OCCASIONAL PAPER No. 279

Records of the Zoological Survey of India

Studies on faunal diversity and Coral Reef Ecosystems of Palk Bay

K. VENKATARAMAN
P. KRISHNAMOORTHY
CH. SATYANARAYANA
G. SIVALEELA

ZOOLOGICAL SURVEY OF INDIA

OCCASIONAL PAPER No. 279

RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA

Studies on faunal diversity and Coral Reef Ecosystems of Palk Bay

K. VENKATARAMAN, P. KRISHNAMOORTHY, CH. SATYANARAYANA AND G. SIVALEELA

Marine Biological Station, Zoological Survey of India
130, Santhome High Road, Chennai 600 028

Edited by the Director, Zoological Survey of India, Kolkata

सत्यमेव जयते

Zoological Survey of India
Kolkata

CITATION

Venkataraman, K., Krishnamoorthy, P., Satyanarayana, Ch. and Sivaleela, G. 2007. Studies on faunal diversity and Coral Reef Ecosystems of Palk Bay, India. *Rec. zool. Surv. India, Occ. Paper No.*, **279** : 1-47, (Published by the Director, *Zool. Surv. India*, Kolkata)

Published : November, 2007

ISBN 978-81-8171-179-3

PRICE
Indian Rs. 100.00
Foreign $ 5 £ 4

Published at the Publication Division, by the Director, Zoological Survey of India, 234/4 A.J.C. Bose Road, 2nd MSO Building, Nizam Palace (13th floor), Kolkata 700 020 and printed at Typographia, 3 Bow Street, Kolkata 700 012.

RECORDS
OF THE
ZOOLOGICAL SURVEY OF INDIA
OCCASIONAL PAPER

No. 279 **2007** **Page 1-47**

CONTENTS

INTRODUCTION

Conservation and sustained development of natural living resources and environmental protection have been the focus of extensive, scholarly attention in this century. The diverse use of coastal and oceanic habitats for fishing, oil and gas, energy, tourism, education and research has naturally generated significant capital returns. This has resulted in increased competition over ocean and coastal resources. Irrational exploitation of natural resources has crossed the sustainable levels and even leads to extermination of a number of species of plants and animals. If this state of over exploitation is allowed to continue, our country may lose more species in the immediate future. Hence, the present survey was undertaken to inventorise the fauna present in the region, Palk Bay. The outcome of the study may help management in a long-term basis.

Of an estimated 30 million species on earth, our knowledge of their diversity is limited to a catalogued 1.4 million with only 20% in the oceans. Although a wealth of data is available on the terrestrial biodiversity, the marine biodiversity is sill imperfectly known and catalogued. Marine conservation strategies compared to that of terrestrial ecosystem suffer from lack of attention and paucity of information on bioresources. Therefore, if the country is to effectively protect its marine biodiversity while fully enjoying the ecological benefits provided by these organisms, data on the faunal diversity is required to evaluate all these important resources. It is hoped that the present study may cater to the need to some extent.

Hornel (1922, 1924) was the first to conduct studies on the pearl banks of Palk Bay. Studies on hydrographic parameters (Murthy and Verma, 1964; Maruthanayagam and Subramanian, 1999; Bindu Suloochan and Muniyandi, 2005; Kathal, 2005) physicochemical parameters (Jayaraman, 1954; Mallik, 1983; Palinichamy and Rajendran, 2000; Wilson *et al.*, 2005) bacteria (Velankar, 1957) seaweeds (Umamaheswar Rao, 1968, 1972, 1973, 1974; CMFRI, 2004; Kaliaperumal, 2004) diatoms (Raghu Prasad, 1960) protozoans (Ameer Hamsa, 1972; Maruthanayagam *et al.*, 2001), meroplankton (Krishnamoorthy and Subramanian, 1998, 1999, 2003) sponges (Thomas, 1972, 1986) crabs (Sankarankutty, 1965; Silas and Sankarankutty, 1965; Ameer Hamsa, 1978; Thomas, 1986) copepods (Kartha, 1959; Maruthanayagam and Subramanian, 2000) coral boring molluscs (Appukuttan, 1972; Balakrishnan Nair and Dharmaraj, 1980), coral reefs (Pillai, 1969, 1973, 1975 Asir Ramesh, 1996; Kumaraguru, 2002; Kumaraguru *et al.*, 2003, 2005; Venkataraman *et al.*, 2003) alcyonaceans (Jayasree and Parulekar, 1977) molluscs (Satyanarayana Rao and Sundaram, 1972; Victor *et al.*, 2001; Lipton and Selakku, 2001) echinoderms (James and Baskar, 1994) fish and fishery (Prabhu, 1954; Bapat, 1955; Mahadevan, 1958; James and Adolph, 1965; Venkataraman and Badrudeen,

1974; James and Badrudeen, 1975; James, 1966; Chacko and Rahim, 1968; Bensam, 1973; Devaraj, 1986, 1987; James *et al.*, 1985; James, 1986; Kasinathan, 1988; Krishna Pillai and Kasinatan, 1995; Jayasankar, 1991, 1997; Ramadoss, 2002; Rekha Nair, 2005), sea turtles (Jones and Bastin Fernando, 1973; Agastheesapillai and Thiagarajan, 1979) and porpoise, whales and sea cow (Lal Mohan, 1976; Nammalwar *et al.*, 1994; Kasinathan *et al.*, 2002) are some of the important studies conducted till today.

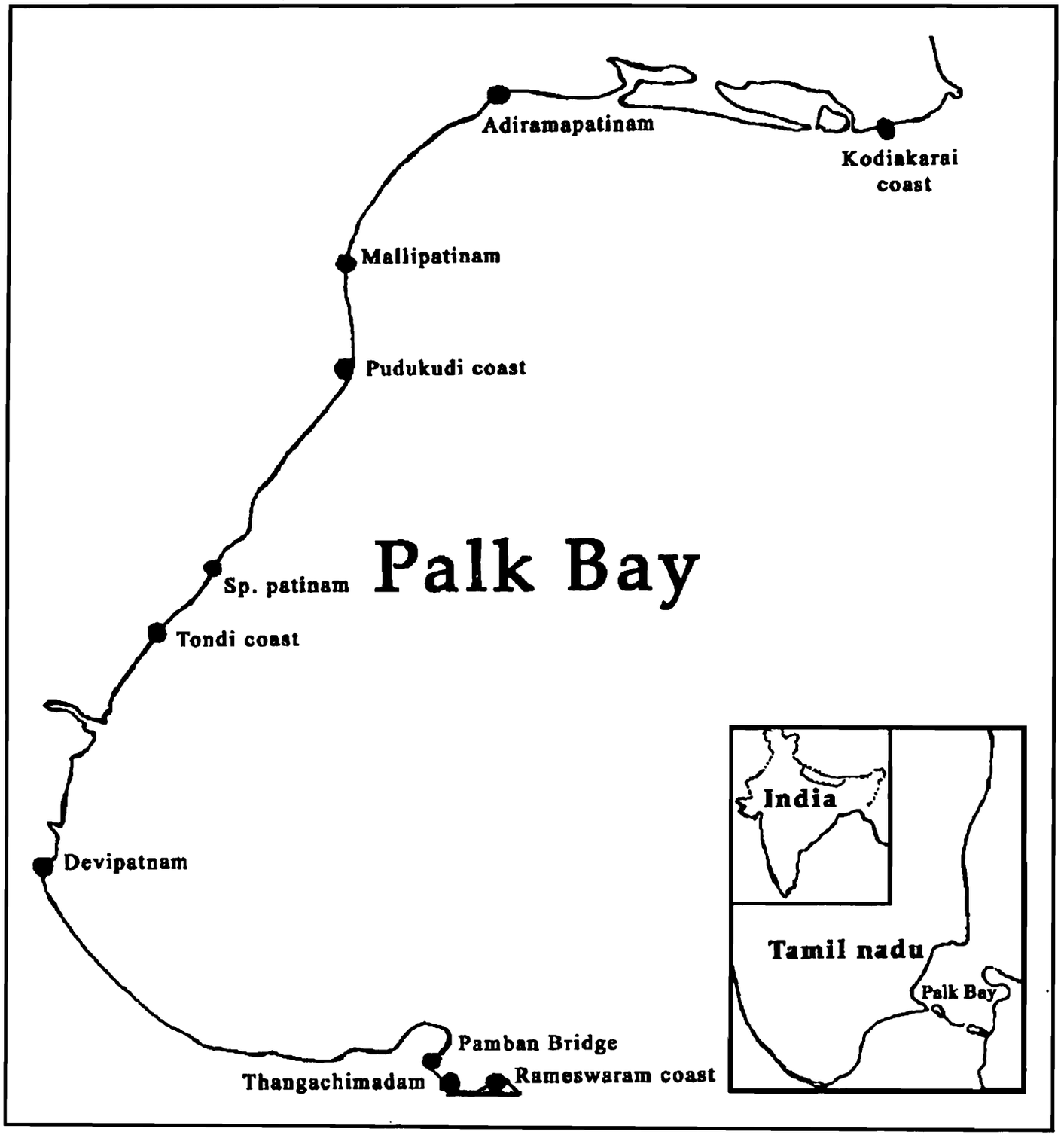

Fig. 1 : Map showing the survey locations of Palk Bay

THE PHYSIOGRAPHY OF THE PALK BAY

The Gulf of Mannar and Palk Bay along the Eastern coast of India are well known for their faunistic richness and variety. The Palk Bay region lies between $9^0$17' N and 100^0 18' N Latitudes (Fig. 1). The mean rainfall varies from 820 to 1650 mm and relative humidity remains between 80 ± 10% throughout the year. Palk Bay is practically calm except at the on set of northeast monsoon when turbulent condition prevails. The wind speed fluctuates between 3 to 21 knots and the maximum of 12 to 15 knots between May and July. The monthly average temperature of Palk Bay waters is ranging between 24.6-29.1°C. Tides on the Palk Bay Coast are irregular, semi-daily or mixed type. The maximum tidal range is about 1.0 m (spring tide) and during neap tides vary often slight changes occur in the water levels with a rise or fall of 2 to 5 cm. From the field observation it is observed that the rise and fall of the tides on the Palk Bay is greatly influenced by the force and direction of the winds, which regulates the duration of submergence and emergence at successive levels. As mentioned by Jayaraman (1954) in the case of inshore waters of this area there has been a fall in salinity in the period December-January. The salinity of the water decreases gradually along an axis in the southwest direction running from the Palk Strait. High saline water is pocketed in the southwest corner of the bay. This may be due to the incursion of Gulf of Mannar water through Pamban pass. The density of the water also decreases along an axis in the southwest direction from the strait. Northeast wind's strength in Nagapattinam is about 8-10 knots (North of Palk Bay) and at Pamban the wind strength is only 2-4 knots. Temperature, salinity, density and dissolved oxygen of the surface waters of the Palk Bay indicates that the Bay of Bengal waters entering the Palk Strait have major influence on the hydrographic condition of Palk Bay. The Gulf water influences the hydrological parameters to a minor extent only (Murthy and Udayavarma, 1964). The inshore waters of Palk Bay during monsoon become muddy due to the presence of suspended sand and silt stirred up from the sandy shore by wave action.

Cyclonic winds with high velocity are capable of generating enough mechanical damage to corals of this area during the monsoon seasons. Huge quantity of silt settlement has a remarkable effect on the distribution and diversity of the coral reef associated plants and animals. This appears to have a greater influence on the inshore regions of Palk Bay especially during the north-east monsoon. The bottom sediments of Mandapam consist of silt and clay, clayey silt and sand, fine to medium sand, coarse sand, and coarse sand with gravel. Distribution of various size classes indicates that the offshore sediment in this areas is usually unimodel with the primary mode around 1.5 – 2 (medium sand), a secondary mode is sometimes present around 3.5. Beach samples have prominent mode around 2.25, 1.75, 2.75 and 3.25 suggesting the polymodal nature of the sediment (Mallick, 1983).

