 3: Protection regime of Lepidopteran Species

Sr No.	Order	Family	Scientific Name	Schedule*
1	Lepidoptera	Lycaenidae	*Euchrysops cnejus* (Fabricius)	II
2	Lepidoptera	Lycaenidae	*Lampides boeticus* (Linnaeus)	II
3	Lepidoptera	Nymphalidae	*Hypolimnas misippus* (Linnaeus)	II
4	Lepidoptera	Lycaenidae	*Mahathala ameria ameria* (Hewitson)	II

Note : * Schedules of Indian Wildlife (Protection) Act, 1972

ANNEXURE

Insect fauna of Sundarbans

Sr. No.	Order	Family	Genus	Species
1	Thysanura	Lepismatidae	*Ctenolepisma* Escherich	*Ctenolepisma longicaudata*
2	Collembola	Entomobryidae	*Lepidocyrtus* Bourlet	*Lepidocyrtus (Acrocyrtus) scaber*
3	Collembola	Entomobryidae	*Lepidocyrtus* Bourlet	*Lepidocyrtus (Acrocyrtus) heterolepis*
4	Collembola	Entomobryidae	*Lepidocyrtus* Bourlet	*Lepidocyrtus (Lepidocyrtus) medius*
5	Collembola	Entomobryidae	*Cyphoderus* Nicolet	*Cyphoderus javanus*
6	Collembola	Entomobryidae	*Cyphoderus* Nicolet	*Cyphoderus albinus*
7	Collembola	Neamuridae	*Lobelia* Burner	*Lobella (Lobella) maxillaris*
8	Isoptera	Rhinotermitidae	*Coptotermes*	*Coptotermes heimi* (Wasmann)
9	Isoptera	Termitidae	*Microcerotermes*	*Microcerotermes cameroni* Snyder
10	Dermaptera	Pygidicranidae	*Pradiplatys*	*Pradiplatys gladiator* (Burr)
11	Dermaptera	Pygidicranidae	*Diplatys*	*Diplatys sinuatus* Hincks
12	Dermaptera	Anisolabididae	*Euborellia*	*Euborellia annulipes* (Lucas)
13	Dermaptera	Labiduridae	*Nala*	*Nala lividipes* (Dufour)
14	Dermaptera	Labiduridae	*Labidura*	*Labidura riparia* (Pallas)
15	Dermaptera	Spongiphoridae	*Pralabella*	*Pralabella curvicauda* (Motschulsky)
16	Blataria	Blattelidae	*Blattella*	*Blattella humbertiana* (Sauss.)
17	Blataria	Blattelidae	*Blattella*	*Blattella germanica* (Linnaeus)
18	Odonata	Coenagrionidae	*Ceriagrion*	*Ceriagrion cerinorubellum* (Brauer, 1865)
19	Odonata	Coenagrionidae	*Ceriagrion*	*Ceriagrion coromandelianum* (Fabricius, 1798)
20	Odonata	Coenagrionidae	*Pseudagrion*	*Pseudagrion australasiae* Selys, 1876
21	Odonata	Coenagrionidae	*Pseudagrion*	*Pseudagrion decorum* (Rambur, 1842)

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22	Odonata	Coenagrionidae	*Cercion*	*Cercion malayanum* (Selys, 1870)
23	Odonata	Coenagrionidae	*Ischnura*	*Ischnura senegalensis* (Rambur, 1842)
24	Odonata	Coenagrionidae	*Ischnura*	*Ischnura aurora aurora* (Brauer, 1865)
25	Odonata	Coenagrionidae	*Agriocnemis*	*Agriocnemis pygmaea* (Rambur, 1842)
26	Odonata	Coenagrionidae	*Onychargia*	*Onychargia atrocyana* Selys, 1865
27	Odonata	Gomomphidae	*Ictinogomphus*	*Ictinogomphus rapax* (Rambur, 1842)
28	Odonata	Libellulidae	*Brachydiplax*	*Brachydiplax sobrina* (Rambur, 1842)
29	Odonata	Libellulidae	*Lathrecista*	*Lathrecista asiatica asiatica* (Fabricius, 1798)
30	Odonata	Libellulidae	*Orthetrum*	*Orthetrum sabina sabina* (Drury, 1770)
31	Odonata	Libellulidae	*Acisoma*	*Acisoma panorpoides panorpoides* (Rambur, 1842)
32	Odonata	Libellulidae	*Brachythemis*	*Brachythemis contaminata* (Fabricius, 1798)
33	Odonata	Libellulidae	*Bradinopyga*	*Bradinopyga geminata* (Rambur, 1842)
34	Odonata	Libellulidae	*Crocothemis*	*Crocothemis servilia servilia* (Drury, 1770)
35	Odonata	Libellulidae	*Diplacodes*	*Diplacodes trivialis* (Rambur, 1842)
36	Odonata	Libellulidae	*Neurothemis*	*Neurothemis tullia tullia* (Drury, 1773)
37	Odonata	Libellulidae	*Trithemis*	*Trithemis pallidinervis* (Kirby, 1889)
38	Odonata	Libellulidae	*Rhyothemis*	*Rhyothemis variegata variegata* (Linnaeus, 1763)
39	Odonata	Libellulidae	*Pantala*	*Pantala flavescens* (Fabricius, 1798)
40	Odonata	Libellulidae	*Tramea*	*Tramea virginia* (Rambur, 1842)
41	Odonata	Libellulidae	*Tholymis*	*Tholymis tillarga* (Fabricius, 1798)
42	Odonata	Libellulidae	*Macrodiplax*	*Macrodiplax cora* (Brauer, 1867)
43	Odonata	Libellulidae	*Urothemis*	*Urothemis signata signata* (Rambur, 1842)
44	Orthoptera	Tetrigidae	*Thoradonta*	*Thoradonta apiculata*
45	Orthoptera	Tetrigidae	*Thoradonta*	*Thoradonta pruthii*
46	Orthoptera	Tetrigidae	*Coptotettix*	*Coptotettix annandalei*
47	Orthoptera	Tetrigidae	*Ergatettix*	*Ergatettix dorsifera*
48	Orthoptera	Tetrigidae	*Ergatettix*	*Ergatettix guntheri*
49	Orthoptera	Tetrigidae	*Euparatettix*	*Euparatettix histricus*
50	Orthoptera	Tetrigidae	*Euparatettix*	*Euparatettix personatus*
51	Orthoptera	Tetrigidae	*Hedotettix*	*Hedotettix gracilis*
52	Orthoptera	Gryllidae	*Gryllotalpa*	*Gryllotalpa africana*
53	Orthoptera	Gryllidae	*Modicogryllus*	*Modicogryllus confirmatus*
54	Orthoptera	Gryllidae	*Plebeiogryllus*	*Plebeiogryllus guttiventris*
55	Orthoptera	Gryllidae	*Pteronemobius*	*Pteronemobius concolor*
56	Orthoptera	Gryllidae	*Pteronemobius*	*Pteronemobius fascipes*
57	Orthoptera	Gryllidae	*Pteronemobius*	*Pteronemobius taprobanensis*
58	Orthoptera	Scleropteridae	*Scleropterus*	*Scleropterus variolosus*
59	Orthoptera	Trigonidiidae	*Trigonidium*	*Trigonidium humbertianum*

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60	Orthoptera	Eneopteridae	*Euscyrtus*	*Euscyrtus hemelytrus*
61	Orthoptera	Pyrginirogudae	*Atractomorpha*	*Atractomorpha crenulata* (Fabr.)
62	Orthoptera	Pyrginirogudae	*Chrotogonus*	*Chrotogonus trachypterus*
63	Orthoptera	Acrididae	*Dnopherula*	*Dnopherula physopoda*
64	Orthoptera	Acrididae	*Acrida*	*Acrida exalata* (Walker)
65	Orthoptera	Acrididae	*Aiolopus*	*Aiolopus thalassinus tamulus* Fabricius
66	Orthoptera	Acrididae	*Dittopternis*	*Dittopternis venusta* Walker
67	Orthoptera	Acrididae	*Oedaleus*	*Oedaleus senegalensi*s (Krauss)
68	Orthoptera	Acrididae	*Phlaeoba*	*Phlaeoba infumata* Brunner
69	Orthoptera	Acrididae	*Trilophidia*	*Trilophidia annulata* (Thunberg)
70	Orthoptera	Acrididae	*Gesonula*	*Gesonula punctifrons* Stal
71	Orthoptera	Acrididae	*Hieroglyphus*	*Hieroglyphus banian* Fabricius
72	Orthoptera	Acrididae	*Spathosternum*	*Spathosternum prasiniferum prasiniferum* (Walker)
73	Orthoptera	Acrididae	*Oxya*	*Oxya fuscobittata (*Marschall)
74	Orthoptera	Acrididae	*Oxya*	*Oxya hyla hyla* Serville
75	Orthoptera	Acrididae	*Oxya*	*Oxya nitidula*
76	Orthoptera	Acrididae	*Epistaurus*	*Epistaurus sinetyi* Bolivar
77	Orthoptera	Acrididae	*Tristria*	*Tristria pulvinata* (Uvarov)
78	Orthoptera	Acrididae	*Eupreponotus*	*Eupreponotus inflatus* Uvarov
79	Orthoptera	Acrididae	*Heteracris*	*Heteracris pulchra* (Bolivar)
80	Orthoptera	Tettigoniidae	*Meroncidius*	*Meroncidius ochraceous*
81	Orthoptera	Tettigoniidae	*Phisispectinata*	*Phisispectinata* sp.
82	Orthoptera	Tettigoniidae	*Elimaea*	*Elimaea securigera*
83	Orthoptera	Tettigoniidae	*Sathrothyllia*	*Sathrothyllia femorata*
84	Orthoptera	Tettigoniidae	*Onomarchus*	*Onomarchus leuconatus*
85	Orthoptera	Tettigoniidae	*Acanthoprion*	*Acanthoprion suspectum*
86	Orthoptera	Tettigoniidae	*Euconocephalus*	*Euconocephalus incertus*
87	Orthoptera	Tettigoniidae	*Euconocephalus*	*Euconocephalus pallidu*
88	Orthoptera	Tettigoniidae	*Xiphidiopsis*	*Xiphidiopsis straminnula*
89	Thysanoptera	Thripidae	*Retithrips*	*Retithrips syriacus* (Mayet)
90	Thysanoptera	Thripidae	*Selenothrips*	*Selenothrips rubrocinetus* (giard)
91	Thysanoptera	Thripidae	*Thrips*	*Thrips hawaiiensis* (Morgan)
92	Thysanoptera	Thripidae	*Thrips*	*Thrips flavus* Schrank
93	Thysanoptera	Thripidae	*Thrips*	*Thrips orientalis* (Baganall)
94	Thysanoptera	Phlaeothripidae	*Elaphrothrips*	*Elaphrothrips procer* (Schmutz)
95	Thysanoptera	Phlaeothripidae	*Haplothrips*	*Haplothrips ceylonicus* Schumutz
96	Thysanoptera	Phlaeothripidae	*Haplothrips*	*Haplothrips clarisetis* Priesner
97	Thysanoptera	Phlaeothripidae	*Haplothrips*	*Haplothrips gangalbaueri* Schmutz
98	Thysanoptera	Phlaeothripidae	*Podothrips*	*Podothrips lucasseni* (Kruger)

