



ICAR

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

TATAPURAM P.O. COCHIN-682 014

1996

MARINE BIODIVERSITY CONSERVATION AND MANAGEMENT

Edited by

N.G. Menon and C.S.G. Pillai



ICAR

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

TATAPURAM P.O., COCHIN-682 014

1996

©

Copyright reserved

Published by: Dr. M. DEVARAJ
Director,
Central Marine Fisheries Research Institute,
Tataparam P.O., Cochin-682 014

Price : Rs. 300 (US\$ 30)

Cover Photograph: National Marine Park, Wandoor,
South Andamans.

Printed in India at Skylark, G.P. Road, Cochin - 682 035

CONTENTS

PREFACE		
I	Introduction	1
II	The Mangroves - Importance, Conservation and Management	4
III	Coral Reefs of India, Their Conservation and Management	16
IV	The Gorgonid Resources and Their Conservation in India	32
V	Crustacean Biodiversity, Conservation and Management	41
VI	Marine Molluscs and Their Conservation	66
VII	Conservation of Sea Cucumbers	80
VIII	The Destruction of Young Fish and Its Impact on Inshore Fisheries	89
IX	Impact of Bottom Trawling on Exploited Resources	97
X	Marine Fishery Resources of India - Present Status and Management Concerns	103
XI	The Marine Turtles and Their Conservation	126
XII	Conservation of Marine Mammals	133
XIII	Marine Pollution in the Coastal Waters of India	143
XIV	Environmental Impacts of Coastal Aquacultural Development	152
XV	Fish Aggregating Devices - A means to Augment Fish Catch.	161
XVI	Guidelines for an Action Plan for the Conservation and Management of Coastal Water bodies.	168
XVII	Coastal Biodiversity - Conservation and Sustainable Management	177
	BIBLIOGRAPHY	193

CONTRIBUTORS

K.K. APPUKUTTAN	Central Marine Fisheries Research Institute, Cochin-682 014
P. BENSAM	Central Marine Fisheries Research Institute, Cochin-682 014
M. DEVARAJ	Central Marine Fisheries Research Institute, Cochin-682 014
C.P. GOPINATHAN	Central Marine Fisheries Research Institute, Cochin-682 014
C.S.GOPINATHA PILLAI	Central Marine Fisheries Research Institute, Cochin-682 014
D.B. JAMES	Tuticorin Research Centre of Central Marine Fisheries Research Institute, Tuticorin-628 001.
MARY ASHA ANTONY	Post Graduate Programme in Mariculture, Central Marine Fisheries Research Institute, Cochin-682 014
N.G. MENON	Central Marine Fisheries Research Institute, Cochin-682 014
K.A. NARASIMHAM	Central Marine Fisheries Research Institute, Cochin-682 014
N.G.K. PILLAI	Central Marine Fisheries Research Institute, Cochin-682 014
V.K. PILLAI	Central Marine Fisheries Research Institute, Cochin-682 014

M. RAJAGOPALAN	Madras Research Centre of Central Marine Fisheries Research Institute, Madras - 600 006
S. SARAVANAN	Post Graduate Programme in Mariculture, Central Marine Fisheries Research Institute, Cochin-682 014
G.S.D. SELVARAJ	Central Marine Fisheries Research Institute, Cochin-682 014
V. SRIRAMACHANDRA MURTY	Central Marine Fisheries Research Institute, Cochin-682 014
C. SUSEELAN	Central Marine Fisheries Research Institute, Cochin-682 014
P.A. THOMAS	Vizhinjam Research Centre of Central Marine Fisheries Research Institute, Vizhinjam, Thiruvananthapuram-695 521
P. VEDAVYASA RAO	Kaveri Compound, Thotankulangara, Alleppey.