Palk Bay comes under three different districts in Tamil Nadu. Under Ramanathapuram district there are about 46 fish landing centres starting from Rameshwaram, Verkotil to S.P. Pattinam, out of which 5 of them are mechanized fish landing centres. Each fish

landing centre has an average of 50-100 non-mechanised fishing vessels and the mechanized landing centres have 350-500 vessels for fishing. Likewise Pudukottai district has 14 landing centres out of which Kottapattinam and Jagadapattinam are mechanized fish landing centres. In the Thanjavur district, out of 66 fish landing centres have 552 mechanised fishing crafts for fishing. Likewise, Pudukottai district has 86 fish landing centres of which 9 are mechanized landing centres and the rest are non-mechanized ones.

The following are the fishing gears operated by the local fishermen for the fish catch in the Palk Bay coasts: Trawl nets, Drift/gill net, Boat scene, Fixed bag net, Hooks and lines, Shore sciene, Traps and Scoop nets (Table 1).

Table 1. Fishing Craft and Gear used in Palk Bay

Items	Thanjavoor district	Pudukottai district	Ramanathapuram district	Total
1. Fishing crafts				
Mechanised	552	36	98	1569
Trawlers	5	?	27	32
Gillnetters				
Others	2	?	1	3
2. Non-mechanised dug-out Canoes				
Plank-built	284	9	626	919
boats	1176	908	4074	6158
Catamarans	1043	128	370	5541
Others	495	?	44	239
3. Fishing gear				
Trawl nets	1496	82	3029	4607
Drift/gill nets	22337	14479	35048	71864
Boat sciene	2262	579	24	2805
Fixed bag net	168	32	732	932
Hooks and line	4140	2756	5362	12258
Shore sciene	1637	57	1523	3217
Traps	166	4067	3312	7545
Scoop nets	698	?	22	720
Others	1571	31	1168	2770

Other than the above-mentioned fishing gears the following are the local-made gears used viz. Disco Thoondi, Shore scene, Kilangavela, Serayavela, Thangoost vala, Olavala, Velamin vala, Suda vala, Kumala vala, Kannikka vala, Disco vala, Chinna thoondi, Periya Thoondi, Nandu vala, Thalluvala, Eral Vala, diving, Koodu, Sheela vala Marrukku, Gutta vala, Chinna Marukkuppam, Paru vala, Sunni vala and Kurrukkuvetta vala. All the above-mentioned fishing gears are used on Mechanised fishing crafts such as Trawlers and Gill-netters or on non-mechanised. Crafts such as Dug-out Canoes, Plank-building boats and Catamarans or individually by venturing into the shore without using fishing crafts. In Palk Bay, there is one public sector Boat-building yard at Nagapattinam and there are about 2-3 private sector yards. In Pudukottai district there is a private sector yard available and there are many hand-fabricating units under cottage industry.

Table 2. Fauna collected during May 1997 Survey (number of examples).

Stations	Porifera	Coel-enterata	Crustacea	Mollusca	Echino-dermata	Fishes	Sea weed and Seagrass
Thankacchimadam	-	2	19	31	3	18	3
Pamban bridge	1	-	32	11	6	10	7
Devipattinam	10	6	36	31	6	24	-
Rameshwaram	-	-	1	1	4	11	-
Thondi	2	-	17	23	9	74	-
S.P.Pattinam	4	3	42	42	12	51	1
Pudukudi coast	1	-	17	3	2	30	1
Mallipattinam	-	-	4	15	2	10	1
Adirampattinam	3	-	3	-	-	15	1
Kodiakarai	-	-	-	15	2	1	2
Total	21	11	171	172	46	244	13
Grand Total : 678 exs.							

AREA SURVEYED AND THE METHODOLOGY OF COLLECTION

Materials for the present study were collected through three extensive surveys conducted by the Marine Biological Station between 1997 and 1999. The important fish landing centers between Dhanushkodi and Kodiakarai were surveyed and the samples were collected. During the low tide period samples were handpicked from the inter-tidal region. Other samples were collected by engaging catamarans, country boats and mechanised boats and also from the refuse of the non-mechanised and mechanised boat catches.

Three surveys were conducted to study the Ecology and Biodiversity of Palk Bay as per the annual programme of Marine Biological Station, Zoological survey of India in three different seasons to record the faunal components (K. Venkataraman - May 1997; M. Srinivasan - July 1998; P. Krishnamoorthy - Nov 1999). The results are presented in Table 2-4. The present report is a consolidation of the above surveys as well as the list of fauna identified in the study area. Some of major studies referred for the identification and compilation of list fauna mentioned below (Rama Rao, 1954; 1972; Srinivasan, 1977; Thomas, 1971; 1976; Thomas, 1969, 1973, Pillai, 1973; 1996).

Table 3. Fauna collected during July 1998 Palk Bay survey (number of examples)

Stations	Porifera	Coel-enterata	Crustacea	Mollusca	Echino-dermata	Fishes	Sea weed and Seagrass
Dhanushkodi	-	1	2.	29	41	14	34
Thankacchimadam	1	-	-	-	1	-	-
Rameshwaram	-	-	-	55	30	12	30
Uchipuli	1	-	-	20	29	3	3
Pamban bridge	3	2	1	8	18	6	49
Devipattinam	-	1	-	13	33	6	14
Thondi	-	2	-	-	33	8	22
Jagathahapattinam	-	1	-	80	22	-	84
Kottaipattinam	1	2	-	20	19	6	39
Mallipattinam	-	-	-	3	1	-	2
Kattumavadi	1	-	-	15	23	-	18
Adirampattinam	-		-	-	11	-	6.
Muthupettai	-	-	-	2	-	-	7
Kodiakarai	1	4	-	12	21	-	30
Total	8	13	3	257	282	55	338
Grand Total : 956 exs.							

Table 4. Classified list of samples collected from Palk Bay during the November 1999 survey (number of examples)

Stations	Porifera	Coel-enterata	Crustacea	Mollusca	Echino-dermata	Fishes	Sea weed and Seagrass
Pamban bridge	43	1	82	27	3	-	69
Uchipuli	-	1	-	-	3		60
Thondi	5	-	64	-	12	-	54
Devipatnam	6	-	12	-	-	-	62
Soliakudi	20	-	-	5	10	-	88
Adhirarnapatnam	5	-	10	-	-	-	80
Mallipattinam	15	37	-	9	-	10	60
Kodiakarai	5	-	-	-	-	-	71
Total	99	39	251	41	28	10	544
Grand Total : 1012 exs.							

LIST OF FAUNAL GROUPS OF PALK BAY IDENTIFIED DURING THE STUDY PERIOD

ARROW WORMS

Phylum **Chaetognatha**

Genus ***Sagitta*** Quoy and Gaimard, 1827

1. *Sagitta bedoti* Beraneck, 1895
2. *Sagitta enflata* Grassi, 1881
3. *Sagitta ferox* Doncaster, 1903
4. *Sagitta hexoptera* Orbigny, 1834
5. *Sagitta neglecta* Aida, 1897
6. *Sagitta pulchra* Doncaster, 1903
7. *Sagitta robusta* Doncaster, 1903
8. *Sagitta regularis* Aida, 1897

Genus ***Krohnitta*** Ritter Zahoons, 1909

9. *Krohnitta pacifera* (Aida, 1897)
10. *Krohnitta subtilis* (Grassi, 1881)

SPONGES

Phylum **Porifera**

Class **Demospongiae Sollas**

Order KERATOSIDA Grant

Family SPONGIDAE Gray

Genus ***Heteronema*** Keller

1. *Heteronema erecta* Keller, 1968

Genus ***Hyatella*** Lendenfeld

2. *Hyatella cribiformes* (Hyatt, 1875)

Genus ***Ircinia*** Nardo

3. *Ircinia fusca* (Carter, 1880)

Genus ***Fasciospongia*** Burton

4. *Fasciospongia cavernosa* (Schmidt, 1862)

Family DYSIDEIDAE Gray

Genus ***Dysideida*** Johnston

5. *Dysidea herbacea* (Keller, 1889)

Genus ***Dendrilla*** Lendenfeld

6. *Dendrilla nigra* (Dendy, 1889)

Genus ***Psammaplysilla*** Keller

7. *Psammaplysilla purpurea* (Carter, 1880)

Order HAPLOSCLERIDA TOPSENT

Family HALICLONIDAE De Laubenfels

Genus ***Haliclona*** Grant

8. *Haliclona exigua* (Kirkpatrick, 1900)

Family DESMACIDONIDAE Gray

Genus ***Iotrochota*** Ridley

9. *Iotrochota baculifera* Ridley, 1884

10. *Sigmadocia fibulata* (Schmidt, 1862)
11. *Sigmadocia pumila* (Lendenfeld, 1887)

Genus ***Taxadocia*** de Laubenfels

12. *Taxadocia toxius* (Topsent, 1897)

Genus ***Orina*** Gray

13. *Orina sagittaria* (Sollas, 1888) (=*Oceanapia sagittaria*)

Genus ***Damiria*** Keller

14. *Damiria simplex* (Keller, 1891)

Genus ***Damirina*** Burton

15. *Petrosia testudinaria* (Lamarck, 1815) (*Xestospongia testudinaria*)

Family CALLYSPONGIIDAE De Laubenfels

Genus ***Callyspongia*** Duch and Mich

16. *Callyspongla diffusa* (Ridley, 1884)
17. *Callyspongia fibrosa* (Ridley and Dendy, 1905)

Order POECILOSCLERIDA TOPSENT

Family PHORBASIDAE De Laubenfels

Subfamily PHORBASINAE de Laubenfels

Genus ***Echinodictyum*** Ridley

17a. *Echinodictyum gorgonoides* Dendy, 1916
18. *Echinodictyum longistylum* Thomas, 1968

Genus ***Demiriana*** de Laubenfels

19. *Damfriana schmidti* (Ridley, 1884) (=*Waldoschmittia schmidti* Ridley, 1884))

Family COELOSPHAERIDAE Henstschel

Genus ***Siderodermella*** Dendy

20. *Siderodermella navicelligera* (Ridley and Dendy, 1905)

Family TEDANIIDAE Ridley and Dendy

21. *Tedania (tedania) anhelans* (Lieberkuhn, 1859)

Family RASPAILIIDAE Hentschel

Genus ***Aulospongus*** Norman

22. *Aulospongus tubulatus* (Bowerbank, 1873)

Genus ***Rhabderemia***Topsent

23. *Rhabderemia prolifera* (Annandale, 1915)

Genus ***Endectyon*** Topsent

24. *Endectyon fruticosa,* 1905
25. *Endectyon thurstoni* Dendy, 1937
26. *Endectyon lamellosa* Thomas, 1976

Family OPHLITASPONGIDAE De Laubenfels

Genus ***Clathria*** Schmidt

27. *Clathria (Thalysias) vulpina* (Lamarck, 1814)
28. *Clathria (Thalysias) procera* var. *tessellata* (Dendy, 1905)
29. *Clathria (Clathria) indica* Dendy, 1905)

Genus ***Mycale*** Gray

30. *Mycale (Mycale) grandis* (Gray, 1867)
31. *Mycale (Mycale) tenuispiculata* (Dendy, 1905)
32. *Mycale (Carmia) monachorata* (Burton and Rao, 1932)

Family AMPHILECTIDAE de Laubenfels

Genus ***Toxemna*** Hallman

33. *Toxemna tubulata* (Dendy, 1905)

Genus ***Biemna*** Gray

34. *Biemna fortis* (Topsent, 1897)

Order HALICHONDRIDA, VOSMAER

Family AXINELLIDAE Ridley and Dendy, 1905

35. *Axinella tenuidigitata* Dendy, 1905
36. *Axinella agariciformis* Dendy, 1905

Genus ***Higginsia*** Higin

37. *Higginsia higgini* Dendy, 1889

Genus ***Myrmekioderma*** Ehlers

38. *Myrmekioderma granulata* (Esper, 1830)