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99	Hemiptera	Cercopidae	*Clovia*	*Clovia bipunctata* Kirby
100	Hemiptera	Cicadellidae	*Amitodus*	*Amitodus atkinsoni* (Lethierry)
101	Hemiptera	Membracidae	*Oxyrhachis*	*Oxyrhachis lefroi* Distant
102	Hemiptera	Membracidae	*Oxyrhachis*	*Oxyrhachis rufescens* Walker
103	Hemiptera	Membracidae	*Oxyrhachis*	*Oxyrhachis tarandus* (Fabricius)
104	Hemiptera	Membracidae	*Tricentrus*	*Tricentrus cinereus* Anathasubrananian
105	Hemiptera	Membracidae	*Tricentrus*	*Tricentrus cornutus* Anathasubrananian
106	Hemiptera	Psyllidae	*Trioza*	*Trioza fletcheri* Crawford
107	Hemiptera	Psyllidae	*Trioza*	*Trioza* sp. *Probably fletcheri*
108	Hemiptera	Aphididae	*Aphis*	*Aphis citricola* Patch
109	Hemiptera	Aphididae	*Aphis*	*Aphis craccivora* Koch
110	Hemiptera	Aphididae	*Aphis*	*Aphis fabae* Scopoli
111	Hemiptera	Aphididae	*Aphis*	*Aphis gossyp*i iGlover
112	Hemiptera	Aphididae	*Aphis*	*Aphis nasturtii* Kaltenbach
113	Hemiptera	Aphididae	*Aphis*	*Aphis nerii* Boyer de Fonscolombe
114	Hemiptera	Aphididae	*Toxoptera*	*Toxoptera aurantii* Boyer de Fonscolombe
115	Hemiptera	Aphididae	*Toxoptera*	*Toxoptera citricidus* (Kirkaldy)
116	Hemiptera	Aphididae	*Toxoptera*	*Toxoptera odinae* (van der Goot)
117	Hemiptera	Aphididae	*Hysteroneura*	*Hysteroneura setariae* (Thomas)
118	Hemiptera	Aphididae	*Melanaphis*	*Melanaphis sacchari* (Zehnter)
119	Hemiptera	Aphididae	*Rhopalosiphum*	*Rhopalosiphum maidis* (Fitch)
120	Hemiptera	Aphididae	*Rhopalosiphum*	*Rhopalosiphum rufiabdominalis* (Sasaki)
121	Hemiptera	Aphididae	*Acyrthosiphon*	*Acyrthosiphon pisum* (Harris)
122	Hemiptera	Aphididae	*Aulacorthum*	*Aulacorthum solani* (Kaltenbach)
123	Hemiptera	Aphididae	*Bachycaudus*	*Bachycaudus helichrysi* (Kaltenbach)
124	Hemiptera	Aphididae	*Brevicoryne*	*Brevicoryne brassicae* (Linnaeus)
125	Hemiptera	Aphididae	*Hyadaphis*	*Hyadaphis coriandri* (Das)
126	Hemiptera	Aphididae	*Lipaphis*	*Lipaphis erysimi* (Kaltenbach)
127	Hemiptera	Aphididae	*Macrosiphoniella*	*Macrosiphoniella sanborni* Gillette
128	Hemiptera	Aphididae	*Macrosiphum*	*Macrosiphum rosaeformis* (Das)
129	Hemiptera	Aphididae	*Myzus*	*Myzus ornatus* Laing
130	Hemiptera	Aphididae	*Myzus*	*Myzus persicae* Laing
131	Hemiptera	Aphididae	*Neomyzus*	*Neomyzus circumflexus* (Buckton)
132	Hemiptera	Aphididae	*Petalonia*	*Petalonia nigronervosa* Coquerel
133	Hemiptera	Reduviidae	*Conorhinus*	*Conorhinus rubrofasciatus de* Geer
134	Hemiptera	Lygaeidae	*Spilostetethus*	*Spilostetethus hospes*
135	Hemiptera	Lygaeidae	*Pseudopachybra-chius*	*Pseudopachybrachius guttus*
136	Hemiptera	Alydidae	*Leptocorisa*	*Leptocorisa acuta* Thumb
137	Hemiptera	Plataspidae	*Coptosoma*	*Coptosoma siamicum*
138	Hemiptera	Plataspidae	*Coptosoma*	*Coptosoma cribrariun*

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139	Hemiptera	Scutelleridae	*Fitha*	*Fitha ardens*
140	Hemiptera	Scutelleridae	*Chrysocoris*	*Chrysocoris stollii*
141	Hemiptera	Pentatomidae	*Eysarcoris*	*Eysarcoris montivagus*
142	Hemiptera	Pentatomidae	*Eysarcoris*	*Eysarcoris ventralis*
143	Hemiptera	Pentatomidae	*Eysarcoris*	*Eysarcoris guttiger*
144	Hemiptera	Mesoveliidae	*Mesovelia*	*Mesovelia vittigera*
145	Hemiptera	Hydrometridae	*Hydrometra*	*Hydrometra vittata*
146	Hemiptera	Veliidae	*Microvelia*	*Microvelia annandalei*
147	Hemiptera	Veliidae	*Microvelia*	*Microvelia albomaculata*
148	Hemiptera	Gerridae	*Rhagadotarsus*	*Rhagadotarsus kraepelini*
149	Hemiptera	Gerridae	*Naboandelus*	*Naboandelus signatus*
150	Hemiptera	Gerridae	*Halobates*	*Halobates flaviventris*
151	Hemiptera	Gerridae	*Asclepios*	*Asclepios annandalei*
152	Hemiptera	Gerridae	*Limlometra*	*Limlometra anadyomene*
153	Hemiptera	Gerridae	*Limlometra*	*Limlometra fluviorum*
154	Hemiptera	Gerridae	*Limlometra*	*Limlometra nitidus*
155	Hemiptera	Gerridae	*Limlometra*	*Limlometra fossarum*
156	Hemiptera	Gerridae	*Limlometra*	*Limlometra parvulus*
157	Hemiptera	Gerridae	*Gerris*	*Gerris spiolae*
158	Hemiptera	Belostomatidae	*Sphaerodema*	*Sphaerodema annulatum*
159	Hemiptera	Belostomatidae	*Sphaerodema*	*Sphaerodema rusticum*
160	Hemiptera	Belostomatidae	*Sphaerodema*	*Sphaerodema molestum*
161	Hemiptera	Belostomatidae	*Lethocerus*	*Lethocerus indicus*
162	Hemiptera	Nepidae	*Laccotrephes*	*Laccotrephes ruber*
163	Hemiptera	Nepidae	*Laccotrephes*	*Laccotrephes griseus*
164	Hemiptera	Nepidae	*Ranatra*	*Ranatra filiformis*
165	Hemiptera	Nepidae	*Ranatra*	*Ranatra sordidula*
166	Hemiptera	Nepidae	*Ranatra*	*Ranatra varipes*
167	Hemiptera	Notonectidae	*Anisops*	*Anisops sardea*
168	Hemiptera	Notonectidae	*Anisops*	*Anisops breddini*
169	Hemiptera	Notonectidae	*Nychia*	*Nychia marshalli*
170	Hemiptera	Pleidae	*Plea*	*Plea liturata*
171	Homoptera	Tachardiidae	*Kerria*	*Kerria fici fici* (Green)
172	Homoptera	Pseudococcidae	*Birendracoccus*	*Birendracoccus saccharifolii* (Green)
173	Homoptera	Pseudococcidae	*Brevennia*	*Brevennia rehi* Lindiger
174	Homoptera	Pseudococcidae	*Rastrococcus*	*Rastrococcus iceryoides* (Green)
175	Homoptera	Cerococcidae	*Ceroccus*	*Ceroccus indicus* (Maskell)
176	Homoptera	Diaspididae	*Aonidiella*	*Aonidiella aurantii* (Maskell)
177	Homoptera	Diaspididae	*Aonidiella*	*Aonidiella orientalis* (Newstead)
178	Homoptera	Diaspididae	*Lopholeucaspis*	*Lopholeucaspis exoecariae* Borchsenius

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179	Homoptera	Diaspididae	*Pinnaspis*	*Pinnaspis strachan*i (Cooley)
180	Lepidoptera	Danaidae	*Danus*	*Danus melanippus* (Cramer)
181	Lepidoptera	Noctuidae	*Ophiusa*	*Ophiusa coronata* (Fabricius)
182	Lepidoptera	Noctuidae	*Polydesma*	*Polydesma inangulata* (Gwen)
183	Lepidoptera	Sphingidae	*Hippotion*	*Hippotion celerio* (Linnaeus)
184	Lepidoptera	Zygaenidae	*Thyrassia*	*Thyrassia subcordata subcordata* (Walker)
185	Lepidoptera	Arctiidae	*Ansacta*	*Ansacta lineola*
186	Lepidoptera	Arctiidae	*Creatonotos*	*Creatonotos gangis* (Linnaeus)
187	Lepidoptera	Arctiidae	*Spilaretia*	*Spilaretia obliqua* (Walker)
188	Lepidoptera	Arctiidae	*Utetheisa*	*Utetheisa pulchella* (Linnaeus)
189	Lepidoptera	Arctiidae	*Agylla*	*Agylla ramelana* (Moore)
190	Lepidoptera	Arctiidae	*Asura*	*Asura undulosa*(Walker)
191	Lepidoptera	Hesperiidae	*Parnara*	*Parnara naso bada* (Moore)
192	Lepidoptera	Hesperiidae	*Parnara*	*Parnara naso* (Fabricius)
193	Lepidoptera	Hesperiidae	*Pelopidas*	*Pelopidas mathias mathias* (Fabricius)
194	Lepidoptera	Hesperiidae	*Pelopidas*	*Pelopidas mathias* (Fabricius)
195	Lepidoptera	Hesperiidae	*Telicota*	*Telicota ancilla bambusae* (Moore)
196	Lepidoptera	Hesperiidae	*Telicota*	*Telicota ancilla* (Herrich-Schaffer)
197	Lepidoptera	Hesperiidae	*Suastus*	*Suastus gremius* (Fabricius)
198	Lepidoptera	Pyralidae	*Scirpophaga*	*Scirpophaga bisignata* (Swinhoe)
199	Lepidoptera	Pyralidae	*Scirpophaga*	*Scirpophaga adjurellus* (Walker)
200	Lepidoptera	Pyralidae	*Scirpophaga*	*Scirpophaga bipunctifer* (Walker)
201	Lepidoptera	Pyralidae	*Tryporyza*	*Tryporyza incertulas* (Walker)
202	Lepidoptera	Pyralidae	*Epicrocis*	*Epicrocis aegnusalis* (Walker)
203	Lepidoptera	Pyralidae	*Nymphula*	*Nymphula diminutalis* (Snella)
204	Lepidoptera	Pyralidae	*Nymphula*	*Nymphula fluctuosalis zeller* (Snella)
205	Lepidoptera	Pyralidae	*Cnaphalocrocis*	*Cnaphalocrocis medinalis* (Guenee)
206	Lepidoptera	Pyralidae	*Syngamia*	*Syngamia abruptalis* (Walker)
207	Lepidoptera	Pyralidae	*Diaphania*	*Diaphania indica* (Saunbers)
208	Lepidoptera	Pyralidae	*Sameodes*	*Sameodes cancellalis* (Zeller)
209	Lepidoptera	Saturniidae	*Actias*	*Actias selene* (Huebner)
210	Lepidoptera	Saturniidae	*Antheraea*	*Antheraea paphia* (Linnaeus)
211	Lepidoptera	Lycaenidae	*Euchrysops*	*Euchrysops cnejus* (Fabricius)
212	Lepidoptera	Lycaenidae	*Euchrysops*	*Euchrysops pandava pandava* (Horsfield)
213	Lepidoptera	Lycaenidae	*Zizeeria*	*Zizeeria maha* (Kollar)
214	Lepidoptera	Lycaenidae	*Anthene*	*Anthene lycaenoids lycambes* (Hewitson)
215	Lepidoptera	Lycaenidae	*Catochrysops*	*Catochrysops strabo strabo* (Fabricius)
216	Lepidoptera	Lycaenidae	*Lampides*	*Lampides boeticus* (Linnaeus)
217	Lepidoptera	Lycaenidae	*Curetis*	*Curetis thetis thetis* (Drury)
218	Lepidoptera	Lycaenidae	*Mahathala*	*Mahathala ameria ameria* (Hewitson)