PREFACE

Conservation and sustained development of natural living resources and environmental protection have been the focus of extensive, scholarly attention in recent times. This has been the subject of debate and concern of all ecofriendly people the world over in the last decades of the 20th century. The diverse use of coastal and oceanic habitats for fishing, oil & gas, energy, tourism, education and research has naturally generated significant capital returns. This has also resulted in increased competition over ocean and coastal space and resources. Many believe that unbridled trade-based growth in this sector has resulted in the overexploitation of natural resources. In many countries conflicts between different interest groups have been reported with grave social, economic and political implications. In India also similar problems are often reported. Therefore, there is growing awareness among the beneficiaries and user agencies of this sector on the imperative need to conserve, protect and manage the various ecosystems and their valuable living resources. Considering the priority of this problem, the Central Marine Fisheries Research Institute has been conducting various multidisciplinary research projects for developing appropriate strategies over the last five decades to facilitate rational exploitation, conservation and management of the diverse exploited marine living resources in the Indian Exclusive Economic Zone as part of its charter of activities. The research results have revealed that consistently intensive exploitation, especially in the shallow coastal waters, has led to habitat and biodiversity degradation, species replacement and even overharvest of a few vulnerable species. Many strategic ecosystems such as the coral reefs, seagrass beds, mangrove forests, estuaries, backwaters, salt marshes and lagoons have also been subjected to intense exploitation, often resulting in serious damages to these life supporting systems. The results of ecological, biological and environmental studies conducted on these habitats are unfolding the magnitude and

dimension of the problems. Based on these studies the Institute could propose many regulatory measures and also recommend the declaration of certain vulnerable ecosystems as National Parks and Biosphere Reserves. It is hoped that the Institute's findings would be put to proper use for policy decisions leading to appropriate action. Large scale reclamation of estuarine and brackishwater areas, dredging, bottom trawling and domestic and industrial pollution constitute the major activities resulting in the progressive degradation of habitats and biodiversity in the coastal regions.

A wide range of resource and environment issues of coastal fisheries, aquaculture and mariculture including their problems and prospects are dealt with in this publication on the basis of the data generated within the Institute over the past few decades. Other relevant literature has also been taken into account, where necessary. The objective of this book is to indicate several management regimes and options to the various users of coastal zone to help them protect the marine habitats and resources, and also to create awareness among them on such threats as : (1) marine habitat modification and destruction; (2) overexploitation of fisheries resources; (3) erosion of species/genetic diversity; 4) anthropogenic modification of species relationships; (5) pollution hazards and (6) dredging and reclamation of natural life supporting systems.

The various chapters have been written by the concerned specialists and postgraduate students of this Institute, and I am thankful to them for presenting the subject matter very lucidly so that the central theme could percolate down to the grassroot level without any difficulty.

January 15, 1996

M. Devaraj

BIBLIOGRAPHY

- ACHARY, G.P.K. 1988. Characteristics of clam resources of Vembanad lake - A case study. *Bull Cent. Mar. Fish. Res. inst.*, 42 (1) : 10 -13.
- AHEMED, M.K. 1993. To have or not to have FADs, *Fish.Chi.* Nov. 11-18.
- ALAGARSWAMY, K., P. BENSAM, M.E. RAJAPANDIAN AND A BASTIAN FERNANDO. 1973. Mass stranding of pilot whales in the Gulf of manar. *Indian J.Fish.*, 20(2): 269-279.
- ALAGARSWAMY, K. 1994. Environmental planning for shrimp aquaculture. *Aquatech Seminars Shrimp/prawn culture - A Management perspective* 7-9 January, Madras.
- ANON., 1982. Bay of Bengal Programme. *BOBP/WP/23*: 1-55.
- ANON., 1987. Mangroves in India - Status report. Govt. of India. *Ministry of Environment and Forests, New Delhi.*
- ANON., 1991. Report of working group on revalidation of the potential marine fisheries resources of the *Exclusive Economic Zone*. (MPEDA, Cochin) pp 57.
- ANON., 1992. Coastal environment. Scientific note, *RSAM/SAC/COM/SN 11/92*.
- APRIETO, V.L. 1990. Payao, tuna aggregating device in the Philippines. *IPFC Symp. Colomo, May 1990*: 1-15.
- APPUKUTTAN, K.K. AND M. BABU PHILIP. 1994. Gastropods - An emerging resource in the by-catch of shrimp trawlers at Sakthikulangra - Neendakara area. *Seafood Export J.*, XXV (21): 5-17.
- ARIF, MM., Y.M. WARWADEKAR AND E.K. RAVINDRAN. 1987. Endangered coral reefs of Bay Islands and their ornamental fishes. *Proc. symp. Management of Coastal Ecosystems and Oceanic*

Resources. Cent. Agri Res. Inst. Port Blair (in press) cited after Dorairaj et al. 1987.