Family HALICHONDRIIDAE

Genus ***Trachyopsis*** Dendy

39. *Trachyopsis halichondroides* Dendy, 1905

Order HADROMERIDA, TOPSENT

Family SPIRASTRELLIDAE (Ridley and Dendy, 1905)

Genus ***Sprirastrella*** Schmidt

40. *Spirastrella coccinea* (Duch and Mich, 1864)
41. *Spirastrella cuspidifera* (Lamarck, 1814)
42. *Spirastrella inconstans* (Dendy, 1887)
43. *Spirastrella aurivilli* Lindgren, 1898

Genus ***Timea*** Gray

44. *Timea stellata* (Bowerbank, 1866
45. *Timea stelligera* (Carter, 1880)

Family SUBERITIDAE Schmidt

Genus ***Suberites*** Nardo

46. *Suberites carnosus* (Johnston, 1842)

Genus ***Laxosuberites*** Topsent

47. *Laxosuberites cruciatus* (Dendy, 1905)

Genus ***Pseudosuberites*** Topsent

48. *Pseudosuberites andrewsi* Kirkpatrick, 1900

Genus ***Aaptos*** Gray

49. *Aaptos aaptos* (Schmidt, 1864)

Family PLACOSPONDIIDAE Gray

Genus ***Placospongia*** Gray

50. *Placospongia carinata* (Bowerbank, 1858)

Family CLIONIDAE Gray

Genus ***Amorphinopsis*** Carter

51. *Amorphinopsis excavans* Carter, 1886

Genus ***Cliona*** Grant

52. *Cliona celata* Grant, 1826
53. *Cliona vastifica* Hancock, 1849
54. *Cliona margaritifera* Dendy, 1905

Order EPIPOLASIDA, SOLLAS

Family JASPIDAE de Laubenfels

Subfamily RHAPHIDISTIINAE de Laubenfels

Genus ***Prostylyssa*** Topsent

55. *Amorphinopsis foetida* Dendy, 1889
56. *Amorphinopsis oculata* Kieschnick, 1869

Genus ***Stellettinopsis*** Carter

57. *Asteropus simplex* Carter, 1879

Family COPPATIIDAE Topsent, 1898

Subfamily JASPINAE de Laubenfels

Genus ***Zaplethea*** de Laubenfels

58. *Zaplethea digonoxea ssp.* diastra Vacelet and Vasseur, 1965

Family HALICHONDRIIDAL Vosmaer, 1887

Genus ***Epipolasis*** de Laubenfels, 1936

59. *Epipolasis topsenti* (Dendy, 1905)

Family TETHYIDAE GRAY

Genus ***Tethya*** Lamarck

60. *Tethya robusta* Bowerbank, 1873

61. *Tethya diploderma* Schmidt, 1870
62. *Tethya japonica* Sollas, 1888

Order CHORISTIDA SOLLAS

Family ANCORINIDAE Schmidt, 1870

Subfamily ANCORINIDAE de Laubenfels

Genus ***Ecionemia*** Bowerbank, 1863

63. *Ecionemia acervus* Bowerbank, 1863

Subfamily STELLETTINAE SOLLAS

Genus ***Myriastva*** Sollas, 1886

64. *Myriastra purpurea* (Ridley, 1884)

Genus ***Rhabdastrella*** Thiele, 1903

65. *Rhabdastrella globostellata* (Carter, 1883)
66. *Rhabdastrella providentiae* (Dendy, 1916)

Family GEODIIDAE Gray

Genus ***Goedia*** Lamarck

67. *Geodia perarmata* Bowerbank, 1873
68. *Geodia lindgreni* (Lendenfeld, 1903)

Family TETILLIDAE Sollas, 1886

Genus ***Cinachyra*** Sollas, 1886

69. *Cinachyra cavernosa* (Lamarck, 1814)

Genus ***Paratetilla*** Dendy

70. *Paratetilla bacca* (Selenka, 1867)

Family DESMANTHİDAE Topsent, 1893

Genus ***Lophacanthus*** hentrechel

71. *Lophocantus rhabdophorus* Hentschel, 1914

Order CARNOSIDA CARTER

Family PACHASTREUIDAE Carter, 1875

Genus ***Pachamphilla*** Lendenfeld, 1907

72. *Pachamphilla dendyi* Hentschel, 1912

Subfamily CORTICIINAE vosmaer

Genus ***Corticum*** Schmidt

73. *Corticum acanthastrum* Thomas, 1968

Genus ***Plakina*** Schulze

74. *Platina monolopha* Schulze, 1889
75. *Plakina acantholopha* Thomas, 1970

Family CHONDRILLIDAE Gray

Genus ***Chondrilla*** Schmidt

76. *Chondrilla saccifomis* Carter, 1873

STONY CORALS

Phylum **Coelenterata**

Class **Anthozoa**

Subclass Zoantharia

Order SCLERACTINIA

Family POCILLOPORIDAE

Genus ***Pocillopora***

1. *Pocillopora damicornis* Linnaeus, 1978

Family ACROPORIDAE

Genus ***Acropora***

2. *Acropora humilis* (Dana, 1876)
3. *Acropora digitifera* (Dana, 1846)
4. *Acropora formosa* (Dana, 1846)
5. *Acropora cytherea* (Dana, 1846)
6. *Acropora hyacinthus* (Dana, 1846)
7. *Acropora indica* (Brook, 1893)

Genus ***Montipora***

8. *Montipora spumosa* (Lamarck, 1816)
9. *Montipora digitata* (Dana, 1846)
10. *Montipora hispida* (Dada, 1846)

11. *Montipora foliosa* (Pallas, 1746)
12. *Montipora exesa* Quelch, 1886
13. *Montipora monasteriata* (Forskal, 1775)

Genus ***Astreopora***

14. *Astreopora myriophthalma* (Lamarck, 1860)

Family AGARCIIDAE

Genus ***Pavona***

15. *Pavona varians* Venill, 1864

Family SIDERASTREIDAE

Genus ***Psammocora***

16. *Psammocora contigua* (Esper, 1797)

Genus ***Pseudosiderastrea***

35. *Pseudosiderastrea tayami* Yabe Sugiyama, 1935

Family PORITIDAE Gray, 1842

Genus ***Porites***

36. *Porites solida* (Forksal, 1775)
37. *Porites lutea* Milne Edwards Heime, 1860
38. *Porites lichen* Dana, 1846
39. *Goniopora stokesi* Milne Edwards and Heime, 1851
40. *Goniopora planulata* (Ehrenberg, 1834)
41. *Goniopora nigra* Pillai, 1967

Family FAVIIDAE

Genus ***Favia***

42. *Favia favus* (Forskal, 1775)
43. *Favia pallida* (Dana, 1846)

Genus ***Favites***

44. *Favites abdita* (Ellis and Solander, 1876)
45. *Favites complanata* (Ehrenberg, 1834)

Genus ***Goniasrea***

46. *Goniastrea retiformis* (Lamarck, 1816)
47. *Goniastrea pectinata* (Ehrenberg, 1834)

Genus ***Platygyra***

48. *Platygra daedalea* (Ellis and Solander, 1786)

Genus ***Leptastrea***

49. *Leptastrea purpurea* (Dana, 1846)
50. *Leptastrea transversa* Klunzinger, 1879

Genus ***Cyphastrea***

51. *Cyphpastrea serailia* (Forskal, 1775)
52. *Cyphastrea microphthalma* (Lamarck, 1816)

Genus ***Echinopora***

53. *Echinopora lamellosa* (Esper, 1795)

Family OCULINIDAE

Genus ***Galaxea***

54. *Galaxea fascicularis* (Linnaeus, 1767)

Family MERULINIDAE

Genus ***Merulina***

55. *Merulina ampliata* (Ellis and Solander, 1876)

Genus ***Hydnophora***

56. *Hydnophora exesa* (Pallas, 1866)
57. *Hydnophora microconos* (Lamarck, 1816)

Family MUSSIDAE

Genus ***Symphyllia***

58. *Symphyllia recta* (Dana, 1846)

Family CARYOPHYLLIDAE* (not collected in the present study)

Genus ***Paracyathus***

59. *Paracyathus profundus* Duncan, 1889
60. *Polycyathus verilli* Duncan, 1889

Genus ***Heterocyathus***

61. *Heterocyathus aequicostatus* Milne Edwards and Haime, 1848

CRABS

BRACHYURA

Family DROMIDAE

1. *Dromia rumphii* Henderson, 1893

Family CALAPPIDAE

2. *Calappa philargius* (Linnaeus, 1758)
3. *Matuta planipes* Fabricius, 1798

Family LEUCOSIIDAE

4. *Philyra scabriscula* (Fabricius, 1798)

Family MAIIDAE

5. *Paratymolus hastatus* Alcock, 1968
6. *Lambrus (Platylambrus) carinatus* H.Milne Edwards, 1936
7. *Oethra scruposa* (Linnaeus, 1893)

Family PORTUNIDAE

8. *Portunus hastotoides* Fabricius, 1894
9. *Portunus pelagicus* (Linnaeus, 1758)
10. *Thalamita parvidens* Rathbun, 1907

Family GRAPSIDAE

11. *Metapograpsus frontalis Miers*
12. *Pachygrapsus pusillus* Heller
13. *Metaplax distincta* H.Milne Edwards, 1893
14. *Sesarma (chiromantes) bidens* (de Haan, 1899

Family OCYOPODIDAE

15. *Ocypoda macrocera* H.Milne Edwards, 1897

Family XANTHIDAE

16. *Actaea granulata* (Audoin, 1893)
17. *Carpilius maculatus* (Linnaeus, 1894)

18. *Menippe rumphii* (Fabricius, 1893)
19. *Pilumnus vespertilio* (Fabricius, 1793)

Family GONOPLACIDAE

20. *Eucrate crenata dentata* De Haan, 1835

PRAWNS

Phylum **Arthropoda**

Class **Crustacea**

Order DECAPODA

Suborder NATANTIA

Infraorder **Penaeidea**

Super family PENAEOIDEA

Family SOLENOCERIDAE

1. *Solenocera crassicornis* (H.Milne - Edwards, 1837)

Family PENAEIDAE

2. *Metapenaeopsis hilarula* (De Man, 1911)
3. *Metapanaeopsis stridulans* (Alcock, 1905)
4. *Metapenaueus affinis* (H. Milne Edwards, 1837)
5. *Metapenaueus brevicornis* (H. Milne Edwards, 1837)
6. *Metapenaueus dobsoni* (Miers, 1878)
7. *Metapenaueus burkenroadi* Kubo, 1854
8. *Metapenaueus monoceros* Fabricius, 1798
9. *Parapenaeopsis acclivirostris* (Alcock, 1905)
10. *Parapenaeopsis cornuta* (Kishinonye, 1900)
11. *Parapenaeopsis maxillipedo* Alcock, 1905
12. *Parapenaeopsis stylifera* (H.Milne Edwards, 1837)
13. *Parapenaeopsis tenella* (Bate, 1888)
14. *Penaeus indicus* H. Milne Edwards, 1837
15. *Penaeus japonicus* Bate, 1888
16. *Penaeus merguiensis* De Man, 1888
17. *Penaeus monodon* Fabricius, 1798
18. *Penaeus semisulcatus* De Haan, 1844

19. *Trachypenaeus pescadorensis* Schmitt, 1931
20. *Trachypenaeus sedili* Hall, 1961

Infra order CARIDEA

Super family ALPHEOIDEA

Family ALPHEOIDEA

22. *Alpheus crossimanus* Heller, 1865
23. *Hippolyte ventricosa* H.Milne Edwards, 1837
24. *Latreutes mucronatus* (Stimpson, 1860)

LOBSTERS

Infra order PALINURIDEA

Super family PALUNUROIDEA

Family PALINURIDAE

1. *Panulirus homarus* (Linnaeus, 1758)
2. *Panulirus ornatus* (Fabricius, 1798)

Family SCYLLARIDAE

Subfamily SCYLLARIDAE

3. *Scyllarus sordidus* (Stimpson, 1860)

Subfamily THENINAE

4. *Thenus orientalis* (Lund, 1793)