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259	Neuroptera	Chrysopidae	*Ankylopteryx*	*Ankylopteryx octopunctata* (Fabricius)
260	Diptera	Tipulidae	*Limonia*	*Limonia (Geranomyia) circipunctata* (Brunetti)
261	Diptera	Tipulidae	*Limonia*	*Limonia (Geranomyia) flavicosta* (Brunetti)
262	Diptera	Tipulidae	*Limonia*	*Limonia (Geranomyia) tridens* (Brynetti)
263	Diptera	Tipulidae	*Trentopohlia*	*Trentopohlia (Trentepohlia) trentepohlii* (Wiedemann)
264	Diptera	Psychodidae	*Psychodu*	*Psychodu alternata* Say
265	Diptera	Psychodidae	*Psychoda*	*Psychoda nigripennis* Brunetti
266	Diptera	Psychodidae	*Phlebotomus*	*Phlebotomus (Euphlebotomus) argentipes* Annadale & Brunetti
267	Diptera	Psychodidae	*Phlebotomus*	*Phlebotomus montana* Rondani
268	Diptera	Psychodidae	*Sergentomyia*	*Sergentomyia (Parrotomyia) babu* (Annadale)
269	Diptera	Ceratopgonidae	*Culicoides*	*Culicoides* (Oecacta) *schultzei* (Enderlein)
270	Diptera	Ceratopgonidae	*Culicoides*	*Culicoides peliliouensis Tokunaga (Unplaced species)*
271	Diptera	Ceratopgonidae	*Culicoides*	*Culicoides similis* Carter, Ingram & Macfie
272	Diptera	Ceratopgonidae	*Alluaudomyia*	*Alluaudomyia formosana* Okada
273	Diptera	Ceratopgonidae	*Alluaudomyia*	*Alluaudomyia maculosipennis* Tokunaga
274	Diptera	Culicidae	*Anopheles*	*Anopheles (Anopheles) peditaeniatus* (Leicester)
275	Diptera	Culicidae	*Anopheles*	*Anopheles (Cellia) annularis* vander Wulp
276	Diptera	Culicidae	*Anopheles*	*Anopheles (Cellia) pseudojamesi* Strickland & Chowdhury
277	Diptera	Culicidae	*Anopheles*	*Anopheles (Cellia) ramsayi* Covell
278	Diptera	Culicidae	*Anopheles*	*Anopheles (Cellia) subpictus* Grassi
279	Diptera	Culicidae	*Anopheles*	*Anopheles (Cellia) sundaicus* (Rodenwaldt)
280	Diptera	Culicidae	*Anopheles*	*Anopheles (Cellia) vagus* Donitz
281	Diptera	Culicidae	*Aedeomyia*	*Aedeomyia (Aedeomyia) catasticta* Knab
282	Diptera	Culicidae	*Lorrainea*	*Lorrainea fumida* Edwards
283	Diptera	Culicidae	*Stegomyia*	*Stegomyia albopictus* (Skuse)
284	Diptera	Culicidae	*Armigers*	*Armigers (Armigeres) kuchingensis* Edwards
285	Diptera	Culicidae	*Armigers*	*Armigers (Armigeres) subalbatus* (Coquillett)
286	Diptera	Culicidae	*Culex*	*Culex (Culex) quinquefasciatus* Say
287	Diptera	Culicidae	*Culex*	*Culex (Culex) pseudovishnui* Colless
288	Diptera	Culicidae	*Culex*	*Culex (Culex) tritaeniorhynchus* Giles
289	Diptera	Culicidae	*Culex*	*Culex (Culex) vishnui* Theobald
290	Diptera	Culicidae	*Culex*	*Culex (Culiciomyia) sitiens* Wiedemann
291	Diptera	Culicidae	*Culex*	*Culex (Eumelanomyia) malayi* (Leicester)
292	Diptera	Culicidae	*Mansonia*	*Mansonia (Mansonoides) annulifera* Theobald
293	Diptera	Culicidae	*Mansonia*	*Mansonia (Mansonoides) indiana* Edwards
294	Diptera	Culicidae	*Mansonia*	*Mansonia (Mansonoides) uniformis* (Theobald)

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219	Lepidoptera	Lycaenidae	*Narathura*	*Narathura atrax* (Hewitson)
220	Lepidoptera	Lycaenidae	*Spindasis*	*Spindasis vulcanus vulcanus* (Fabricius)
221	Lepidoptera	Lycaenidae	*Spindasis*	*Spindasis ictis ictis* (Hewitson)
222	Lepidoptera	Lycaenidae	*Spindasis*	*Spindasis elima elima* (Moore)
223	Lepidoptera	Lycaenidae	*Tajuria*	*Tajuria jehana* Moore
224	Lepidoptera	Geometridae	*Agathia*	*Agathia lycaenaria* (Kollar, 1844)
225	Lepidoptera	Nymphalidae	*Ariadne*	*Ariadne ariadne indica* (Moore)
226	Lepidoptera	Nymphalidae	*Hypolimnas*	*Hypolimnas misippus* (Linnaeus)
227	Lepidoptera	Nymphalidae	*Cirrochroa*	*Cirrochroa tyche mithila* Moore
228	Lepidoptera	Nymphalidae	*Precis*	*Precis atlites* (Linnaeus)
229	Lepidoptera	Nymphalidae	*Precis*	*Precis lemonis lemonis* (Linnaeus)
230	Lepidoptera	Nymphalidae	*Precis*	*Precis almana almana* (Linnaeus)
231	Lepidoptera	Nymphalidae	*Neptis*	*Neptis jumbah jumbah* Moore
232	Lepidoptera	Ctenuchidae	*Ceryx*	*Ceryx godartii* (Boisduval)
233	Lepidoptera	Ctenuchidae	*Syntomis*	*Syntomis diaphana*
234	Lepidoptera	Ctenuchidae	*Syntomis*	*Syntomis passalis fabricius*
235	Lepidoptera	Ctenuchidae	*Syntomis*	*Syntomis cyssea* (Stoll)
236	Lepidoptera	Pieridae	*Eurema*	*Eurema hecabe contubernalis* (Moore)
237	Lepidoptera	Pieridae	*Valeria*	*Valeria valeria hippia* (Fabricius)
238	Lepidoptera	Pieridae	*Delias*	*Delias eucharis* (Drury)
239	Lepidoptera	Pieridae	*Leptosia*	*Leptosia nina nina* (Fabricius)
240	Lepidoptera	Pieridae	*Ixias*	*Ixias marianne* (Cramer)
241	Lepidoptera	Pieridae	*Cepora*	*Cepora nerissa phryner* (Fabricius)
242	Lepidoptera	Pieridae	*Catopsilia*	*Catopsilia pyranthe pyranthe* (Linnaeus)
243	Lepidoptera	Pieridae	*Catopsilia*	*Catopsilia florella gnoma* (Fabricius)
244	Lepidoptera	Satyridae	*Mycalesis*	*Mycalesis perseus blasius* (Fabricius)
245	Lepidoptera	Satyridae	*Ypthima*	*Ypthima ceylonica hubneri* Kirby
246	Lepidoptera	Satyridae	*Melanitis*	*Melanitis leda ismene* (Cramer)
247	Lepidoptera	Papilionidae	*Pachliopta*	*Pachliopta hector* (Linnaeus)
248	Lepidoptera	Papilionidae	*Princeps*	*Princeps polytes* (Linnaeus, 1758)
249	Lepidoptera	Papilionidae	*Princeps*	*Princeps demoleus* (Linnaeus, 1758)
250	Lepidoptera	Nymphalidae	*Trirumala*	*Trirumala limniace* (Cramer, 1775)
251	Lepidoptera	Nymphalidae	*Danaus*	*Danaus genutia* (Cramer, 1779)
252	Lepidoptera	Nymphalidae	*Danaus*	*Danaus melanippus* (Cramer, 1777)
253	Lepidoptera	Nymphalidae	*Danaus*	*Danaus chrysippus* (Linnaeus, 1758)
254	Lepidoptera	Nymphalidae	*Euploea*	*Euploea core* (Cramer, 1780)
255	Lepidoptera	Nymphalidae	*Euploea*	*Euploea crameri* Lucas (1853)
256	Lepidoptera	Nymphalidae	*Idea*	*Idea agamarschana* (C. & R. Felder, 1865)
257	Neuroptera	Mantispidae	*Mantispa*	*Mantispa femoralis* Banks
258	Neuroptera	Hemerobiidae	*Mixomicromus*	*Mixomicromus lampus* Ghosh

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295	Diptera	Chironomidae	*Chironomus*	*Chironomus barbatitarsis*
296	Diptera	Cecidomyiidae	*Stephaniola*	*Stephaniola bengalensis* Mani
297	Diptera	Stratiomyidae	*Odontomyia*	*Odontomyia dorsoangulata* Brunetti
298	Diptera	Stratiomyidae	*Oplodontha*	*Oplodontha rubrithorax* (Macquart)
299	Diptera	Tabanidae	*Chrysops*	*Chrysops dispar* (Fabricius)
300	Diptera	Tabanidae	*Atylotus*	*Atylotus agrestis* (Wiedemann)
301	Diptera	Tabanidae	*Tabanus*	*Tabanus (Tabanus) striatus* Fabricius
302	Diptera	Tabanidae	*Haematopota*	*Haematopota javana* Wiedemann
303	Diptera	Asilidae	*Philodicus*	*Philodicus femoralis* Ricardo
304	Diptera	Asilidae	*Philodicus*	*Philodicus javanus* (Wiedemann)
305	Diptera	Empidaidae	*Drapetis*	*Drapetis (Elaphropeza) ferruginea* Brunetti
306	Diptera	Dolichopodidae	*Medetera*	*Medetera grisescens* de Meijere
307	Diptera	Phoridae	*Megaselia*	*Megaselia (Megaselia) scalaris* Loew
308	Diptera	Pipunculidae	*Pipunculus*	*Pipunculus (Eudorylus) biroi* Kertesz
309	Diptera	Syrphidae	*Ischiodon*	*Ischiodon scutellaris* (Fabricius)
310	Diptera	Syrphidae	*Paragus*	*Paragus* (Paragus) *serratus* (Fabricius)
311	Diptera	Syrphidae	*Eristalinus*	*Eristalinus (Eristalinus) obscuritarsis* (de Meijere)
312	Diptera	Syrphidae	*Mesembrius*	*Mesembrius quadrivittatus* (Wiedemann)
313	Diptera	Syrphidae	*Syritta*	*Syritta indica* (Wiedemann)
314	Diptera	Syrphidae	*Syritta*	*Syritta orientalis* Macquart
315	Diptera	Syrphidae	*Baccha*	*Baccha (Allobaccha) apicalis* Loew.
316	Diptera	Ephydridae	*Drachydeutera*	*Drachydeutera longipes* Hendel
317	Diptera	Tephritidae	*Platensina*	*Platensina acrostacta* (Wiedemann)
318	Diptera	Sepsidae	*Sepsis*	*Sepsis indica* Wiedemann
319	Diptera	Muscidae	*Musca*	*Musca (Byomya) conducens* Walker
320	Diptera	Muscidae	*Musca*	*Musca (Byomya) confiscata* Speiser
321	Diptera	Muscidae	*Musca*	*Musca (Byomya) endeni* Nandi & Sinha
322	Diptera	Muscidae	*Musca*	*Musca (Byomya) pattoni* Austen
323	Diptera	Muscidae	*Musca*	*Musca (Byomya) sorbens* Wiedemann
324	Diptera	Muscidae	*Musca*	*Musca (Byomya) ventrosa* Wiedemann
325	Diptera	Muscidae	*Musca*	*Musca (Eumusca) hervei* Villeneuve
326	Diptera	Muscidae	*Musca*	*Musca (Eumusca) seniorwhitei* Patton
327	Diptera	Muscidae	*Musca*	*Musca (Musca) domestica* Linnaeus
328	Diptera	Muscidae	*Musca*	*Musca (Philaematomyia) crassirostris* Stein
329	Diptera	Muscidae	*Orthellia*	*Orthellia indica* (Robineau-Desvoidy)
330	Diptera	Muscidae	*Orthellia*	*Orthellia lauta* (Wiedemann)
331	Diptera	Muscidae	*Orthellia*	*Orthellia timorensis* (Robineau- Desvoidy)
332	Diptera	Muscidae	*Muscina*	*Muscina stabulans* (Fallen)
333	Diptera	Muscidae	*Ophyra*	*Ophyra leucostoma* (Wiedemann)