- ATAPPATU, A.R. 1990. The experience of fish aggregating devices for fisheries resources enhancement and management in Sri Lanka. *IPFC Sym. Colombo, May 1990. 16-40.*
- AYYAKKANNU. 1994. Fishery status of *Babylonia spirata* at Portonova, Southeast coast of India. *Phuket mar. bio. cent. Spc. Publ. 13: 53-56.*
- BAKUS, G.J. (Ed). 1994. *Coral Reef Ecosystems*. Oxford and IBH Publishing Co., Pvt. Ltd., pp. 231.
- BALDEV SAHAI. 1994. Wetlands, Mangroves and Coral reefs. *ISRO Report to Ministry of Forests and environment. New Delhi (un pub.) 1-16.*
- BARG, U.C. 1992. Guidelines for promotion of environmental management of Coastal aquaculture development. *FAO Fisheries Technical Paper, 328. pp 112.*
- BENSAM, P. 1994. An overview of the present status and future prospects of demersal finfish resources in India. *Indian J. Fish., 39(1 & 2): 104-110 (1992).*
- BENSAM, P. AND N.G. MENON, 1994. The endangered, vulnerable and rare demersal marine finfishes of india. *Threatened Fishes of India. NATCON publication 4: 297-305.*
- BENSAM, P., N.G. MENON, K. BALACHANDRAN AND JOSEPH ANDREWS. 1994. Need for protecting the non-edible benthic biota of the inshore waters for the benefit of the coastal resources and the fishing industry. *Mar. Fish. Infor., serv. T & E. ser. No. 128: 1-5.*
- BLASCO, F. 1975. The mangroves of India. *French Institute, Pondichery, 1-175.*
- BLASCO, F. 1977. Outlines of ecology, Botany and Forestry of the mangal of the Indian sub-continent. *In: Ecosystems of the world 1. West coastal ecosystem. 241-260.*

- BOHNSACK, J.A. 1993. Marine reserve. *Oceanus*. 36(3): 64-71.
- CHANDRIKA, V AND C.S.G. PILLAI. 1992 Bacteria flora on corals, sponges and reef sediments of Manauli Island in Gulf of Mannar. *Assoc. Microbiologists of India 32nd Annual Conference, Madurai*. P. 174 (Abstract).
- CHUA THIA ENG. 1993. Essential elements of integrated coastal zone management. *Ocean and coastal management* 21 : 1-3.
- DELMENDO, M.N. 1990 A review of artificial reefs development and use of fish aggregating devices. *IPFC Symp. Colombo, 1990*. :116-141.
- DESHMUKH, S.V. AND V. BALAJI (Eds) 1994. Conservation of mangrove forest genetic resources - A training Manual. *M.S. Swaminathan Research Foundation. CRSARD, Madras* 1-487.
- DORIRAJ, K., R. SOUNDRARAJAN AND N.T. SINGH. 1987 Coral of Andaman and Nicobar Islands- A status report. *Cent. Agri. Res. Int. Port Blair*. pp. 29.
- FAO., 1991. Reducing environmental impacts of coastal aquaculture. *Reports and studies. No. 47*. pp. 35.
- FAO., 1992. Guidelines for the promotion of environmental management of coastal aquaculture development. *Fisheries Technical Paper.No. 328*. pp. 122.
- GEORGE, M.J. 1979. Taxonomy of Indian prawns. In: *Contributions to Marine Sciences Dedicated to Dr. C.V. Kurian*. 21-59.
- GOLDBERG, E.D. 1976. *Strategies of Marine Pollution monitoring*. Ed. Goldberg. *John Wiley & Sons Inc*. pp. 304.
- GOPAKUMAR, G., C.S. GOINADHA PILLAI AND D.B. JAMES. 1994. The occurrence of live bait fish in S.Andaman waters and its significance. *Mar. Fish., Infor. Serv. T & E. ser.*, 105: 5-7.
- GOPALAN U.K., D.T. VENUGOPAL, P. UDAYAVARMA AND M. KRISHNANKUTTY . 1983. The shrinking backwaters of Kerala. *J. mar. biol. Ass. India*, 25: 131-141.