MOLLUSCA

Class **Gastropoda**

Subclass **Prosobranchia**

Order ARCHAEOGASTROPODA

Superfamily PATELLIACEA (True limpets)

Family PATELLIACEA (Limpets)

1. *Cellana radiata* (Born, 1778)

Family TURBINIDAE (Turban shells)

2. *Turbo intercostalis* (Menke)

Order CAENOGASTROPODA

Superfamily CERITHIACEA

Family TURRITELLIDAE (Screw shells)

3. *Turritella duplicata* (Lamarck, 1799)

Family STROMBIDAE (Wing shells)

4. *Strombus rubbosa* (Selandr)

Superfamily NATICACAE (Moon shells)

Family NATICIDAE

5. *Natica albula* (Roeding, 1791)
6. *Polinices mamilla* (Linnaeus) (=*Polinices tumides* Swainson, 1840)

Superfamily TONNACEA

Family CASSIDAE (Helmet Shells)

7. *Phalium areola* (Linnaeus, 1768)
8. *Phalium canaliculatum* (Brugiere, 1792)

Family FICIDAE (Fig shells)

9. *Ficus ficus* (Linnaeus, 1758)

Family TONNIDAE (Tun shells)

10. *Tonna dolium* (Linnaeus, 1758)

Family BURSIDAE (Frog shells)

11. *Bursa rubeta* (Linnaeus, 1758)

Order NEOGASTROPODA

Superfamily MURICIDAE

Family MURICIDAE

12. *Murex trapa* (Roeding, 1798)
13. *Murex tribulus* (Linnaeus, 1758)

Family THAIDIDAE (Rock shells)

14. *Thias carnifera* (Links)

Superfamily BUCCINICEA

Family BUCCINIDAE (Whelks)

15. *Babylonia spirata* (Linnaeus, 1758)
16. *Babylonia zeylanica* (Bruguiere)

Superfamily VOLUTACEA

Family OLIVIDAE (Olives)

17. *Olivancillana gibbosa* (Born, 1778)

Family TURBINELLIDAE (Chanks)

18. *Turbinella pyrum* (Linnaeus, 1758)

Superfamily CONACFA

Family CONIDAE (Cones)

19. *Conus amadis* (Gemlin, 1791)

Super family BULLACEA

Family BULLIDAE

20. *Bulla ampulla* (Linnaeus, 1758)

Bivalves

Family ARCIDAE

21. *Arca fusa* Bruguiere 1789

Family MYTILIDAE

22. *Modiolus metacalfei* (Hanley, 1843)
23. *Perna viridis* Linnaeus, 1758

Family PECTINIDAE

24. *Pecten tranquebaricus* (Gemlin, 41790)

Family ANOMIIDAE

25. *Placenta placenta* (Linnaeus, 1758)

Family OSTERIDAE

26. *Crassostrea cucullata,* 1780

Family CARDITIDAE

27. *Cardita biocolor* Lamarck, 1819

Family CARDIIDAE

28. *Cardium flavum* Linaeus, 1758

Family VENERIDAE

29. *Circe scripta* (Linnaeus, 1758)
30. *Meretrix casta* (Chernnitz, 1782)
31. *Paphia textile* (Gemlin, 1790)
32. *Papia malabarica* (Chernnitz, 1782)

Family MACTRIDAE

33. *Mactra cuneata* Chernnitz, 1782

Family DONACIDAE

34. *Donax cuneatus* Linnaeus, 1758
35. *Donax laba* Gemlin, 1790

Family SEPIIDAE

36. *Sepia aculeata* Orbigny, 1848
37. *Sepia pharaonis* Ehrenberg, 1831
38. *Sepia brevimana* Steenstrup, 1875
39. *Sepia prashadi* Winckworth, 1936
40. *Sepiella inermis* Orbigny, 1898

Family LOLIGINIDAE

41. *Loligo duvauceli* Orbigny, 1848
42. *Doryteuthis singhalensis* Ortmann, 1891
43. *Sepioteuthis lessoniana* Lesson, 1830
44. *Loliolus investigatoris* Goodrich, 1896

Family OCTOPODIDAE

45. *Octopus rugosus* Bose, 1792
46. *Octopus macropus* Risso, 1826
47. *Octopus fusiformis* Brock, 1887
48. *Cistopus indicus* Orbigny, 1840

ECHINODERMS

Asteroids

Family GONEASTERIDAE

Genus ***Anthinea***

1. *Anthinea pentagonula* (Lamarck, 1816)

Genus ***Astropecten***

2. *Astropecten hemprichii* Muller and Treschel, 1843

Genus ***Goniodiscus***

3. *Goniodiscus grunuliferus* Sladen, 1889

Family PENTACEROSTEREDAE

Genus ***Pentaceroster***

4. *Pentaceroster multispinus* Doderlein 1936

Family OREASTEREIDAE

Genus ***Oreaster***

5. *Oreaster thurstoni* Bell, 1888

Family ASTRINIDAE

Genus ***Asterina***

6. *Asterina cepheus* (Muller Troschel, 1842)
7. *Asterina coronata* Von Martens, 1866

Genus ***Anseropoda***

8. *Palmipes sarasini* Gravely, 1927

Ophiuroids

Family OPHIOTRICHDAE

Genus ***Ophiothrix***

9. *Ophiothrix korena* Duncan, 1878
10. *Ophiothrix galathea* Luthen, 1872

Family PECTINURADAE

Genus ***Pectinura***

11. *Pectinura intermedia* Bell, 1888

Family OPHIACTIDAE

Genus ***Ophiactis***

12. *Ophiactis savignyi* Muller and Troschel, 1842

Family AMPHURIDAE

Genus ***Amphioplus***

13. *Amphioplus gravelyi* James, 1970

Family OPHEOTHRICIDAE

Genus ***Opheothrix***

14. *Ophiothrix hirsuta* Muller and Troschel, 1842

Echinoids

Family STOMOPNEUSTIDAE

Genus ***Stomopneustes***

15. *Stomopneustes variolaris* (Lamarck)

Family TEMPNOPLEURIDAE

Genus ***Tempnopleures***

16. *Temnopleures toreumaticus* (Leske) 1880

Genus ***Salmacis***

17. *Salmacis virgulata* L. Agassiz

Family CLYPEASTERIDAE

Genus ***Clypeaster***

18. Clypeaster humilis (Leske, 1788)

Family LOVENIIDAE

Genus ***Lovenia***

19. Lovenia elongata (Grey, 1845)

Family LAGANIDAE

Genus ***Laganum***

20. *Laganum depressum* Lesson, 1841
21. *Echinolampus ovata* (Leske, 1778)

Family ECHINIDAE

Genus ***Echinus***

22. *Parachinus angulosus* (Leske, 1778)

Family ECHINOMETRIDAE

Genus ***Echinometra***

23. *Echinometra mathoei* (de BIainville, 1825)

Family ECHNINKOLAMPADIDAE

Genus ***Echinolampus***

24. *Echinolampus ovata* (Leske, 1778)

Family SCUTELLIDAE

Genus ***Echinodiscus***

25. *Echinodiscus auritus* Leske, 1778.

Holothuroids

Family HOLOTHUROIDEA

Genus ***Bohadschia***

26. *Bohadschia marmorata* Jaeger, 1833

Family CUCUMARIIDAE

Genus ***Stoles***

27. *Stolus buccalis* (Stemson, 1966)

Family CUCUMARIIDAE

Genus ***Thyone***

28. Thyone mirubelis Gravely, 1927

Family CUCUMARIIDAE

Genus ***Actinocucumis***

29. *Actinocucumis typicus* Gravely, 1927

Family PSOLUS COMPLANATA Semper, 1868

Genus ***Phylloporus***

31. *Phylloporus (urodemella) brocki* Ludwig, 1833

Family HOLOTHURIDOEA

Genus ***Holothuria***

32. *Holothuria (Halodeima) atra* Jager, 1833
33. *Holothuria (Metriatyla) scabra* Jager, 1833

Family STICHOPODIDAE

Genus ***Stichopus***

34. *Stichopus chnloronotus* Brandt, 1835

Family SYNAPTIDAE

Genus ***Synapta***

35. *Synapta recta* Semper, 1868

Family CUCUMARIIDAE

Genus ***Cucumaria***

36. *Cucumaria cunjungens* Semper, 1868
37. *Cucumaria frauenfeldi* Semper, 1868

FISHES

Phylum **Chordata**

Grade **Pisces**

Class **Choridrichthyes**

Subclass **Elasmobranchii**

Order LAMNIFORMES

Suborder LAMNOIDEI

Family RHINODONTIDAE

1. *Rhinodon typus* Smith, 1828

Family ORECTOLOBIDAE

2. *Chiloscyllium griseum* Muller and Henle, 1841
3. *Chiloscyllium indicus* (Gmelin, 1789)

Family STEGOSTOMATIDAE

4. *Stegostoma fasciatum* (Hermann, 1783)

Family CARCHARINIDAE

5. *Carcharinus dussumieri* (Muller and Henle, 1841)
6. *Carcharinus hemiodon* (Valenciennes, 1841)
7. *Carcharinus sorrah* (Muller and Henle, 1841)
8. *Scoliodon laficaudus* (Muller and Henle, 1841)

Family RHINOBATIDAE

9. *Rhinobatos grannulatus* Cuvier, 1829
10. *Rhina ancylostoma* (Schneider, 1801)

Family DASYATIDAE

11. *Dasyatis imbricata* (Schneider, 1801)

Family MOBULIDAE

12. *Mobule diabolus* (Shaw, 1804)

Class **Psteichthyes**

Subclass **Actinopterygil**

Order CLUPEIFORMES

Suborder CLUPEIDEI

Family CLUPEIDAE

13. *Dussumieria acuta* Valenciennes, 1847
14. *Escualosa thoracata* (Valenciennes, 1847)
15. *Sardinilla dayi* Regan, 1917
16. *Sardinella longiceps* Valenciennes, 1847
17. *Ilisha filigera* Misra, 1976
18. *Ilisha megaloptera* (Swainson, 1838)
19. *Ilisha melastoma* (Schneider, 1801)

20. *Ilisha sirishai* Seshagiri Rao, 1975
21. *Opisthopterus tardoore* (Cuvier, 1829)
22. *Pellona ditchela* Valenciennes, 1847
23. *Hilsa kelee* (Cuvier, 1829)
24. *Hilsa toli* (Valenciennes, 1847)

Family ENGRAULIDAE

25. *Setipinna taty* (Valenciennes, 1848)

Family CHIROCENTRIDAE

26. *Chirocentrus nudus* Swainson, 1839

Family CONGRIDAE

27. *Congresox talabon* (Cuvier, 1829)

Family ARRIDAE

28. *Arius arius* (Hamilton-Buchanan, 1822)
29. *Arius jella,* Day, 1877

Family PLOTOSIDAE

30. *Plotosus lineatus* (Thunberg, 1791)

Family HARPADONTIDAE

31. *Harpadon nehereus* (Hamilton-Buchanan, 1822)

Family EXOCOETIDAE

32. *Hirundichthys coromandelensis* (Homell, 1923)
33. *Parexocoetus mentao* (Cuvier, 1846)
34. *Hyporhamphus limbatus* (Valenciennes, 1976)
35. *Rhynchoramphus malabaricus* Collette, 1976

Family BELONIDAE

36. *Strongylura strongylura* (Van hasselt, 1823)

Family PIATYCEP HALIDAE

37. *Platycephalus bengalensis* Visweswara Rao, 1966
38. *Platycephalus tuberculatus* Cuvier, 1829

Order PERCIFORMES

Family AMBASSIDAE

39. *Ambassis commersoni* Cuvier, 1828
40. *Ambassis gymnocephalus* (Lacepede, 1802)

Family SERRANIDAE

41. *Cephalopholis leopardus* (Lacepede, 1802)
42. *Cephalopholis sonnerati* (Valenciennes, 1828)
43. *Epinephelus diacanthus* (Valenciennes, 1828)
44. *Epinephelus latifasciatus* (Temminek and Schlegel, 1842)
45. *Epinephelus maculatus* Block, 1790
46. *Epinephelus malabaricus* (Schneider, 1801)
47. *Epinephelus tauvina* (Forsskal, 1775)