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334	Diptera	Muscidae	*Synthesiomyia*	*Synthesiomyia nudiseta* (Van der Wulp)
335	Diptera	Muscidae	*Gymnodia*	*Gymnodia tonitrui* (Wiedemann)
336	Diptera	Muscidae	*Lispe*	*Lispe pumila* (Wiedemann)
337	Diptera	Muscidae	*Haematobia*	*Haematobia irritans exigua* de Mejire Sagar
338	Diptera	Muscidae	*Stomoxys*	*Stomoxys calcitrans* (Linnaeus)
339	Diptera	Muscidae	*Stomoxys*	*Stomoxys indica* Picard
340	Diptera	Caliphoridae	*Hemipyrellia*	*Hemipyrellia ligurriens* (Wiedemann)
341	Diptera	Caliphoridae	*Hemipyrellia*	*Hemipyrellia pulchra* (Wiedemann)
342	Diptera	Caliphoridae	*Calliphora*	*Calliphora (Calliphora) vicina* Robineau-Desvoidy
343	Diptera	Caliphoridae	*Chrysomya*	*Chrysomyia bezziana* Villeneuve
344	Diptera	Caliphoridae	*Chrysomya*	*Chrysomya megacephala* (Fabricius)
345	Diptera	Caliphoridae	*Idiella*	*Idiella mandarina* (Wiedemann)
346	Diptera	Sarcophagidae	*Parasarcophaga*	*Parasarcophaga (Liopygia) ruficornis* (Fabricius)
347	Diptera	Sarcophagidae	*Parasarcophaga*	*Parasarcophaga (Liosarcophaga) choudhuryi* Sinha & Nandi,
348	Diptera	Sarcophagidae	*Parasarcophaga*	*Parasarcophaga (Liosarcophaga) dux* (Thomson)
349	Diptera	Sarcophagidae	*Parasarcophaga*	*Parasarcophaga (Parasarcophaga) albiceps* (Meigen)
350	Diptera	Sarcophagidae	*Parasarcophaga*	*Parasarcophaga (Parasarcophaga) misera* (Walker)
351	Diptera	Sarcophagidae	*Liproctia*	*Liproctia lothianensis* Sinha & Nandi
352	Diptera	Sarcophagidae	*Leucomyia*	*Leucomyia cinerea* (Fabricius)
353	Coleoptera	Carabidae	*Pheropsophus*	*Pheropsophus cetorei*
354	Coleoptera	Carabidae	*Pachytrachelus*	*Pachytrachelus oblongus* (Dejean)
355	Coleoptera	Cerambycidae	*Xystrocera* Serville	*Xystrocera globosa* Olivier
356	Coleoptera	Cerambycidae	*Ceresium* Newmann	*Ceresium zeylanicum* White
357	Coleoptera	Cerambycidae	*Diorthus*	*Diorthus emeritus* Whiti
358	Coleoptera	Cerambycidae	*Derolus*	*Derolus discicollis* Gahan
359	Coleoptera	Cerambycidae	*Macrotoma* Serville	*Macrotoma plagiata*
360	Coleoptera	Cerambycidae	*Gelonaetha*	*Gelonaetha hirta* Fairmine
361	Coleoptera	Cicindelidae	*Cicindela*	*Cicindela erudata* Wiedemann
362	Coleoptera	Cicindelidae	*Cicindela*	*Cicindela biromasa* Fabricius
363	Coleoptera	Cicindelidae	*Cicindela*	*Cicindela quadrilineata* Fabricius
364	Coleoptera	Cicindelidae	*Cicindela*	*Cicindela sexpunctata* Fabricius
365	Coleoptera	Cicindelidae	*Cicindela*	*Cicindela haemorrhoidalis* Wied
366	Coleoptera	Dytiscidae	*Hydrocoptus*	*Hydrocoptus subvittulus* Mots.
367	Coleoptera	Dytiscidae	*Canthydrus*	*Canthydrus flavus* (Motschulsky)

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368	Coleoptera	Dytiscidae	*Canthydrus*	*Canthydrus morsbachi* (Wehncke)
369	Coleoptera	Dytiscidae	*Laccophilus*	*Laccophilus anticatus* Sharp
370	Coleoptera	Dytiscidae	*Laccophilus*	*Laccophilus basalis* Motscholsky
371	Coleoptera	Dytiscidae	*Laccophilus*	*Laccophilus chinensis inefficiens* Walker
372	Coleoptera	Dytiscidae	*Laccophilus*	*Laccophilus parvulus* Aube
373	Coleoptera	Dytiscidae	*Hydrovatus*	*Hydrovatus bonvouloiri* Sharp
374	Coleoptera	Dytiscidae	*Hydrovatus*	*Hydrovatus fusculus* Sharp
375	Coleoptera	Dytiscidae	*Hydrovatus*	*Hyphoporus aper* Sharp
376	Coleoptera	Dytiscidae	*Peschetius*	*Peschetius quadricostatus* Aube
377	Coleoptera	Dytiscidae	*Fretes*	*Fretes sticticus* (Linnaeus)
378	Coleoptera	Dytiscidae	*Hydaticus*	*Hydaticus (G.) fabricii* Macleay
379	Coleoptera	Dytiscidae	*Hydaticus*	*Hydaticus (G.) luzonicus* Aube
380	Coleoptera	Dytiscidae	*Cybister*	*Cybister (M.) confusus* Sharp
381	Coleoptera	Dytiscidae	*Cybister*	*Cybister (M.) guerini* Aube
382	Coleoptera	Dytiscidae	*Cybister*	*Cybister (M.) limbatus* (Fabricius)
383	Coleoptera	Dytiscidae	*Cybister*	*Cybister (M.) ventralis* Sharp
384	Coleoptera	Gyrinidae	*Orectochilus*	*Orectochilus similis* Ochs
385	Coleoptera	Gyrinidae	*Orectochilus*	*Orectochilus haemorrhous* Regimbart
386	Coleoptera	Gyrinidae	*Orectochilus*	*Orectochilus ribeiroi* Vazirani
387	Coleoptera	Hydrophilidae	*Sternolophus*	*Sternolophus rufipes* (Fabricius)
388	Coleoptera	Hydrophilidae	*Spercheus*	*Spercheus gibbus* Champion
389	Coleoptera	Hydrophilidae	*Sphaeridiun*	*Sphaeridiun cameroni* d'Orchymond
390	Coleoptera	Hydrophilidae	*Helochares*	*Helochares luntus* Sharp
391	Coleoptera	Silvanidae	*Oryzaephilus*	*Oryzaephilus mercator* (Fauvel)
392	Coleoptera	Scarabaeidae	*Adoretus*	*Adoretus lacustris* Arrow
393	Coleoptera	Scarabaeidae	*Adoretus*	*Adoretus gemmifer* Arrow
394	Coleoptera	Scarabaeidae	*Glycosia*	*Glycosia tricolor* Oliver
395	Coleoptera	Scarabaeidae	*Heliocopris*	*Heliocopris gigas* (Linnaeus)
396	Coleoptera	Scarabaeidae	*Heterorychus*	*Heterorychus lioderes* Retd.
397	Coleoptera	Scarabaeidae	*Onthophagus*	*Onthophagus quadridentatus* (Fabricius)
398	Coleoptera	Scarabaeidae	*Phyllognathus*	*Phyllognathus dionysius* (Fabricius)
399	Coleoptera	Bostrichidae	*Heterobostrichus*	*Heterobostrichus aequalis* Watson
400	Coleoptera	Bostrichidae	*Rhizopertha*	*Rhizopertha dominica* (Fabricius)
401	Coleoptera	Tenebrionidae	*Alphitobius*	*Alphitobius diaperinus* (Panz.)
402	Coleoptera	Chrysomelidae	*Dicladispa*	*Dicladispa armigera* (Olivier)
403	Coleoptera	Chrysomelidae	*Dactylispa*	*Dactylispa armigera* (Fabricius)
404	Coleoptera	Curculionidae	*Tanymecus*	*Tanymecus albomarginatus* Gyl.
405	Coleoptera	Curculionidae	*Tanymeans*	*Tanymeans albomarginatus* Gyl.
406	Coleoptera	Curculionidae	*Platypus*	*Platypus maritimus* Schedl
407	Coleoptera	Curculionidae	*Xyleborus* Eichhoff	*Xyleborus cognatus* Blanford

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408	Coleoptera	Scolytidae	*Coccotrypes* Eichhoff	*Coccotrypes nepheli* (Eggers)
409	Coleoptera	Coccinellidae	*Brumus*	*Brumus suturalis* (Fab.)
410	Coleoptera	Coccinellidae	*Pseudaspidi-merus*	*Pseudaspidimerus circumflexa* var. testaceus (Weise)
411	Coleoptera	Coccinellidae	*Rodolia*	*R. fumida var. roseipennis* Muls.
412	Coleoptera	Coccinellidae	*Coccinella*	*Coccinella transversalis* Fab
413	Coleoptera	Coccinellidae	*Menochilus*	*Menochilus sexmaculatus* (Fab.)
414	Coleoptera	Coccinellidae	*Oenopia*	*Oenopia luteopustulata* Mulsant
415	Coleoptera	Coccinellidae	*Micraspis*	*Micraspis discolor* (Fab.)
416	Coleoptera	Coccinellidae	*Afidenta*	*Afidenta mimetica ssp. simplex* Dieke
417	Coleoptera	Coccinellidae	*Epilachna*	*Epilachna dodecastigma* (Weidmann)
418	Coleoptera	Coccinellidae	*Epilachna*	*Epilachna septima* Dieke
419	Coleoptera	Coccinellidae	*Epilachna*	*Epilachna viginitioctopunctata* (Fab.)
420	Coleoptera	Meloidae	*Mylabris*	*Mylabris cichorii* (Linnaeus)
421	Coleoptera	Meloidae	*Mylabris*	*Mylabris phalerata* (Pallas)
422	Coleoptera	Meloidae	*Mylabris*	*Mylabris thunbergi* Billbarg
423	Coleoptera	Tenebrionidae	*Gonocephalum*	*Gonocephalum depressum*
424	Coleoptera	Tenebrionidae	*Anthracius*	*Anthracius punctipennis*
425	Coleoptera	Tenebrionidae	*Stenosis*	*Stenosis medinipurensis n* .sp.
426	Coleoptera	Chrysomelidae	*Lema*	*Lema lacertosa* Lacord
427	Coleoptera	Chrysomelidae	*Diapromorpha*	*Diapromorpha pallens* (Fabricius)
428	Coleoptera	Chrysomelidae	*Cryptocephalus*	*Cryptocephalus sehestedti* Fabricius
429	Coleoptera	Chrysomelidae	*Pachnephorus*	*Pachnephorus lewisii* Baly
430	Coleoptera	Chrysomelidae	*Platycorynus*	*Platycorynus pyrophorus* (Parry)
431	Coleoptera	Chrysomelidae	*Chrysolina*	*Chrysolina conglomerata* Maulik
432	Coleoptera	Chrysomelidae	*Gallerucella*	*Gallerucella placida* Baly
433	Coleoptera	Chrysomelidae	*Oides*	*Oides maculata* (Olivier)
434	Coleoptera	Chrysomelidae	*Oides*	*Oides flava* (Olivier)
435	Coleoptera	Chrysomelidae	*Hoplasoma*	*Hoplasoma unicolor* (Illiger)
436	Coleoptera	Chrysomelidae	*Aulacophora*	*Aulacophora foveicollis* (Lucas)
437	Coleoptera	Chrysomelidae	*Aulacophora*	*Aulacophora excavata* Baly
438	Coleoptera	Chrysomelidae	*Aulacophora*	*Aulacophora lewisii* Baly
439	Coleoptera	Chrysomelidae	*Medythia*	*Medythia nigrobilineata* (Mots.)
440	Coleoptera	Chrysomelidae	*Monolepta*	*Monolepta orientalis* Jacoby
441	Coleoptera	Chrysomelidae	*Monolepta*	*Monolepta bifasciata* (Hornst.)
442	Coleoptera	Chrysomelidae	*Monolepta*	*Monolepta signata* (Oliv.)
443	Coleoptera	Chrysomelidae	*Monolepta*	*Monolepta limbata* (Oliv.)
444	Coleoptera	Chrysomelidae	*Sphenoraia*	*Sphenoraia bicolor* (Hope)
445	Coleoptera	Chrysomelidae	*Aspidomorpha*	*Aspidomorpha indica* Boh.
446	Coleoptera	Chrysomelidae	*Aspidomorpha*	*Aspidomorpha furcata* (Thunberg)