Family TERAPONIDAE

48. *Pelates quadrilineatus* (Bloch, 1790)
49. *Terapon jarbua* (Forsskal, 1775)
50. *Terapon theraps* Cuvier, 1828

Family APOGONIDAE

51. *Apogon taeniatus* (Cuvier, 1828)

Family SILLAGINIDAE

52. *Sillago sihama* (Forsskal, 1775)

Family LACTARIIDAE

53. *Lactarius lactarius* (Schneider, 1801)

Family CARANGIDAE

54. *Alectis ciliaris* (Bloch, 1788)
55. *Alectis indicus* (Ruppell, 1828)
56. *Alepes djedaba* (Forsskal, 1775)
57. *Alepes vari* (Cuvier, 1833)
58. *Atropus atropus* (Bloch, 1801)
59. *Atule mate* (Cuvier, 1833)
60. *Carangoides tala* (Cuvier, 1831)

Family MENIDAE

61. *Mene maculata* (Bloch, 1801)

Family LEIOGNATHIDAE

62. *Gazza minuta* (Bloch, 1797)
63. *Leiognathus bindus* (Valenciennes, 1835)
64. *Leiognathus daura* (Cuvier, 1829)
65. *Leiognathus dussumieri* (Valenciennes, 1835)
66. *Leiognathus jonesi* James, 1971
67. *Secutor insidiator* (Bloch, 1787)
68. *Leiognathus brevirostris* (Valenciennes, 1835)

Family LUTJANIDAE

69. *Lutjanus argentimaculatus* (Forsskal, 1775)
70. *Lutjanus biguttatus* (Valenciennes, 1830)
71. *Lutjanus johni* (Bloch, 1972)
72. *Lutjanus kasmira* (Forsskal, 1775)
73. *Lutjanus lineolatus* (Ruppell, 1828)
74. *Lutjanus lutjanus* Bloch, 1790
75. *Lutjanus lunulatus* (Mungopark, 1797)
76. *Lutjanus malabaricus* (Bloch and Schneider, 1801)
77. *Lutjanus monostigma* (Cuvier, 1828)
78. *Lutjanus rivulatus* (Cuvier, 1828)

Family NEMIPTERIDAE

79. *Nemipterus bleekeri* (Day, 1875)
80. *Nemipterus luteus* (Schneider, 1801)
81. *Nemiperus toilu* (Valenciennes, 1830)

Family GERRIDAE

82. *Gerres filamentosus* Cuvier, 1854
83. *Gerres macracanthus* Bleeker, 1854

Family LETHRINIDAE

84. *Lethrinus cinereus* Valenciennes, 1830
85. *Lethrinus lantjan* (Lacepede, 1854)
86. *Lethrinus microdon* Valenciennes, 1830

Family SCIANIDAE

87. *Daysciaena albida* (Cuvier, 1830)
88. *Dendrophysa russellil* (Cuvier, 1830)
89. *Johnius carutta* Bloch, 1793
90. *Johnius belangerii* (Cuvier, 1830)
91. *Johnius macropterus* (Bleeker, 1853)
92. *Paranibea semiluctuosa* (Cuvier, 1830)

Family MULLIDAE

93. *Mulloides falvolineatus* (Lacepede, 1802)
94. *Parupeneus indicus* (Shaw, 1803)
95. *Upeneus (Pennon) tragula* Richardson, 1846
96. *Upeneus (Upeneus) vittatus* (Lacepede, 1801)

Family MONODACTYLIDAE

97. *Monodactylus argenteus* (Linnaeus, 1758)

Family CHAETODONTIDAE

98. *Chaetodon decussatus* Cuvier, 1831
99. *Heniochus acuminatus* (Linnaeus, 1758)

Family MUGLIDAE

100. *Mugil cephalus* (Linnaeus, 1758)

Family TRICHIURIDAE

101. *Trichiurus lepturus* Linnaeus, 1758

Family SCOMBRIDAE

102. *Rastrellilger brachysoma* (Bleeker, 1851)
103. *Rastrelliger kanagurta* (Cuvier, 1817)

Family BOTHIDAE

104. *Pseudorhombus arsius* (Hamilton-Buchanan, 1822)
105. *Pseudorhombus elevatus* (Ogilby, 1912)

Family SOLEIDAE

106. *Aesopia cornuta* Kaup, 18584
107. *Zeprias quagga* (Kaup, 1858)

Family CYNOGLOSSIDAE

108. *Cynoglossus arel* (Schneider, 1801)
109. *Cynoglossus bilineatus* (Lacepede, 1802)
110. *Cynoglossus punticeps* (Richardson, 1846)

Family TRIACANTHIDAE

111. *Triacanthus biculeatus* (Bloch, 1782)
112. *Triacanthus indicus* ma Bura, 1982
113. *Triacanthus brevirostris* Schlegel, 1844
114. *Pseudotriacanthus striglifen* (Cantor, 1949)

Family BALISTIDAE

115. *Abalistes stellaris* (Lacepede, 1798)
116. *Aluterus scripta* (Osbek, 1771)
117. *Balistes vetula* Linnaeus, 1758

Family MONOCANTHIDAE

118. *Monocanthus choirocephalus* Bleeker, 1822
119. *Psilocephalus barbatus* Gray, 1831

Family OSTRACIIDAE

120. *Ostraction nasus* Bloch, 1785
121. *Tetrasomus gibbosus* (Linnaeus, 1758)

Family TETRADONTIDAE

122. *Chelonodon pataca* (Hamilton, 1822)
123. *Lagocephalus lunaris* (Bloch and Schneider, 1801)
124. *Lagocephalus spadicius* (Richardson, 1844)
125. *Takifugu oblongus* (Bloch, 1786)
126. *Arothron immaculatus* (Bloch & Schneider, 1801)
127. *Arothron hispidius* (Linnaeus, 1802)
128. *Arothron leopardus* (Day, 1818)
129. *Arothron nigropunctatus* (Bloch and Schneider,1801)
130. *Arothron reticularis* (Bloch, 1801)

REPTILES

1. *Enhydrina schistoae* (Daudin)
2. *Hydrophis cyanocinctus* (Daudin)

ECOLOGY OF CORAL REEFS OF PALK BAY

The coral reefs of Palk Bay are a small strip of fringing reefs present almost parallel to the shore in an east-westerly direction. The lagoon is small and shallow and can be waded through at low tides. The width of lagoon varies from 400 ± 200 meters in different regions. A channel 2-4 meters deep, almost at the mid length of the reef, through which fishing boats enter the lagoon, separates the reef into the eastern and western halves. The eastern half, which extends eastward up to Pamban Bridge, is called Kathuvallimunai reef, and the western half, which extends westward up to Tehdai village is called Vellapertumuni Reef. The Kathuvallimuni Reef is comparatively wider than the Vellaperutumuni Reef for most of its length. Because of their continuity and similarity in faunal assemblage, earlier workers had treated both these reefs as single biotype.

A general survey along the beach to the open bay is demarcated as sandy shore, lagoon, back reef, reef-crest, and the fore reef for the purpose of the present study. The shore throughout the coral reef area of the Palk Bay was purely sandy, except at the extreme eastern end near the Pamban Bridge where there were a few sandstone formations. The sandy beach harbored a variety of fauna. The burrowing crabs, *Dotilla myctiroides* and *Scopimera proxima* the bivalve, *Donax* spp. were common along the sandy shore. Oysters were alo present in this rocky area. During the first survey (May 1997) the scyphomedusa, *Rhopilema hispidum* were found washed ashore in large numbers. The gastropods, *Umbonium vestoarium* and *Cerithidia jluviatalis* are common, the latter representing the commonest molluscan shell of this area, found on the shore. The starfish, *Pentaceraster australis* (Lutkin) was often found stranded on the shore by the receding tides.

The width of the lagoon ranged from 200 to 600 m, with a depth of 1.5 to 2 m at its central part during spring tides. Since the beach was of loose white sand, the waves, especially during the period of northeast monsoon, whipped up considerable quantities of beach sand and deposited it in the lagoon, gradually filling its bottom. Further the loose sand blown off by the southwest wind from land may also get deposited in the lagoon. The absence of living corals in the lagoon may probably be on account of the absence of solid substratum on which the planula larvae can settle. The bottom sand was found mixed with a good percentage of dead shells of *Cerithidia jluviatalis*. In the deeper parts of the lagoon variously coloured, branching sponges were fairly common. *Hèrcinia fusca* Carter, *Dysidea fragilis* (Montagu), *Spirastrella inconstans* Dendy, *Haliclona tenuiramosa* (Burton), *Callyspongia diffusa* (Riddley) and *C. fibrosa* (Ridley and Dendy) etc. were some of the common sponges encountered during transect studies in this area. The sea anemone *Stoichactes* sp. was not uncommon. The small tube dwelling polycheate

Spirobis sp. was found in abundance on the sea grass *Cymodocea*. At least three species of echinoderms viz. *Pentacerastar australis* (Lutkin), *Holothuria atra* (Jager) and *H. scabra* (Jager) were observed within the lagoon. The bottom of the lagoon was covered with sea weeds such as *Cymodocea, Ulva reticulata, Amphiroa* and the calcareous green alga *Halimeda*. Among the other major algae *Turbinaria* sp. and *Padina* spp. were also common.

The shoreward side of the reef was composed of massive dead reefs. They were widely spaced with their interspaces filled with loose sand similar to that of the shore. Majority of the corals occurring in this part of the reef were mostly massive. Individual colonies were small, generally ranging from 10 to 20 cm in greater diameters. Though the fauna was rich in regard to the number of species, none of the species were said to be abundant but *Favia pallida* and *Leptastrea transversa* out number the others. Other massive corals like *Goniopora stokesi, Porites* spp. *Favia favus, Goniastrea retiformis, Platygyra lamellina, Hydnopora excesa, Symphyllia recta and Cyphastrea microphthalma* occurred in numbers. *Galaxea fascicularis* and *Pavona varians* was also noticed during the investigation from this reef. Other fauna such as encrusting sponges and bryozonans were abundant on corals of this area. Soft corals such as *Lobophyton* sp. *Sarcophyton* sp. and polychaetes were numerous on corals, the parasitisation by some of them causing irregular nodular branches in certain colonies of corals. Both, *Holothuria atra* and *H. scabra* were found in the sandy interspaces of the rocks.

The reef crest of these reefs was often observed exposed at low tides. Corals were very rare at the reef crest, probably due to the influence of exposure to sunlight and waves. However, under the dead rocks occasionally *Leptastrea* sp. and *Goniopora* were seen. This part of the reef was comparatively less in live corals, probably due to the influence of intermittent exposure to sun during low tides. The non-calcareous algae *Padina* sp. and *Caulerpa peltata* were common in this region.

The reef slope composed of majority of the branching coral genera viz. *Pocillopora* sp. *Acropora* sp. as well as *Montipora* sp. They were comparatively diverse than the shoreward side. The seaweeds such as *Turbinaria* sp. *Sargassum* sp. *Fading* sp. *Caulerpa* sp. and rarely *Cymodocea* sp. *Halimeda* sp. and a few other encrusting calcareous algae were commonly found in this region. This part of the reef is composed of massive corals with a luxuriant growth of branching corals. Many of the encrusting and massive species occurring in the shoreward side could also be found in this part, but not in such greater abundance as they were in the shoreward side. Among the branching forms, *Pocillopora damicornis* and *Acropora corymbosa* are common in this region.

Many coral associates were found associated with the corals of this part of the reef. At least two species of *Alpheus* were recorded from *Pocillopora damicornis* and *Acropora corymbosa*. Trapezian crabs were found associated with almost all colonies of *P. damicornis*. The spider crab *Tylocaroinus styx* (Herbst) was recorded in plenty on *Pocillopora damicornis* and *Acropora corymbosa*. At least three species of coral reef,

fishes viz. *Chaetopod octofasciatus, Pseudochromis tusens* and *Holocentrus diadema* were found among *Montipora foliosa.*

A total of 61 species of algae was recorded among the three major groups viz, green algae (14 genera and 28 species), brown algae (8 genera and 13 species), red algae (17 genera and 2.0 species). Species of *Caulerpa* and *Sargasam* were the most common plants found in the reef. The physical conditions like the nature of the substratum and water level above the substratum influence the distribution of the flora of the coral reef area (Umamaheswara Rao, 1969). Boring sponges was the major group among the marine organisms causing considerable destruction to the reef system. The bores made by the sponges weaken the entire reef, making it more susceptible to the wear and tear caused by the waves. There are altogether 20 species of boring sponges now known from the Gulf of Mannar and Palk Bay, falling into 9 genera. The most conspicuous genus is *Cliona* both in number of species and in distribution (Thomas, 1969). Among the coral boring organisms bivalve mollusc found to cause considerable destruction to coral reefs of Palk Bay. They act as biological agents in the erosion of hard corals stones. In Palk Bay and Gulf of Mannar 17 boring bivalve species were recorded (under 10 genera of six families, Appukuttan, 1973). Asir Ramesh *et al.* (1996) recorded a total of 73 species of molluscs associated with corals in Palk Bay viz. 46 species of gastropods belonging to 17 families and 27 species of bivalves belonging to 13 families.

The dried sea horse *(Hippocampus kuda)* occurring in great numbers is in great demand in the south-east Asian countries especially in Singapore and China not only for extraction of soup which is a delicacy but also for its medicinal values. Along the Ramnad District coast, the dried sea horse is harvested in large quantities and is used as medicine to arrest whooping cough in children. For whooping cough, the dried sea horse is powdered and heated in the earthen pot. The fried powder mixed with honey is administered as medicine. In some places the fried powder is mixed with the coconut oil and pasted on the cut wounds and also used for curing asthma (Marichamy *et al.*, 1993).

Dugongs are long living animals with a low reproductive rate, a long generation time and a large gap in between off springs. Fishing of dugong in Palk Bay region during 1960 was about 25, which were caught accidentally in the fishing gears. In Palk Bay Karangadu, Nambuthaalai, Morepani and Mullimunai are the minor fishing villages of Dugong. Valivalai (drift net) shore sceins and Thirukkaivalai are being used to capture the dugong in the shallow regions. The explosives (country bombs and dynamites) are also used for capturing the dugong around the deep regions of Thiruppalaikudi and Devipatinam (major fish landing centers of Ramnad District).

THREATS TO THE PALK BAY ECOSYSTEM

Natural threats :

The major stresses on reefs are storms and waves, particularly tropical storms and cyclones. These cause major intermittent damage to reefs, particularly to those reefs that

rarely experience these storms. Cyclonic disturbances develop during certain months (October-November) along the Indian Sea coast and elsewhere in the tropical region.

These cyclones have sustained winds with speed ranging from 65 to 120 km per hour. High-speed winds cause extreme wave action that break corals into rubbles and sometimes-large amounts of sand and other materials may be dumped on to the coral reef. Due to 1969 cyclone, a large area of coral was buried under the sand in Rameswaram area of Gulf of Mannar and Palk Bay. Freshwater runoff damages reefs in semi-enclosed bays and lagoons by lowering salinity and depositing large amounts of sediments and nutrients. There is now considerable speculation that the incidence of both these stresses has been exacerbated by human activities.

Human induced threats :

Varied human activities which are a cause for concern includes runoff and sedimentation from developmental activities, eutrophication from sewage and agriculture, physical impact from maritime activities, dredging, collecting, and destructive fishing practices, pollution from industrial sources and oil refineries and the synergistic impacts of anthropogenic disturbance on top of natural disturbance.

Sedimentation, which is the most well studied impact, may affect corals in three different ways: photosynthetically, physically, and chemically. As most reef-building corals obtain the majority of their nutritional requirements through translocation of metabolites from their photosynthetic partners (Zooxanthellae), any reduction in the availability of light will affect coral nutrition, growth, reproduction and depth distribution.

Physically, sediments also interfere with coral nutrition by coating the feeding surfaces responsible for catching prey items needed to supplement the energy provided by zooxanthellae. While corals do have the ability to cleanse themselves using a combination of mucus secretion and ciliary action, chronic sedimentation may end up in a high energetic cost, adding to the overall impact on the colony. Sedimentation can alter species composition of reefs through photosynthetic and physical effects. Change in relative abundance of morphological types as well as individual species are an important reflection of how sedimentation as a disturbance affects community structure. The standing examples are the coral reefs of Gulf of Mannar islands and the reefs of Palk Bay. So far, the presence of sediment load in the coral reef areas has been confirmed in Gulf of Mannar and Palk Bay, however, quantitatively they are not reported.

Sedimentation can also physically interfere with recruitment of coral larvae, which require a solid substratum upon which to settle and metamorphose. Dredging projects have been particularly damaging the reefs, (Sethu Samudram project, Gulf of Mannar region) primarily through the initial physical disturbance, habitat alteration and the subsequent problems associated with sedimentation. Sand mining in Palk Bay and coral

quarrying in Gulf of Mannar (Tuticorin group of Islands) cause a lot of sedimentation and siltation on coral reefs.

A general rule for coastal zone: whatever is used on land today ends up in the aquifer or coastal zone tomorrow. Salinity changes alone have proven to affect corals, especially on shallow water reef flats, which are most likely to be affected by freshwater runoff. The amount of sediments and chemicals the runoff water carries to the sea has profound effects on fertilization of eggs of coral species and other associated fauna. Likewise, the quality of runoff water can affect the metamorphosis of the larvae of corals. Many areas in Palk Bay and Gulf of Mannar area have large quantities of sediment laden freshwater runoff impinged on coastal reefs, causing high levels of coral mortality, rapid growth of fleshy algae species, and large areas of reduced salinity/quality seawater. Local fishermen of Palk Bay have complained of decreased fisheries and reef vitality not only on these coastal reefs, but also on off shore islands and reefs not directly affected by contact with the sediment. Inspection of these reefs revealed (Zoological Survey of India, Chennai) live adult coral colonies, but less signs of larval recruits with increased levels of sedimentation.

Oil pollution is an extreme example of how chemicals, in these case hydrocarbons, can affect reefs. Research performed in many areas has documented coral mortality, decreased fecundity and recruitment failure in response to chronic oil pollution. The number of mechanised fishing boat may contribute a lot to this effect in Palk Bay especially in the coral reef and sea grass beds.

The overall impact of sewage on a coral reef community depends on sewage, level of treatment, presence of toxic materials and receiving water characteristics. The effects of sewage-related nutrient enrichment on coral reef communities have been documented and include alteration of competitive interactions, reduction of coral calcification rates from decreased light levels and increased phosphate concentrations and increased mortality from bacterial infection. Corals are adapted to live in nutrient poor environments and are relatively slow growing compared to algae, sponges, tunicates and other groups of sessile benthic organisms. Nutrients not only increase the bio-mass of phytoplankton, affecting light transmission and increasing the biological oxygen demand (BOD) which may have some impact on the corals, but also give a competitive advantage to faster growing benthic species. The green algae have formed large mats, covering and killing corals in Mandapam coast coral reefs in Palk Bay, due to sewage pollution from the town. The nutrient enrichment via sewage reduces the photosynthetic efficiency of corals, as algal cells increase in density to the point of becoming self-shading. Since the coral zooxanthellae symbiosis evolved under nutrient limited conditions, it is reasonable to assume that the relationship will become altered in response to changes in the level of nutrients available. Further studies of the physiological effects of such changes are needed to determine the sub lethal or long-term effects of sewage and nutrient enrichment on coral reefs of Palk Bay.

There has been unprecedented bleaching of hard and soft corals throughout the coral reefs of the world from mid-1997 to late-1998. Much of the bleaching coincided with a large *El Nino* event followed by a strong *La Nina* but bleaching in all the coral reefs are uncorrelated. During this event, bleaching and mortality were most pronounced in shallow water (less than 15 m) and particularly affected stag horn and plate *Acropora* and other fast growing corals. Many of the massive, slow-growing species bleached, but some corals have recovered with in one or two months. This bleaching event has resulted in poor coral cover (1999-2000 study by Zoological Survey of India, Chennai) (Venkataraman, 2000) and possibly fewer new coral recruits in Palk Bay for the next 10 years until recovery gains speed. In the short term, this may affect adversely the economy of India, particularly fisheries. There will be a shift in the composition of coral communities; some will have greater dominance of slow growing massive corals, whereas other reefs will lose century-old colonies. Nevertheless, such shifts have occurred in the past and are part of the normal variability of many coral reefs. If however, the recent bleaching event is linked to global climate change, the consequences would be serious for many coral reefs if sea temperatures show a continuing upward trend.

Four types of coral diseases have been "identified": white band disease, black band disease, bacterial infection, and shutdown reaction. While there is a degree of uncertainty over the causes responsible for each disease, they all appear to be stress- related. Synergism is believed to play an important role, as stressed coral seems to be the most susceptible to the above diseases. Sediment, sewage, pesticides, heavy metals, bleaching and other human impacts have tumors, bacterial attack and parasitic worms. White Band Disease has been reported from Andaman and Nicobar and Lakshadweep islands. In addition, a new disease called Pink Line disease is also reported from Lakshadweep.

The use of destructive fishing practices has been responsible for the destruction of coral reefs throughout the world. Destructive fishing practices have seriously damaged many of the Palk Bay and Gulf of Mannar's richest and most diverse coral reefs, necessitating an urgent warning that immediate and far-reaching action is warranted. The Gulf of Mannar and Palk Bay stands out as one of the hardest hit areas, with 60% of its reef in varying stages of deterioration. Because of the large size of the areas concerned and the general lack of resources for enforcement, education appears to be more successful than legislation in controlling these practices. Poverty reduces the alternatives for fishermen who must feed their families and rely on fishing as a source of protein and income. This same problem has led to another human induced impact on reefs: Over Fishing. The uses of fish traps made of long-lasting materials with small mesh sizes results in the capture of pre-reproductive juveniles, affecting future populations and the death of fish when traps become dislodged during storms, yet continue to capture fish, which eventually starve. Several types of net fishing have also been responsible for over-exploitation of reef. As with all biological communities in a coral reef, each species plays an important role in the dynamics of balance. The depletion of grazers, for example, may eventually lead to overgrowth of alga as in the case Palk Bay reefs.

Although it is now illegal, blast fishing has been a widespread and accepted fishing technique in some of the reef areas in Palk Bay and Gulf of Mannar. Schooling reef fishes are located visually, after which the capture boat moves within close range and a lighted bomb is thrown into the middle of the school. After the bomb is exploded, fishermen enter the water to collect the fish that have been killed or stunned by the resulting shock wave. Due to blasting, branching, tabulate and foliose of hard corals are shattered while massive and columnar corals are often fractured. Although this effect of blasting is quite localized, reefs subject to repeated blasting are often do little more than shifting rubble fields or puncture by the occasional massive coral head. In addition to damaging the reef framework, blast fishing results in side-kills of non-target and juvenile fish and invertebrates.

The use of bamboo mesh traps, locally known as koodu, is wide spread throughout Palk Bay and Gulf of Mannar islands reef fisheries. In Ramanathapuram alone 3,312 (37% of the total trap in the Tamil Nadu State) traps are found. Although this gear is not intrinsically destructive, the process of setting and retrieving the trap is largely responsible for the destruction wrought on the reef. These traps set by simply lowering the trap from boat-side via a buoyed rope are responsible for the most reef damage. The traps are often heavily weighed with wooden runners or stones and can destroy entire stands of branching and foliose corals on the reef during their installation and especially removal (by pulling on the rope). If the current trend continues, Koodu trap activities will become an increasingly important cause of reef damage in Palk Bay and Gulf of Mannar.