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447	Coleoptera	Chrysomelidae	*Aspidomorpha*	*Aspidomorpha miliaris* (F.)
448	Coleoptera	Chrysomelidae	*Laccoptera*	*Laccoptera quadrimaculata* (Thun.)
449	Coleoptera	Chrysomelidae	*Oocassida*	*Oocassida obscura* (F.)
450	Coleoptera	Chrysomelidae	*Chiridopsis*	*Chiridopsis bipunctata* (Linn.)
451	Coleoptera	Chrysomelidae	*Cassida*	*Cassida enervis* Boh.
452	Coleoptera	Chrysomelidae	*Cassida*	*Cassida circumdata* Herbst
453	Hymenoptera	Apidae	*Apis*	*Apis dorsata*
454	Hymenoptera	Apidae	*Apis*	*Apis mellifera*
455	Hymenoptera	Vespidae	*Polistes*	*Polistes olivaceus* (De Geer, 1773)
456	Hymenoptera	Vespidae	*Polistes*	*Polistes rothneyi rothneyi* Cameroon, 1900
457	Hymenoptera	Vespidae	*Polistes*	*Polistes nigritarsis* Cameroon, 1900
458	Hymenoptera	Vespidae	*Polistes*	*Polistes stigma tamula* (Fabricius, 1798)
459	Hymenoptera	Vespidae	*Polistes*	*Polistes sagittarius* Saussure,1853
460	Hymenoptera	Vespidae	*Ropalidia*	*Ropalidia marginata marginata* (Lepeletier,1836)
461	Hymenoptera	Vespidae	*Ropalidia*	*Ropalidia artifex artifex* (Saussure, 1853)
462	Hymenoptera	Vespidae	*Ropalidia*	*Ropalidia stigma stigma* (Smith, 1858)
463	Hymenoptera	Vespidae	*Parapolybia*	*Parapolybia varia* (Fabricius, 1787)
464	Hymenoptera	Vespidae	*Vespa*	*Vespa basilis* Smith,1852
465	Hymenoptera	Vespidae	*Vespa*	*Vespa tropica tropica* (Linnaeus, 1758)
466	Hymenoptera	Vespidae	*Vespa*	*Vespa tropica leefmansi* van der Vecht, 1959
467	Hymenoptera	Scoliidae	*Campsomeriella*	*Campsomeriella collaris collaris* (Fabricius)
468	Hymenoptera	Scoliidae	*Scolia*	*Scolia cianipennis* Fabricius
469	Hymenoptera	Scoliidae	*Scolia*	*Scolia affinis* Guerin
470	Hymenoptera	Formicidae	*Aenictus*	*Aenictus clavitibia* Forel
471	Hymenoptera	Formicidae	*Bothroponera*	*Bothroponera tesserinoda* (Emery)
472	Hymenoptera	Formicidae	*Diacamma*	*Diacamma rugosum* var. *sculptum* (Jerdon)
473	Hymenoptera	Formicidae	*Diacamma*	*Diacamma vagans* (Smith)
474	Hymenoptera	Formicidae	*Leptogenys*	*Leptogenys chinensis* (Forel)
475	Hymenoptera	Formicidae	*Leptogenys*	*Leptogenys kitteli* Forel
476	Hymenoptera	Formicidae	*Ponera*	*Ponera* sp.
477	Hymenoptera	Formicidae	*Tertaponera*	*Tertaponera rufonigira* (Jerdon)
478	Hymenoptera	Formicidae	*Meranoplus*	*Meranoplus rothneyi* Forel
479	Hymenoptera	Formicidae	*Messor*	*Messor barbarus* Linnaeus
480	Hymenoptera	Formicidae	*Oligomyrmex*	*Oligomyrmex rothneyi* Forel
481	Hymenoptera	Formicidae	*Pheidole*	*Pheidole spathifera* Forel
482	Hymenoptera	Formicidae	*Solenopsis*	*Solenopsis geminata* (Fabricius)
483	Hymenoptera	Formicidae	*Camponotus*	*Camponotus angustata* (Mayr)
484	Hymenoptera	Formicidae	*Camponotus*	*Camponotus compressus* (Fabricius)
485	Hymenoptera	Formicidae	*Camponotus*	*Camponotus oblongus* (Smith)

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486	Hymenoptera	Formicidae	*Camponotus*	*Camponotus rothneyi* (Forel)
487	Hymenoptera	Formicidae	*Camponotus*	*Camponotus rufoglaucus dolenda* (Forel)
488	Hymenoptera	Formicidae	*Camponotus*	*Camponotus sericeus* (Fabricius)
489	Hymenoptera	Formicidae	*Polyrhachis*	*Polyrhachis tubericeps* Forel
490	Hymenoptera	Formicidae	*Acantholepis*	*Acantholepis frauenfeldi* (Mayr)
491	Hymenoptera	Formicidae	*Plagiolepis*	*Plagiolepis dichroa* Forel
492	Hymenoptera	Ichneumonidae	*Echthromorpha*	*Echthromorpha agrestoria notulatoria* (Fabricius)
493	Hymenoptera	Ichneumonidae	*Xanthopimpla*	*Xanthopimpla sikkimensis* Cameron
494	Hymenoptera	Ichneumonidae	*Leptobatopsis*	*Leptobatopsis indica* (Cameron)
495	Hymenoptera	Ichneumonidae	*Menaforia*	*Menaforia indica* Gupta & Saxena
496	Hymenoptera	Braconidae	*Chelonus*	*Chelonus heliope* Gupta
497	Hymenoptera	Braconidae	*Bracon*	*Bracon famulus* Bingham

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2.14 COASTAL FISHES

The Sundarbans have numerous rivers, creeks, and channels which form important fish resources.

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32500
extant fishes

It is bounded on the west by the Hooghly River and on the east by the Saptamukhi River. From east of Calcutta flows the Bidyadhari, which along with other streams forms the river Matla. The Kankalmari River joins Matla downstream. The other main rivers are Gosaba and the Harinbhanga. The Raimangal River flows along the Indo-Bangladesh boundary. Such an environment provides an ideal environment for fish diversity (figure 1).

The term 'fish' precisely descri- bes any non-tetrapod craniate (that is, an animal with a skull and, in most cases, a backbone) that has gills throughout life and whose limbs, if any, are in the shape of fins (Nelson 2006). Unlike groupings such as birds or mammals, fish are not a single clade but a paraphyletic collection of taxa, including hagfishes, lampreys, sharks and rays, ray-finned fishes, coelacanths, and lungfishes (Helfman et al. 1997).

Fish come in many shapes and sizes. Tuna, swordfish, and some species of sharks show some warm-blooded adaptations; they can heat their bodies significantly above ambient water temperature. Streamlining and swimming performance varies from fish such as tuna, salmon, and jacks that can cover 10–20 body-lengths per second to species such as eels and rays that swim no more than 0.5 body-lengths per second. Many groups of freshwater fish extract oxygen from the air as well as from the water using a variety of different structures. Lungfish have paired lungs similar to those of tetrapods; gouramis have a structure called the labyrinth organ that performs a similar function, while many catfish such as *Corydoras* extract oxygen through the intestine or stomach (Moyle and Cech 2003). Body shape and the arrangement of the fins are highly variable, covering such seemingly un-fishlike forms as seahorses, pufferfish, anglerfish, and gulpers. Similarly, the surface of the skin may be naked (as in moray eels) or covered with scales of different types, usually defined as placoid (typical of sharks and rays); cosmoid (fossil lungfishes and coelacanths); ganoid (various fossil fishes but also living gars and bichirs); cycloid; and ctenoid (these last two are found on most bony fish). There are even fishes that live mostly on land, for example, mudskippers. They feed and interact with one another on mudflats and go underwater to hide in their burrows (Froese et al. 2006).

The living fishes belong to class Infraphylum Gnathostomata (jawed vertebrates); the cartilaginous fishes belong to class Chondrichthyes; and the bony fishes belong to class Actinopterygii (ray-finned fish) and class Sarcopterygii (lobe-finned fish), under the superclass Osteichthyes (Nelson 2006). There are almost 28,000 known extant species, of which almost 27,000 are bony fish, with 970 sharks, rays, and chimeras and about 108 hagfishes and lampreys. About 64 families are monotypic, containing only one species. The total of extant species may grow to exceed 32,500 (Nelson 2006).

OVERVIEW

1442
SPECIES RECORDED FROM INDIA

Nelson (2006) estimated 27,977 valid species of fishes world over under 62 orders, 515 families, and 4,494 genera, and the eventual number of extant fish species is projected to be close to 32,500. About 11,952 species or 42.72 percent normally live in freshwater lakes and rivers that cover only 1 percent of the earth's surface and account for a little less than 0.01 percent of its water. The secondary freshwater species numbers 12,457 and the remaining 3,568 species are exclusively marine.

The Indian subcontinent harbors rich ichthyofaunal diversity, comprising about 2,500 species (Talwar 1991), of which 930 species are freshwater inhabitants and 1,570 are marine. The Indian species represent about 11.72 percent of the known fish species of the world (Lakra et. al. 2010).

Species composition and community structure vary from east to west and along the hydrological and salinity gradients (Gopal and Chauhan 2006). Jhingran (1977) recorded a total of 172 species from a variety of sources and also mentioned that the diversity of the Hooghly-Matlah estuary increases along an increasing salinity gradient. Numerous species (estimated to be 400) are known to use mangrove swamps in India as nursery grounds (Gundermann and Popper 1984; McConnell 1987). The number of fish species in the world, India, and the Sundarbans is shown in table 1.

Table-1: Comparison between the Number of Fish Species in World, India and the Sundarbans:

Group	No. of available species				
	World	India	Percentage	Sundar-bans	Percentage
Fishes	29977 (Nelson, 2006)	2500 (Talwar, 1991)	About 11.72% of world spe-cies (Lakra et. al., (2010)	364	About 14.56 % of Indian species About 1.21% of World spe-cies

The Indian Sundarbans at the apex of the Bay of Bengal (between 21°40′ N, 88°03′ E and 22°40′ N, 89°07′ E) located on the southern fringe of West Bengal, on the northeast coast of India, is a dynamic environment with a complex of features and biogeochemical properties. The aquatic biodiversity in the Sundarbans delta is largely controlled by freshwater flux, nutrient inputs, and changing environmental conditions such as salinity and temperature. Plankton communities are generally well studied in the deltaic ecosystem over a time scale encompassing more than three decades and show patterns or trends similar to those found in other man -grove ecosystems at a regional and global scale.