Ola valai is a type of drive-in net fishing technique where by a line of fishermen in the water use scare-lines, lines with palm leaves tied off at regular intervals to drive fish down a bag net. The scare lines are rhythmically lifted and dropped into the shore areas, often breaking live corals while the fish are driven ahead. Next to this are the shore seines form the major gear of Gulf of Mannar. There are about 1523 numbers of shore seines found in Ramanathapuram district alone, forming about 33% of the total shore seines in the Tamil Nadu state. Although this gear is not intrinsically destructive, the process of shore seines is largely responsible for the destruction of new colonies emerging near lagoon.

While it is simple to prove how damaging destructive fishing practices are to the productivity of fisheries, the economic realities of day-to-day life in Gulf of Mannar and Palk Bay makes the solution difficult to obtain.

The villagers around Palk Bay harvest holothurians, seahorse and pipefishes. Other harvesting activities include chanks and milk fish fry. Turtles are being harvested up to 1000 annually; Dugongs are also illegally poached. The destruction of reefs and reef associated organisms in the Gulf of Mannar and Palk Bay is perhaps unparalleled in the history of environmental damage to nature and natural resources in the recent past (Pillai, 1996). The coral reefs on Palk Bay and Gulf of Mannar have been quarried for industrial purposes from early sixties from Mandapam to Tuticorin. The estimate of coral quarried

varies. At Tuticorin the estimate was 80,000 t per year. Pillai (1973) estimated the exploitation of corals from Mandapam area during sixties and early seventies to the tune of 250 m3 per day. It is found that some of the islands (Vilanguchalli in Tuticorin group and Poovarasanpatti Island in Keelakarai group) are totally submerged below three to four meters under water and vanished may be because of quarrying. A recent status survey on the coral reefs of Gulf of Mannar has revealed that only 25% live coral survived after the recent bleaching event in 1998 (Venkataraman, 2000). The huge colonies of corals that occupied large areas in the lagoons of many islands are no more there due to bleaching, over exploitation of" algae and shells by fishermen in an extensive scale. During collection of algae, fishermen brake most of the corals while negotiating their boats. The export of live crabs and lobsters from this area in the recent years is also causing damage to live corals because fish traps (Koodu) used to collect live crabs are causing a lot of destruction to coral reefs in these areas. Other than these disturbances, siltation, agricultural run off, sewage discharge as well as the faecal pollution is the major problems in these areas.

Due to increased urban development throughout coastal belt of Palk Bay as well as due to the development of getting East coast Road, most of the near shore areas are polluted. The sewage outlets and aquaculture ponds are increasing the suspended load, increasing turbidity, increasing nutrient of the coastal waters of Palk Bay. Wherever the fish processing industries are out letting the sewages, the coastal ecosystem is differing from the adjacent healthy areas. The indiscriminate cutting of the near shore forest in some areas of Palk Bay coast has led to coastal soil erosion with huge quantities of nutrients increasing the physical stresses on the coastal ecosystem of Palk Bay.

SUMMARY

Three different survey parties surveyed the Palk Bay region from Pamban to Kodiakarai during the period from 1997 to 1999. During these surveys a total number of 2625 specimens were collected, which include Fishes (1126), Crustaceans (817), Molluscs, Echinoderms (111), Sponges (24) and coelenterates. The present study reveals that the marine biodiversity of this region is qualitatively very rich and varied, and an extensive taxonomic study would reveal the occurrence of many more species in this region. The following are the list of species identified/recorded from Palk Bay: Chaetognatha 10, Sponges 77, Corals 61, Brachyura 20, Prawns 24, Lobsters 4, Mollusca 48, Echinoderms 36 and Fishes 130. An account of the coral reef ecosystem of Palk Bay has been attempted in this paper explaining the ecology and faunal assemblage of the following areas such as sandy shore, lagoon, back reef, reef-crest, and the fore reef. The natural threats such as storms and waves, particularly tropical storms and cyclones and the human induced threats such as pollution, over fishing, diseases, bleaching and destructive fishing practices in Palk Bay are explained.

ACKNOWLEDGEMENTS

The authors are grateful to the Director, Zoological Survey of India, Kolkata for the facilities. The scientists of Marine Biological Station have identified the species such as Chaetognatha, molluscs, crustaceans, echinoderms and fishes. We thank them for their kind help. The co-operation extended by Mr. M. Ramalingam and Mr. A. Sivasamy of the Marine Biological Station during survey is highly appreciated. We also thank the Junior Research Fellows (All India Coordinated Project on Marine Biodiversity, Ministry of Environment and Forests) for their help in the preparation of the faunal list.

REFERENCES

Agastheesapillai, A. and R. Thiagarajan 1979. Biology of the green turtle *Chelonia mydas* (Linnaeus) in the Gulf of Mannar and Palk Bay, *J. mar. biol. Assoc. India,* **21**(1&2) : 45-60

Ameer Hamsa, K. M. S. 1972. Foraminifera of the Palk Bay and Gulf of Mannar, *J. mar. biol. Assoc. India,* **14**(1) : 418-423

Ameer Hamsa, K. M. S. 1978. Fishery of the Swimming Crab *Portunus pelagicus* Linnaeus from Palk Bay and Gulf of Mannar, *Indian J. Fish*, **25**(1&2) : 229-233

Appukuttan K. K. 1972. Coral boring bivalves of Gulf of Mannar and Palk Bay, *Proc. Symp. Corals and Coral reefs.* MBAI., 379-398

Appukuttan, K. K. 1973. Distribution of coral boring bivalves along the Indian coasts. *J. mar. biol. Ass. India,* **15**(1) : 427-430.

Asir Ramesh, D. 1996. Studies on the ecology of coral reefs in Gulf of Mannar and Palk Bay, Southeastern coast of India. Ph.D. Thesis, Annamalai Univ., India, 82 p.

Asir Ramesh, D., Jeyabaskaran R. and A. L. Paul Pandian 1996. Gastropods and bivalve associated with reef building corals, Palk Bay, Southeastern coast of India. Puket Marine Biological Centre, Special Publication, **16** : 257-260.

Balskrishnan Nair, N and K. Dharmaraj, 1980. Wood boring mollusks of the Palk Bay and Gulf of Mannar, *Mahasagar,* **13**(3) : 249-260

Bapat, S.V. 1955. A preliminary study of the pelagic fish eggs and larvae of Gulf of Mannar and Palk Bay, *Indian J. Fish.*, **2**(1): 231-255

Batcha, H and M. Badrudeen, 1992. Length-weight relationship and relative condition of *Liognathus brevirostris* (Valenciennes) from the Palk Bay, *J. mar. biol. Assoc. India,* **34**(1&2) : 269-270

Bensam, P. 1973. Sciaenid fishery resources of the Gulf of Mannar and Palk Bay. *Proc. Symp. Resources of seas around India* : 461-469.

Bindu Sulochan and K. Muniyandi, 2005. Hydrographic parameters off Gulf of Mannar and Palk Bay during a year of abnormal rainfall, *J. mar. biol. Assoc. India,* **47**(2) : 198-200.

Chacko, P. I. and A. Rahim 1968. Survey of fishing ground in the Palk Bay and Northern sector of Gulf of Mannar off Rameshwaram, Pambam and Mandapam. *Madras. J. Fish.*, **4** : 47-55.

CMFRI, 2004. Production of agar from the seaweeds of Gulf of Mannar and Palk Bay. CMFRI *Ann. Rep.* (2003-2004) ICAR Revolving Fund. 82-83.

Devaraj, M. 1986. Maturity, spawning and fecundity of the streaked seer, *Scomberomorus lineolatus* (Cuvier and Valenciennes), in the Gulf of Mannar and Palk Bay, *Indian. J. Fish.*, **33**(3) : 293-319.

Devaraj, M. 1987. Maturity, spawning and fecundity of the streaked seer, *Scomberomorus guttatus,* in the Gulf of Mannar and Palk Bay, *Indian J. Fish.*, **34**(1) : 48-77.

Devaraj, M. 1998. Food and feeding habits of the streaked seer, *Scomberomorus lineolatus* (Cuvier and Valenciennes), in the Gulf of Mannar and Palk Bay, *J. mar. biol. Assoc. India,* **40**(1&2) : 91-104.

Jayaraman, R. 1954 Seasonal variations in salinity, dissolved oxygen and nutrient salts in the inshore waters of the Gulf of Mannar and Palk Bay near Mandapam (S. India). *Indian J. Fish.*, **1** : 345-364.

Hornell, J. 1922. The Indian pearl fisheries of the Gulf of Mannar and Palk Bay. *Proc. Symp. Madras Fish. Bull.*, **16** : 1-188.

Hornell, J. 1924. Report on the inspection of pearl banks in the Gulf of Mannar and Palk Bay in March and April 1923, *Madras Fish. Bull.*, **17** : 199-214.

James, D. B and B. K. Baskar 1994. Present status of the Beche-de-mer industry in the Palk Bay and Gulf of Mannar, *CMFRI Bulletin,* **46** : 85-90.

James, P. S. B. R and C. Adolph. 1965. Observations on trawl fishing in the Palk Bay and Gulf of Mannar in the vicinity of Mandapam, Indian, *J. Fish.*, **12**(1&2) : 530-545.

James, P. S. B. R. 1966. Notes on the biology and fishery of the butterfly Ray, *Gymnura poecilura* from the Palk Bay and Gulf of Mannar, Indian. *J. Fish.*, **13**(1&2) : 150-157.

James, P. S. B. R. and M. Badrudeen 1975. Biolofy and Fishery of *Leiognathus breviristris* (Valenciennes) from the Palk Bay and Gulf of Mannar, *Indian J. Mar. Sci.*, **4**(1) : 50-59.

James, P.S.B.R., R.Soundararajan and J. Xavier Rodrigo 1985. Preliminary studies on culture of fin-fishes in cages in the coastal waters of Palk Bay at Mandapam, *Symp. Ser. mar. biol. Assoc. India,* **6** : 910-915.

James, P. S. B. R. 1986. Biology and Fishery of *Leiognathus jonesi* James from the Palk Bay and Gulf of Mannar. Pp.29-101. In: Recent Advances in Marine Biology, (ed.) P.S.B.R. James, Today and Tommorow's New Delhi, 591 pp.

Jayamani, K. 2002. Status of organic load in coastal waters of chosen sites in the Gulf of Mannar and Palk Bay. M. Phil., dissertation submitted to Madurai Kamaraj University, 140 pp.

Jayaraman, R. 1954. Seasonal variations in salinity, dissolved oxygen and nutrient salts in the inshore waters of the Gulf of Mannar and Palk Bay near Mandapam (S. India), *Indian J. Fish.*, **1**(1&2) : 345-364.

Jayasankar, P. 1991. Sillaginid fishes of Palk Bay and Gulf of Mannar. Indian with an account on the maturation and spawning of Indian sand whiting, *Sillago sihama* (Forsskal), *Indian J. Fish.*, **38**(1) : 13-25.

Jayasankar, P. 1997. Population parameters of *Pennahia anea* and *Nibea maculate* in the Palk Bay / Gulf of Mannar area, India, *NAGA.*, **29**(2) : 46-48.

Jayasree, V and A. H. Parulekar 1977. The ecology and distribution of alcyonaceans at Mandapam (Palk Bay and Gulf of Mannar) South India, *J. Bombay nat. Hist. Soc.*, **94**(3) : 521-524.

Kaliaperumal, N. 2004. Production of agar from the seaweeds of Gulf of Mannar and Palk Bay. *CMFRI Annual Report,* 2003-04 : 82-83.

Kartha, K. N. K. 1959. A study of the copepoda of the inshore waters of Palk Bay and Gulf of Mannar. *Indian J. Fish.*, **6**(1&2) : 265-267.

Kasinathan, C. 1988. Bumper catch of 'Kalaru' from Dhanushkodi and Moondrurayar chathiram (Palk Bay). Rameswaram Island. *Mar. Fish Infor. Serv. T and E. Ser.*, **89** : 16-17.