SUMMARY

Diversity

The dynamics of the fish communities of the Sundarbans are poorly understood (Rainboth, 1990). Although there are many published works on the fish fauna of different states of India including that of West Bengal, there is no comprehensive account of the fishes recorded from the Sundarbans. However, the works of Talwar et al. (1992); Mukherjee (1995); Das and Nandi (1999); and Gopal and Chauhan (2006) report the fish diversity of the Sundarbans. Compilations of the species listed in these works reveal that 364 species distributed under 215 genera are available in the Sundarbans as against 4,494 genera world over.

364 SPECIES ARE DISTRIBUTED UNDER 215 GENERA

It was hypothesized that fish assemblages would vary between mangroves and mudflats and that species richness and abundance would decrease with increasing distance from the mangrove forest. Patterns were expected to be species specific, that is, some species are found in higher numbers in mangroves and others are more abundant in mudflat habitats (Payne and Gillanders 2009).

Species Richness and Functional Groups

Functional type classification is a contemporary topic at the forefront of ecology throughout the world. The species guild is frequently cited as an ecological entity but lacks any formal or testable definition (Adams 1985). A review of literatures worldwide shows that functional groups in fishes have been formed on the basis of diet similarity, namely piscivores, benthivores, planktivores, and so on. Functional guilds of the species representing their families are listed in the annexure.

Gopal and Chauhan (2006) reported 250 fish species from the Indian Sundarbans. Among fin fish, the highly priced Hilsa (*Hilsa ilisha*), Bhetki (*Lates calcarifer*), Bhangon (*Liza tade*), and Mullets (*Liza parsia*) form a lucrative fishery of this region. About 400 fish species (pelagic and demersal) are reportedly available in the combined Sundarbans (India and Bangladesh). The largest fishing ground in the Bay of Bengal is close to the Sundarbans.

A list of the fish species recorded from the Indian Sundarbans is given in the annexure. Table 2 lists the fish families recorded from the Sundarbans together with the number of species under each of them.

Table-2: List of the fish families recorded from the Sundarbans together with the number of species

Sl. No.	Family	No. of Sp.	Sl. No.	Family	No. of Sp.
1	Hemiscyllidae	2	41	Rachycentridae	1
2	Stegostomatidae	1	42	Carangidae	19
3	Rhincodontidae	1	43	Coryphaenidae	1
4	Proscylliidae	1	44	Parastromateidae	1
5	Carcharhinidae	9	45	Leiognathidae	10
6	Sphyrnidae	1	46	Lutjanidae	4
7	Pristidae	3	47	Lobotidae	1
8	Torpedinidae	4	48	Gerreidae	4
9	Rhinobatidae	6	49	Haemulidae	4
10	Dasyatidae	7	50	Sparidae	3
11	Gymnuridae	2	51	Nemipterydae	3
12	Myliobatidae	2	52	Sciaenidae	25
13	Elopidae	1	53	Mullidae	2
14	Megalopidae	1	54	Toxotidae	1
15	Anguillidae	2	55	Ephippididae	4
16	Moriguidae	2	56	Scatophagidae	1
17	Muraenidae	10	57	Mugilidae	11
18	Muraenesocidae	4	58	Sphyraenidae	2
19	Ophichthidae	3	59	Polynemidae	7
20	Clupeidae	12	60	Uranoscopidae	1
21	Pristigasteridae	8	61	Callionymidae	5
22	Engraulidae	16	62	Blennidae	2
23	Chirocentridae	1	63	Eleotridae	8
24	Ariidae	15	64	Gobiidae	47
25	Harpadontidae	1	65	Kurtidae	1
26	Synodontidae	1	66	Siganidae	2
27	Bregmacerotidae	1	67	Trichiuridae	6
28	Antennariidae	1	68	Scombridae	3
29	Hemiramphidae	7	69	Stromateidae	2
30	Belonidae	3	70	Psettodidae	1
31	Fistulariidae	1	71	Citharidae	1
32	Syngnathidae	1	72	Bothidae	5
33	Synanceiidae	2	73	Cynoglossidae	9
34	Platycephalidae	1	74	Soleidae	6
35	Ambassidae	2	75	Triacanthidae	3
36	Centropomidae	1	76	Balistidae	1
37	Serranidae	3	77	Ostraciidae	1
38	Teraponidae	3	78	Tetraodontidae	11
39	Sillaginidae	2			
40	Lactaridae	1			

Distribution and Local Community Dependencies

The Sundarbans at present has an estimated water area of 27,085.39 ha under fishing and 19,390.73 ha under aquaculture in its northern and southern parts, respectively (Das 2009). The estimated total number of inland fisherfolk families in the 24-Parganas South District is 52,917 and 50,897 in the 24-Parganas North District (Government of West Bengal 2005). The 24-

Parganas South District has a marine fisherfolk population of 269,565, with an active fisher population of 70,750, located in 237 villages (CMFRI 2005). Some of the popular commercial fishes are listed in table 3.

Table 3: Commercially important fishes

Scientific name	Common Name	Local name
Lates calcarifer	Sea perches	Bhetki
Johnius spp.	Croakers	Bhola
Mugil cephalus	Mullets	Parse
Polynemus spp.	Threadfins	Tapse
Pampus spp.	Pomfrets	Pomfret
Hilsa ilisha	Hilsa	Ilish
Trichiurus spp.	Ribbonfishes	Rupabati, Patia
Harpadon nehereus	Bombay duck	Nehara, Lote
Cynoglossus spp.	Tongue soles	Pata machh
Arius spp.	Sea cat fishes	Kanta
Mystus spp.	Cat fishes	Tangra
Parastromateus niger	Black pomfret	Baul
Setipinna phasa	Anchovies	Phyasa, Tapra
Coilia dussumieri	Anchovies	Ruli

During winter, a large number of fishermen migrate in groups from different areas of the Hoogly-Matla estuary to practice traditional fishing. They move to suitable areas near the sea or in lower zones to establish fishing camps and remain engaged in bag net fishing till early February. Traditional fishers use rowboats or boats with small diesel engines while fishing in rivers and creeks. Estimation of the number of fishing boats in the region is very difficult as the smaller boats require no registration or license except when fishing within the protected area (Danda 2007).

Sarkar (2009) highlights the processes and procedures of the indigenous fishing communities through time and space to grapple with the eco-environmental setting in making their living through uninterrupted fishing operations. Around 2,069 km^2 inside the SBR is considered ideal for riverine fishing using traditional methods (Mukherjee 2007). The Sundarbans being the nursery for nearly 90 percent of the aquatic species of the eastern coast, the coastal fishery of eastern India is dependent upon the Sundarbans (Chandra et al. 2003). Since fishes are active swimmers, they are not confined to particular blocks; all riverine fishes are distributed in all blocks of South 24-Parganas and North 24-Parganas parts of the Sundarbans and coastal fishes are distributed in all blocks of South 24-Parganas. Brackish-water fish farms (*bheries*) are predominant in North 24-Parganas District. Block-wise distribution of important fish landing centers, fishing harbors, and *bheries* are shown in table 4.

Table-4: Distribution of important fish landing centers, fishing harbours and 'bheries'

Blocks	Important Fish Landing Centers	Fishing harbours	Large scale 'Bheries'
Sagar	-	+	-
Namkhana	+	+	-
Patharpra-tima	+	+	-
Mathurapur-I	-	-	-
Mathurapur-II	+	-	-
Canning-II	+	-	-
Kakdwip	+	+	-
Sandesh-khali-I	-	-	+
Sandesh-khali-II	-	-	+
Haroa	-	-	+
Mina-khan	-	-	+

Note: '+' denotes predominant

The main areas of traditional fishing (migratory bag net fishery) are Sagar Island, Frasergunj, Bakkhali, and Kalisthan. The significant inland fish landing centers in the Sundarbans include Canning, Herobhanga, and Gosaba. Other landing centers deemed important by the Fisheries Department, where traditional fishing is predominant, are Kakdwip, Frazerganj, Buroburir tath, Bakkhali, Namkhana, Jambu Island, Chemaguri, Hatipitha, Maragoli, Haribhanga, Sagar, Shikarpur, Gobindapur, Bankimpur, Boatkhali, Roydighi, Domkhal, Sitarampur, and Kakramari.

Block-wise location of traditional fishing zones and important fish landing centers are shown in figure 1. Sorting of commercial catches and some fish and prawns are shown in figures 2 and 3. Different types of traditional gears used in the inland waters of Sundarbans (Mukherjee 2007) are shown in figure 4. In 2005–06, West Bengal recorded the highest fish production in India of 1.2 million tons, of which 1.09 million tons were from inland resources (Government of India 2006).

Fig.1: Rivers and location of important inland fish landing centers and traditional inland fishing zones in Sundarban Biosphere Reserve

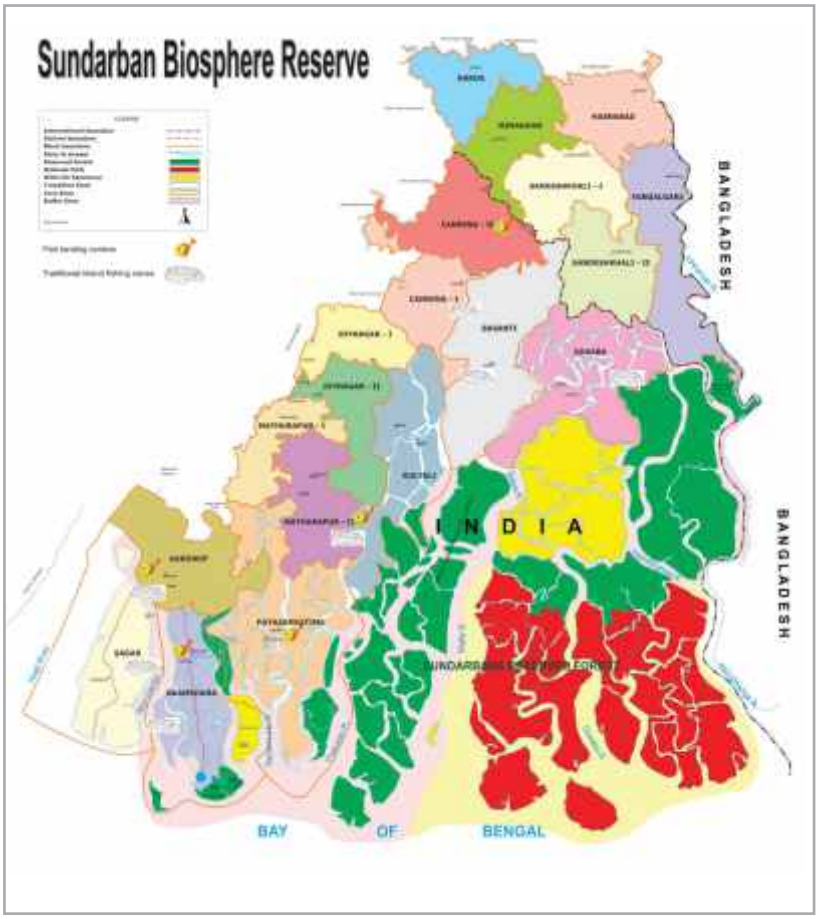

Fig.2 - Sorting of fishes

Fig.3 - A collection of prawn

Fig.4: Traditional fishing nets (after Mukherjee, 2007)

A large section of the poor tribal population of the Sundarbans, especially the females and minors living far below subsistence level, are engaged in the practice of spawn collection of *Penaeus monodon* and *Penaeus indicus* during daily tides using unscientific gears like mosquito nets (figure 5). A number of individual groups of commercial fishermen and multinational companies are collecting large-scale commercial catch from the vast coastal, estuarine, and deep-sea zone of the Sundarbans throughout the year. The fish-landing stations at Canning, Raidighi, Diamond Harbour, Kakdwip, and Namkhana are for the latest fishing crafts and gears like big bull trawlers; mechanized boats; and polyvinyl chloride (PVC) trawl, gill, and bag nets. Built-in slaughting-washing units and artificial units are collectively helping in profitable export-based fishing economy as well as in degrading the sensitive aqua-mangrove ecosystem of the Sundarbans (Das 2009).