Kasinathan, C., K. Muniyandi, M. Bose and A. Gandhi 2002. Observations on whale shark Rhincodon typus (smith) caught at Pamban, Palk Bay and Gulf of Mannar. *Mar. Fish Infor. Serv. T and E. Ser.,* **174** : 12-13.

Kathal, P. K. 2005. Sethusamudram Ship Canal Project: Ocenographic / geological and ecological impact on marine life in the Gulf of Mannar and Palk Bay, Southeastern coast of India. *Curr. Sci.,* **89**(7) : 1082-1083.

Krishnamoorthy, P. and P. Subramanian 1998. Meroplankton production in the Gulf of Mannar and Palk Bay on the southeast coast of India. *J. mar. biol. Assoc. India,* **39** : 44-48.

Krishnamoorthy, P. and P. Subramanian 1999. Organisation of commercially supporting meroplankton in Palk Bay and Gulf of Mannar biosphere reserve areas, southeast coast of India. *Indian J. Mar. Sci.*, **28**(2) : 211-215.

Krishnamoorthy, P. and P. Subramanian 2003. Seasonal variations and species association of meroplankton in the Palk Bay and Gulf of Mannar along the east coast of India. *J. mar. biol. Assoc. India,* **45**(2) : 152-157.

Krishna Pillai, N. and C. Kasinathan 1995. Movement of a large shoal of Hilsa kelee from Palk Bay to Gulf of Mannar. *Mar. Fish Infor. Serv. T and E. Ser.*, **140** : 8-9.

Kumaraguru, A. K. 2002. Assesment of the impact of bleaching phenomenon on the corals and their recovery in the Gulf of Mannar and Plak Bay. Report No. **3-8/99**, 105 pp.

Kumaraguru, A. K., J. J. Wilson and N. Marimuthu 2003. Recovery of corals from bleaching event of 2002 in Palk Bay, southeast coast of India, (Abstract only). *Nat. Sem. Reef ecosystem remediation; SDMRI, Tuticorin*-628001, 24th to 26th Sep 2003, p. 23.

Kumaraguru, A. K, K. Jayakumar and C.M. Ramakrishnan 2003. Coral bleaching 2002 in the Palk Bay. Southeast coast of India. *Curr. Sci.*, **85**(12) : 1787-1793.

Kumaraguru, A. K, K. Jayakumar, J. J. Wilson and C. M. Ramakrishnan 2005. Impact of the tsunami of 26 December 2004 on the coral reef environment of Gulf of Mannar and Palk Bay in the southeast coast of India. *Curr. Sci.*, **89**(10) : 1729-1741.

Lal Mohan, R. S. 1976. Some observations on the cow, *Dugong Dugon* from the Gulf of Mannar and Plak Bay during 1971-75. *J. mar. biol. Assoc. India,* **18**(2) : 391-397.

Lipton, A. P. and M. Selvakku 2001. Tagging and recapture experiments in the Indian sacred chank, *Turbinella pyrum* along the Gulf of Mannar and Palk Bay. India. Phuket. *Mar. Biol. Cent. Spec. Publ.*, **25**(1) : 51-55.

Malik, T. K. 1983. Shelf sediments and mineral distribution patterns off Mandapam, Palk Bay, *Indian J. Mar. Sci.*, **19** : 203-208.

Mahadevan, S. 1958. Report on the "Kaaral" (Leiognathus spp.) and (Gaza minuta) .Fishery of Rameshwaram Island in the Gulf of Mannar and Palk Bay, *Proc. Indian. Soc. Cong. Assn.* 45th Session.

Marichamy, R. Lipton, A. P., Ganapathy, A. and Ramalingam J. R. 1993. Large scale exploitation of sea horse *(Hippocampus kuda)* along the Palk Bay coast of Tamil Nadu, CMFRI, *Marine Fisheries Information Service,* **19** : 17-20.

Maruthanayagam, C. and P. Subramanian 1999. Hydrological and Zooplankton biomass variation in Palk Bay and Gulf of Mannar along the east coast of India, *J. mar. biol. Assoc., India,* **41**(1&2) : 7-18.

Maruthanayagam, C. and P. Subramanian 2000. Diversity of copepods in Palk Bay and Gulf of Mannar along the southeast coast of India, *Seshaiyana,* **8**(2) : 13-14.

Maruthanayagam, C., C. Senthil Kumar and P. Subramanian 2001. Seasonal variation of protozoans in Palk Bay and Gulf of Mannar along the southeast coast of India, *J. mar. biol. Assoc. India,* **43**(1&2) : 186-189.

Murthy, A. V .S. and P. U. Verma 1964. The hydrographical features of the waters of Palk Bay during March, 1963, *J. mar. biol. Assoc. India,* **6**(2) : 207-216.

Nammalwar, P., A. P. Lipton, S. Krishna Pillai, G. Maheswardu, C. Kasinathan, M. Bose, N. Ramamoorthy and P. Thilairajan 1994. Instances of finless black porpoise, *Neophacaena* phocaenoides caught in Mnadapam region along the Palk bay coast in Tamil Nadu, *Mar. Fish.. Infor. Serv. T. and E. Ser.,* **127** : 16-17.

Palanichamy, S. and A. Rajendran 2000. Heavy metal concentrations in sea water and sediments of Diversity of Gulf of Mannar and Palk Bay, southeast coast of India, *Indian J. Mar. Sci.,* **29**(2) : 116-119.

Pillai, C. S. G. 1969. The distribution of corals on a reef at Mandapam (Palk Bay) S. India. *J. mar. biol. Assoc. India,* **11**(1&2) : 62-72.

Pillai, C. S. G. 1973. Corals resource of India with special reference to Palk Bay and Gulf of Mannar. *Proc. Symp. Living Resources of Seas around India.* 700-705.

Pillai, C. S. G. 1975. An assessment of the effects of environment and human interference on the coral reefs of Palk Bay and Gulf of Mannar along the Indian Coast. *Seafood export J.,* 7(12) : 1-13.

Pillai, C. S. G. 1996. Coral reef of India, their conservation, and management (eds. Menon. N. G. and Pillai. C.S.G.) (In Marine Biodiversity conservation and management) *CMFRI, Cochin, India* : 16-31.

Prabhu, M. S. 1954. The perch fishery by special traps in the area around Mandapam in the Gulf of Mannar and Palk Bay, *Indian J. Fish,* **1**(1&2) : 84-129.

Raghu Prasad, R. 1960. Observations on the distribution and occurrence of diatoms in the inshore waters of the Gulf of Mannar and Palk Bay, *Indian J. Fish,* **7**(1&2) : 49-68.

Ramadoss, V. 2002. Studies on the Ecology and biology of Butterflyfish *Chaetodon collare* in the Gulf of Mannar and Palk Bay, Ph.D. Thesis, Madurai Kamaraj Univ., Madurai : 1-272.

Rama Rao, K. V. 1954. Biology and fisheries of Palk Bay squid *Sepioteuthis arctipinnia* Gould *Indian. J. Fish,* **1** : 37-66.

Rama Rao, K. V. 1972. On a collection of shore fishes from the Coromandel coast, Palk Bay and Gulf of Mannar *Rec. zool. Surv. India,* **67** : 15-57

Rekha Nair, J. 2005. Silverbelly fishery of Palk Bay and Gulf of Mannar with special refernce to *"Leiognathus jonesi"* (James, 1967), *Indian J. Fish.,* **52**(2) : 189-195.

Sankarankutty, C. 1965. On decapoda brachyuran from the Gulf of Mannar and Palk Bay, *Proc. Symp. on Crutacea, MBAI,* **1**(2) : 347-362.

Satyanarayana Rao, K and K. S. Sundaram, 1972. Ecology of intertidal mollusca of Gulf of Mannar and Palk Bay, *Indian. Nat. Sci. Acad.,* **38B**(5&6) : 462-474.

Silas, E. G. and C. Sankarankutty, 1965. Field investigations on the shoe crabs of the Gulf of Mannar and Palk Bay with special reference to the ecology and behaviour of the pellet crab *Scopimera proxima* Kemo. *Proc. Symp. On Crustacea, MBAI,* **3** : 1008-1025.

Srinivasan, M. 1977. Chaetognaths of the Indian seas. *Indian. J. Zootomy* : 53-56

Thomas, P. A. 1969. Boring sponges of the reefs of Gulf of Mannar and Palk Bay. *Proc. 1st Inter. Symp. on corals and coral reefs of India* : 303-362.

Thomas, M. M. 1971. Notes on some interesting penaeid prawns (Crustacea : Decapoda) from the South East Coast of India *J. mar. biol. Assn. India* **11**(1&2) : 191- 197

Thomas, M. M. 1976. Decapod crustaceans from Palk Bay and Gulf of Mannar : In : *Recent advances in marine biology* Ed : PSBR James 405-435.

Thomas, P. A. 1972. Boring sponges of the reefs of Gulf of Mannar and Palk Bay, *Proc. Symp. Corals and Coral reefs, MBAI.* : 333-362.

Thomas, P. A. 1973. The sponge resources of India, *Proc. Symp. Living. Res. India* : 693-699.

Thomas, M. M. 1986. Decapod crustacaceans from Palk Bay and Gulf of Mannar. Pp. 405-438. In : Recent advances in Marine Biology, (ed.) P.S.B.R. James, Today and Tomorrow, New Delhi : 591 pp.

Thomas, P.A. 1986. Demospongiae of the Gulf of Mannar and Palk Bay, (In : Recent advances in Marine Biology, (ed) P.S.B.R. James, Today and Tomorrow, New Delhi), 205-365.

Umamaheswar Rao, M. 1968. Additions to the Flora of the Gulf of Mannar and Palk Bay from Mandapam area, *J. mar. biol. Assoc. India,* **10**(2) : 366-369.

Umamaheswara Rao, M. 1969. Coral reef flora of the Gulf of Mannar and Palk Bay. *Proc. 1st Inter. Symp. on corals and coral reefs India,* 217-230.

Umamaheswara Rao, M. 1972. Coral reef flora of the Gulf of Mannar and Palk Bay. *Proc. Symp. Coral reefs, MBAI,* : 217-230.

Umamaheswara Rao, M. 1973. Growth and reproduction in some species of *Gracilaria* and *Gracilariopsis* in the Palk Bay, *Indian J. Fish,* **20**(1) : 182.

Umamaheswara Rao, M. 1974. Additions to the algal flora of the Gulf of Mannar and Palk Bay, *Phykos,* **13** : 56-69.

Velankar, N. K. 1957. Bacteria isolated from seawater and marine mud off Mandapam (Gulf of Mannar and Palk Bay), *Indian J. Fish,* **4**(1&2) : 208-227.

Venkataraman, G and M. Badrudeen 1974. On the diurnal variation in the catches of silverbellies in Palk Bay, *Indian J. Fish,* **21**(1) : 254-265.

Venkataraman, K. 2000. Status of coral reefs of Gulf of Mannar, India, Poster presented in the *9th International Coral reef Symposium, Bali, Indonesia,* Poster D, **1** : Status, 365.

Venkataraman, K., Ch. Satyanarayana, J. R. B. Alfred and J. Wolstenholme 2003. Diversity of Corals : Palk Bay and Gulf of Mannar. Indian : 10-12. In : Hand Book on Hard Corals of India. (eds.0 K. Venkataraman, Ch. Satyanarayana, J.R.B. Alfred and J. Wolstenholme. *Zool. Surv. India,* 350 pp.

Victor, A. C. C., D. Kandasami, I. Jagadis, Boby Ignatius, A. Chellam, G. Chitra, P. Villan and M. Rajkumar 2001. Results of the mother Oyster culture and pearl production in *Pinctada fucata* (Gould) in the inshore waters of the Gulf of Mannar and Palk Bay. Perspectives in Mariculture. (eds.) N.G. Menon and P.P. Pillai, Cochin-India, MBAI, 251-258.

Wilson, J. J., N. Marimuthu and A. K. Kumaraguru 2005. Sedimentation of silt in the coral reef environment of Palk bay, *J. mar. biol. Assoc. India,* **47**(1) : 83-87.