Fisheries in the Sundarbans are based on both inland and marine fisheries' resources. West Bengal is the highest fish-producing state of India and in 2002–03, 11.20 lakhs metric tons of fish were exported earning 5331.34 million of rupees. In this coastal terrain, there is vast scope for shrimp-based polyculture. Fisheries extension programs need to be strengthened through the active involvement of fisherfolk working in inland, brackish-water, and marine sectors; industrialists; end users; the Fisheries Department; universities; research institutes; and nongovernmental organizations. The new infrastructural facilities, such as six new fishing harbors, are being set up by the Fisheries Department, complete with cold storage facilities, packaging centers, and modern fish markets at Frazerganj, Diamond Harbour, Kakdwip, Sagar, and Patharpratima. Construction works have already been completed at Frazerganj and Diamond Harbour. These harbors together will provide export opportunities to fish farmers and fish sellers (*Fish Biz Bonanza to Boost State* 2003).

STATUS AND THREATS

Six fish species of the Sundarbans are under the Indian Wildlife (Protection) Act, 1972. Schedule-I Part 2 (A) Fishes (Lakra et al. 2010). According to the IUCN Red List of all life forms, 16,928 species are threatened globally and of these, 1,275 species are fishes. Further, out of 659 globally threatened Indian fauna, 42 species belong to fishes according to the IUCN classification under different categories. Eight fish species from the Sundarbans are in this list. The Convention on International Trade in Endangered Species (CITES) Appendices II includes two species of fishes common to the Sundarbans, namely *Pristis microdon* and *Rhincodon typus* (table 5).

Table- 5: Protection regime of Fish in Sundarbans.

Sr. No.	Name	Schedules of Wildlife (Protection) Act 1972	IUCN Red Data Book	CITES appendices
1	*Anoxypristis cuspidata* : (Knifetooth Sawfish)	I	Critically Endangered	-
2	*Aetomylaeus nichofii* (Banded Eagle Ray)	-	Vulnerable	-
3	*Carcharhinus hemiodon* (Pondicherry Shark)	-	Critically Endangered	-
4	*Glyphis gangeticus* (Ganges Shark)	I	Critically Endangered	-
5	*Himantura fluviatilis* (Ganges Stingray)	I	Endangered	-
6	*Pristis pectinata* (Wide Sawfish)	-	Critically Endangered	-
7	*Pristis microdon* (Largetooth Sawfish)	I	Critically Endangered	II
8	*Rhincodon typus* (Whale Shark)	I	Vulnerable	II
9	*Rhina ancylostoma* (Bowmouth Guitarfish)	-	Vulnerable	-
10	*Rhinobatos obtusus* (Widenose Guitarfish)	-	Vulnerable	-
11	*Rhynchobatus djiddensis* (Whitespotted Wedgefish)	I	Vulnerable	-

Limited extraction of mangroves for fuelwood and poles is an old practice. However, in the revenue areas, the destruction of mangroves is conspicuous and at places the area has been reclaimed for agriculture as well as for settlement. The extent and condition of the crop and the threat to such mangrove areas need to be assessed. The problems of marine and estuarine fisheries in the Sundarbans can be categorized into the following groups:

- **Indiscriminate seed collection and bycatch.** Thousands of untrained workers who collect shrimp fry from the sea, channels, and rivers cause significant losses to the fry of other fishes. Frequently, collectors discard non-shrimp fry, perhaps one of the main causes of a gradually declining supply of different natural fish (Baer 2001). In a study in the SBR, it was found that to catch 1 tiger prawn seed in the Sundarbans, collectors destroyed juveniles of 161 other prawns, 7 fishes, 30 crabs, 1 mollusc, and 8 unidentified meroplanktons (Das and Nandi 1999).
- **Lack of post-harvest and other infra-structure.** Proper storage, preservation, and prompt disposal or transport service are essential (Yadava 2004).
- **Water pollution.** The current environmental status of the Sundarbans water systems is relatively poor. A mixture of domestic sewage and industrial waste is discharged into the canal systems of Kolkata and these waters eventually reach the Sundarbans and are responsible for the accumulation of heavy metals and the presence of organic pollutants in the tissue of fish (ADB 2003). The river channels of the Sundarbans have experienced high rates of deterioration largely due to this sewage discharge. Choudhury and Choudhury (1994) note that the Bidhadhari and Piali Rivers have been transformed into dead water bodies and these waters have experienced the knock-on impact of affecting the Matla River. The same review notes the steady degradation of fisheries resources in the Ichhamati, Bidyadhari, Kalagachia, Matla, Moni, Satumukhi, and Hataniadoania waterways. Agricultural runoff and effluents from fish farms are thought to be responsible for increased levels of eutrophication in the Indian Sundarbans and are also thought to be the cause of dinoflagellate blooms that are now a common phenomenon in the coastal waters of West Bengal (Mukherjee et al. 2007).
- **Impact of coastal aquaculture (*bheri* fishing).** Local fishermen have converted many coastal swamps into *bheries*, that is, artificial enclosures for taking the tidal saline water in and out through sluices from nearby rivers for commercial pisciculture. Sinha (1998) reports that 1,392 *bheries* covering 43,000 ha are operative in the Sundarbans.

Fig.5 - Collection of prawn seeds

Table 6: Magnitude of commercial coastal fishing in southern Sundarbans

Police Station	Total production in Kgs (1997-'98)	No. of Vessels	Distance of Fishing trips	No. of Trips/ months	Capacity Of Vessels
Canning	50,40, 000	Trawlers-10 Mechanized Boats-12	60 kms (monsoon), 100 kms (winter).	7 days x 4 trips(monsoon), 15 days x 2 trips (winter).	8000 kgs.
Diamond Harbour	151,60,000	Trawler-100 Mechanized boats-60	25 kms. (monsoon), 180 kms (winter).	7 days x 4 trips (monsoon), 10 days x 3 trips(winter).	18,000 kgs.
Kakdwip	435,40,000	Trawlers-100 Mechanized boats-2000.	80 kms. (monsoon) 180 kms (winter)	7 days x 4 trips (monsoon), 15 Days x 2 trips (winter).	12,000 kgs.
Roydighi	62,22,400	Trawlers-200 Mechanized boats-600	100 kms (monsoon), 180 kms (winter)	7 days x 4 trips (monsoon) 15 days x 2 trips(winter).	8000 kgs
Namkhana	1,49,200,00	Trawler-200 Mechanized boat-500	70 kms (monsoon), 200 kms (winter).	10 days x 4 trips (monsoon), 15 days x 2 trips(winter).	8000 kgs.

Source: Primary data from field survey at Namkhana, Kakdwip, Diamond Harbour, Roydighi & Canning on 30.4.99, 25.4.99, 23.4.99, 1.4.99 & 14.4.99 respectively (Das, 2009).

ANNEXURE

Family/ Species	Common name	Habitat
CLASS CHONDRICHTHYES		
ORDER ORECTOLOBIFORMES		
Family Hemiscyllidae	**Bamboo sharks**	**Pelagic**
Chiloscyllium indicum (Gmelin)		
Chiloscyllium griseum Muller and Henle		
Family Stegostomatidae	**Zebra sharks**	**Pelagic**
Stegostoma fasciatum (Hermann)		
Family Rhincodontidae	**Whale sharks**	**Pelagic**
Rhincodon typus Smith		
Order Carcharhiniformes		
Family Proscylliidae	**Finback catsharks**	**Pelagic**
Eridancis radcliffei Smith		
Family Carcharhinidae	**Requim sharks**	**Oceanic/Pelagic/semi pelagic/ littoral**
Carcharhinus dussumieri (Valenciennes)		
Carcharhinus hemiodon (Valenciennes)		
Carcharhinus leucas (Valenciennes)		
Carcharhinus melanopterus (Quoy and Gaimard)		
Carcharhinus limbatus (Valenciennes)		
Glyphis gangeticus (Muller and Henle)		
Lamiopsis temmincki (Muller and Henle)		
Rhizoprionodon acutus (Ruppell)		
Scoliodon laticaudus (Muller and Henle)		
Family Sphyrnidae	**Hammerhead sharks**	**Semi pelagic and littoral**
Eusphyrna blochii (Cuvier)		
Order Rajiformes		
Family Pristidae	**Sawfishes**	**Demersal**
Anoxypristes cuspidata (Latham)		
Pristis microdon Latham		
Pristis pectinata Latham		
Family Torpedinidae	**Electric Rays**	**Benthic and semi pelagic**
Bengalichthyes impennis Annandale		

Family/ Species	Common name	Habitat
Narke dipterygia (Schneider)		
Narcine timlei (Schneider)		
Narcine brunnea Annandale		
Family Rhinobatidae	**Guitar fishes**	**Demersal**
Rhina ancylostoma Schneider		
Rhina grannulatus Cuvier		
Rhina lionotus Norman		
Rhinobatos obtusus Muller and Henle		
Rhinobatos annandalei Norman		
Rhynchobatus djeddensis (Forsskal)		
Family Dasyatidae	**Sting Rays**	**Demersal**
Dasyatis microps (Annandale)		
Himantura bleekeri (Blyth)		
Himantura fluviatilis (Hamilton-Buchanan)		
Himantura marginata (Blyth)		
Dasyatus zugei (Muller and Henle)		
Himantura imbricata (Schneider)		
Himantura uarnak (Forsskal)		
Family Gymnuridae	**Butterfly Rays**	**Demersal**
Aetoplatea tentaculata (Valenciennes)		
Gymnura (Gymnura) poecilura (Shaw)		
Family Myliobatidae	**Eagle Rays**	**Benthic littoral and semi pelagic**
Aetobatus narinari (Blainville)		
Aetomylaeus nichofii (Schneider)		
CLASS: ACTINOPTERYGII		
Family Elopidae	**Lady fishes**	**Pelagic**
Elops machnata (Forsskal)		
Family Megalopidae	**Tarpons**	**Demersal/Pelagic**
Megalops cyprinoides (Broussonet)		
Family Anguillidae	**Freshwater Eels**	**Demersal**
Anguilla bengalensis bengalensis (Gray)		
Angilla bicolor bicolor Mc Clelland		
Family Moriguidae	**Worm Eels**	**Demersal**

Family/ Species	Common name	Habitat
Moringua arundinacea (Mc Clelland)		
Moringua raitaborua (Hamilton-Buchanan)		
Family Muraenidae	**Moray Eels**	**Demersal**
Sideria picta (Ahl)		
Thyrsoidea macrura (Bleeker)		
Uropterygius tigrinus (Lesson)		
Echidna nebulosa (Ahl)		
Echidna zebra (Shaw)		
Gymnothorax meleagris (Shaw and Nodder)		
Gynothorax sathete (Hamilton-Buchanan)		
Gymnothorax tile (Hamilton-Buchanan)		
Leptocephalus milnei Southwell and Prasad		
Leptocephalus vermicularis Southwell and Prasad		
Family Muraenesocidae	**Pike Congers**	**Demersal**
Congresox talabon (Cuvier)		
Congresox talabonoides (Bleeker)		
Muraenesox bagio (Hamilton-Buchanan)		
Muraenesox cinerius (Forsskal)		
Family Ophichthidae	**Snake Eels**	**Demersal**
Neenchelys buitendijki Weber and de Beaufort		
Pisodonophis boro (Hamilton-Buchanan)		
Lamnostoma orientalis (McClelland)		
Order Clupeiformes		
Family Clupeidae	**Herrings, Sardines, Sprats, Gizzard shads**	**Pelagic**
Hilsa (Hilsa) kelee (Cuvier)		
Hilsa (Tenualosa) ilisha (Hamilton-Buchanan)		
Hilsa (Tenualosa) toli (Valenciennes)		
Escualosa thoracata (Valenciennes)		
Herklotsichthys quadrimaculatus (Ruppell)		
Sardinella brachysoma Bleeker		
Sardinella fimbriata (Valenciennes)		
Sardinella gibbosa (Bleeker)		
Anodostoma chacunda (Hamilton-Buchanan)		

Family/ Species	Common name	Habitat
Anodostoma thailandiae Wongratana		
Nematalosa nasus (Bloch)		
Corica soborna Hamilton-Buchanan		
Family Pristigasteridae	**Ilishas, Pellonas**	**Pelagic**
Ilisha filigera (Valenciennes)		
Ilisha kampeni Weber and De Beaufort		
Ilisha megaloptera (Swainson)		
Ilisha melastoma (Schneider)		
Opisthopterus tardoore (Cuvier)		
Opisthopterus valenciennesi Bleeker		
Pellona ditchela Valenciennes		
Raconda russeliana Gray		
Family Engraulidae	**Anchovies**	**Pelagic**
Coilia dussumieri Valenciennes		
Coilia neglecta Whitehead		
Coilia ramcarati Hamilton-Buchanan		
Coilia reynaldi Valenciennes		
Setipinna brevifilis (Valenciennes)		
Setipinna phasa (Hamilton-Buchanan)		
Setipinna taty (Valenciennes)		
Setipinna tenuifilis Valenciennes		
Stolephorus baganensis Hardenberg		
Stolephorus commersonii Lacepede		
Stolephorus heterolobus (Rupell)		
Stolephorus indicus (van Hasselt)		
Thryssa dussumieri (Valenciennes)		
Thryssa hamiltonii (Gray)		
Thryssa malabarica (Bloch)		
Thryssa purava (Hamilton-Buchanan)		
Family Chirocentridae	**Wolf Herring**	**Pelagic**
Chirocentrus nudus Swainson		
ORDER SILURIFORMES		
Family Ariidae	**Sea catfishes**	**Demersal**
Arius arius (Hamilton-Buchanan)		

Family/ Species	Common name	Habitat
Arius caelatus Valenciennes		
Arius dussumieri Valenciennes		
Arius gagora Hamilton-Buchanan		
Arius jella Day		
Arius maculatus (Thunberg)		
Arius parvipinnis Day		
Arius platystomus Day		
Arius sagor (Hamilton-Buchanan)		
Arius sona (Hamilton-Buchanan)		
Arius tenuispinnis Day		
Arius thalassinus (Ruppell)		
Batrachocephalus mino (Hamilton-Buchanan)		
Hemipimelodus jatius (Hamilton-Buchanan)		
Osteogeniosus militaris (Linnaeus)		
ORDER AULOPIFORMES		
Family Harpadontidae	**Bombay Duck**	**Pelagic**
Harpadon neherius (Hamilton-Buchanan)		
Family Synodontidae	**Lizard fishes**	**Demersal**
Saurida tumbil (Bloch)		
ORDER GADIFORMES		
Family Bregmacerotidae	**Codlets**	**Demersal**
Bregmaceros macclellandi Thompson		
ORDER LOPHIFORMES		
Family Antennariidae	**Frog fishes**	**Demersal**
Antennarius hispidus (Bloch and Schneider)		
ORDER CYPRINODONTIFORMES		
Family Hemiramphidae	**Halfbeaks**	**Demersal**
Dermogenys brachynopterus (Bleeker)		
Hemiramphus far (Forsskal)		
ORDER SYNGNATHIFORMES		
Family Fistulariidae	**Cornet fishes**	**Pelagic**
Fistularia petimba Lacepede		
Family Syngnathidae	**Pipe fishes and Sea horses**	**Shallow coastal waters and estuaries**

Family/ Species	Common name	Habitat
Ichtyocampus carce (Hamilton-Buchanan)		
ORDER SCORPAENIFORMES		
Family Synanceiidae	**Minous**	**Pelagic**
Minous coccineus (Alcock)		
Trachicephalus uranoscopus (Bloch and Schneider)		
Family Platycephalidae	**Spiny flatheads**	**Benthic**
Platycephalus indicus (Linnaeus)		
ORDER PERCIFORMES		
Family Ambassidae	**Perchlets**	**Near river mouths**
Ambassis nalua (Hamilton-Buchanan)		
Ambassis kopsii Bleeker		
Family Centropomidae	**Sea Perches, Sea bass, Barramundi**	**Demersal and bottom dwelling**
Lates calcarfer (Bloch)		
Family Serranidae	**Groupers**	**Pelagic**
Epinephelus malabaricus (Schneider)		
Epinephelus tauvina (Forsskal)		
Promicrops lanceolatus (Bloch)		
Family Teraponidae	**Tiger perches**	**Pelagic**
Terapon jarbua (Forsskal)		
Terapon puta (Cuvier)		
Terapon theraps (Cuvier)		
Family Sillaginidae	**Whitings**	**Sandy shores and estuarine waters**
Sillago sihama (Forsskal)		
Sillaginopsis panijus (Hamilton-Buchanan)		
Family Lactaridae	**False trevallis**	**Waters shallower than 100m**
Lactarius lactarius (Schneider)		
Family Rachycentridae	**Cobia**	**Pelagic**
Rachycentron canadum (Linnaeus)		
Family Carangidae	**Jacks, Scads**	**Pelagic**
Alectis ciliaris (Bloch)		
Alectis indicus ((Ruppell)		
Alepes djedaba (Forsskal)		

Family/ Species	Common name	Habitat
Atropus atropus (Schneider)		
Atule mate (Cuvier)		
Carangoides chrysophrys (Cuvier)		
Carangoides malabaricus (Bloch and Scneider)		
Caranx carangus (Bloch)		
Caranx ignobilis (Forsskal)		
Caranx sexfasciatus Quoy and Gaimard		
Decapterus russelli (Ruppell)		
Elagatis bipinnulata (Quoy and Gaimard)		
Megalaspis cordyla (Linnaeus)		
Scomberoides commersonianus Lacepede		
Scomberoides lysan (Forsskal)		
Scomberoides tala (Cuvier)		
Selar crumenopthalmus (Bloch)		
Trachynotus blochii (Lacepede)		
Uraspis uraspis (Gunther)		
Family Coryphaenidae	**Dolphin fish**	**Pelagic**
Coryphaena hippurus Linnaeus		
Family Parastromateidae	**Black Pomfret**	**Deep coastal waters**
Parastromateus niger (Bloch)		
Family Leiognathidae	**Slipmouths**	**Pelagic**
Gazza minuta (Bloch)		
Leiognathus blochii (Valenciennes)		
Leiognathus brevirostris (Valenciennes)		
Leiognathus daura (Cuvier)		
Leiognathus dussumieri (Valenciennes)		
Leiognathus equulus (Forsskal)		
Leiognathus fasciatus (Lacepede)		
Leiognathus splendens (Cuvier)		
Secutor insidiator (Bloch)		
Secutor ruconius (Hamilton-Buchanan)		
Family Lutjanidae	**Snappers**	**Deep coastal waters**
Lutjanus argentimaculatus (Forsskal)		
Lutjanus bengalensis (Bloch)		

Family/ Species	Common name	Habitat
Lutjanus johnii (Bloch)		
Lutjanus russelli (Bleeker)		
Family Lobotidae	**Tripletails**	**Brackish waters and large river mouths**
Datnioides quadrifasciatus (Sevastianov)		
Family Gerreidae	**Mojarras**	**Sandy shores**
Gerres (Gerres) oyena (Forsskal)		
Gerres (Gerres) poieti Cuvier		
Gerres (Pertica) filamentosus Cuvier		
Gerreomorpha setifer (Hamilton-Buchanan)		
Family Haemulidae	**Grunts**	**Demersal**
Pomadasys argenteus (Forsskal)		
Pomadasys argyreus (Valenciennes)		
Pomadasys furcatus (Schneider)		
Pomadasys maculatum (Bloch)		
Family Sparidae	**Seabreams**	**Demersal**
Acanthopagrus berda (Forsskal)		
Acanthopagrus latus (Houttuyn)		
Rhabdosargus sarba (Forssal)		
Family Nemipterydae	**Threadfin Breams**	**Pelagic and Demersal**
Nemipterus bipunctatus (Ehrenberg)		
Nemipterus japonicus (Bloch)		
Nemipterus tolu (Valenciennes)		
Family Sciaenidae	**Croakers**	**Demersal**
Bahaba chaptis (Hamilton-Buchanan)		
Chrysochir aureus (Richardson)		
Daysciaena albida (Cuvier)		
Dendrophysa russelli (Cuvier)		
Johnius (Blythsciaena) macropterus (Bleeker)		
Johnius (Johnieops) dussumieri (Cuvier)		
Johnius (Johnieops) sina (Cuvier)		
Johnius (Johnieops) vogleri (Bleeker)		
Johnius (Johnius) belangerii (Cuvier)		
Johnius (Johnius) carutta Bloch		
Johnius (Johnius) coitor (Hamilton-Buchanan)		

Family/ Species	Common name	Habitat
Johnius (Johnius) macrorhynus (Mohan)		
Nibea maculata (Schneider)		
Nibea soldado (Lacepede)		
Macrospinosa cuja (Hamilton-Buchanan)		
Otolithoides biauritus (Cuvier)		
Otolithes cavieri Trewavas		
Otolithes ruber (Schneider)		
Pama pama (Hamilton-Buchanan)		
Panna microdon (Bleeker)		
Panna heterolepis Trewavas		
Pennahia macrocephalus (Tang)		
Pennahia macrophthalmus (Bleeker)		
Protonibea diacanthus (Lacepede)		
Pterotolithus maculatus (Kuhl and van Hasselt)		
Family Mullidae	**Goat fishes**	**Benthic predator**
Parupeneus indicus (Shaw)		
Upeneus vittatus (Forsskal)		
Family Toxotidae	**Archer fishes**	**Demersal**
Toxotes chatareus (Hamilton-Buchanan)		
Family Ephippididae	**Space-fishes**	**Pelagic and often enters estuaries**
Depane longimana (Bloch and Schneider)		
Drepane punctata (Linnaeus)		
Ephippus orbis (Bloch)		
Platax pinnatus (Linnaeus)		
Family Scatophagidae	**Scats**	**Shallow brackish waters**
Scatophagus argus (Bloch)		
Family Mugilidae	**Mullets**	**Coastal waters and estuaries**
Liza macrolepis (Smith)		
Liza parsia (Hamilton-Buchanan)		
Liza subviridis (Valenciennes)		
Liza tade (Forsskal)		
Liza vaigiensis (Quoy and Gaimard)		

Family/ Species	Common name	Habitat
Mugil cephalus Linnaeus		
Rhinomugil corsula (Hamilton-Buchanan)		
Valamugil buchanani ((Bleeker)		
Valamugil cunnesius (Valenciennes)		
Valamugil seheli (Forsskal)		
Valamugil spigleri (Bleeker)		
Family Sphyraenidae	**Barracudas**	**Mostly occurring in coastal waters, from the surface to about 100m depth**
Sphyraena jello Cuvier		
Sphyraena obtusata Cuvier		
Family Polynemidae	**Threadfins**	**Shallow coastal waters and in estuaties**
Polynemus paradiseus Linnaeus		
Eleotheronema tetradactylum (Shaw)		
Polydactylus indicus (Shaw)		
Polydactylus plebeius (Broussonet)		
Polydactylus sextarius (Bloch)		
Polynemus paradiseus Linnaeus		
Polynemus longipectoralis Weber and de Beaufort		
Family Uranoscopidae	**Stargazers**	**Demersal- typically lie buried in sand**
Uranoscopus cognatus Cantor		
Family Callionymidae	**Dragonets**	**Benthic**
Callionymus carebares Alcock		
Callionymus fluviatilis Day		
Callionymus recurvispinnis Li		
Callionymus sagitta Pallas		
Eleutherochir opercularis (Vallenciennes)		
Family Blennidae	**Blennies**	**Primarily in shallow marine habitats, and are especially common in the intertidal and subtidal zones.**
Petroscirtes breviceps Valenciennes		
Petroscirtes variabilis Cantor		