- GOPINATHAN, C.P. AND M.S. RAJAGOPALAN. 1983 Mangrove resources, *Bull. Cent. Mar. Fish. Res. Inst.*, 34: 44-46.
- GROVE, R.S. MAKOTO NAKAMURA, HIROSHI KAKIMOTA AND CHOULE J. SONO. 1994. Aquatic habitat technology innovation in Japan. *Bull. Mar. Sci.*, 55 (2-3): 276-294.
- HARDJONO, 1990. Indonesia's experience of fish aggregating devices (FAD's) . *IPFC Symp. Colombo, May 1990*, 164-15.
- HORNELL, J. 1917. The Indian *Beche-de-mer* industry its history and its recent revival. *Madras Fish. Bull.*, 11(4) : 119-150.
- IMRE CSANAS, 1994. Important factors in the success of shrimp farming. *Special Report World Aquaculture*, 250. Mar. 94.
- IYER C.S.P. 1994 Status of heavy metal pollution in coastal waters of India. *Proc. 3rd Nat. Symp. on Environment, Trivandrum, March 1994*.
- JAMES. D.B. 1973. *Beche-de-mer* resources of India. *Proc. Symp. Living Resources*, 706-711.
- JAMES. D.B. 1986. The holothurian resources. *R&D. Series No. 10 for Marine Fishery Resources and Management*, CMFRI, Cochin. pp.4.
- JAMES.D.B. 1988. Echinoderms fauna of the proposed National Marine Park in the Gulf of Mannar. *Proc. Symp. Endangered Marine Animals and Marine Parks. M.B.A. India.* 1:19-25.
- JAMES. D.B. 1989. *Beche-de-mer* its resources, fishery and industry. *Mar.Fish. Infor. Serv., T & E Ser.*, 92:1-35.
- JAMES. D.B. 1994. Conservation and management of sea cucumber resources of India. *Bull.Cent. Mar. Fish. Res. Inst.*, 46: 23-26.
- JAMES.D.B. M.E. RAJAPANDIAN, B.K. BASKAR AND C.P. GOPINATHAN. 1988. Successful induced spawning and rearing of the holothurian, *Holothuria (Metriatyla) scabra* Jaeger at Tuticorin. *Mar. Fish. Infor. Serv. T & E., ser. 87:* 30-33.
- JAMES, D.B., C.S. GOPINADHA PILLAI AND G. GOPAKMAR. 1990. A case study of infestation of *Acanthaster planci* in Andaman waters. *Mar. Fish. Infor. Serv. T & E. ser.* 106: 1-13.

- JAMES, D.B., M.E. RAJAPANDIAN, C.P. GOPINATHAN AND B.K. BASKAR. 1994. Breakthrough in induced breeding and rearing of larva and juveniels of *Holothuria (Meriatyla) scabra* Jaeger at Tuticorin *Proceedings of the national Workshp on Beche-de-mer. Bull. Cent. Mar. Fish. Res. Inst., 46:66-70.*
- JAMES, D.B. AND P.S.B.R. JAMES 1994 Hand book on Indian Sea Cucumbers. *CMFRI Spl. Pub., No. 59. pp.46.*
- JAMES, P.S.B.R. 1992. Impact of fising along the west coast of India during southwest monsoon period on the finfish and shellfish resources and the associated management consideraitons. *Monsoon Fisheries of the Westcoast of India - Prospects, Problems and Management. Bull. Cent., Mar. Fish. Res. Inst., 45: pp. 259.*
- JAMES, P.S.B.R. 1994. The Indian Marine Fisheries Resource senario - Past, Present and Future. *Indian J. Fish., 39(1 & 2) : 1-8(1992).*
- JAMES, P.S.B.R. AND R. SOUNDARAJAN, 1979. On a Sperm whale, *Pysater macrocephalus* Linnaeus stranded at Krusadi Island in the Gulf of Mannar, with an upto date list of diagnostic features of whales stranded along the Indian coast. *J.mar. biol.Ass. India, 21 (1 &2) : 17-40.*
- JAMES, P.S.B.R. AND R.S. LALMOHAN. 1987. The marine mammals of India., *Mar. Fish., Infor. serv.,T & E Ser. 71:1-12.*
- JAMES, P.S.B.R., V.N. BANDE, N. GOPINATHA MENON AND K. BALACHANDRAN. 1989 The catfish resources of southwest coast of India- Prospectsand management problems. *Bull. Cent. Mar. Fish. Res. Inst., 44 (1) : 78 - 94.*
- JAMES, P.S.B.R., C.S. GOPINADHA PILLAI, P.A. THOMAS, D.B. JAMES AND SAID KOYA 1989. Environmental damages and consequences. *Bull. cent. Mar. fish. Res. Institute. 43:212-227.*
- JAMES, P.S.B.R. AND D.B. JAMES 1994. Management of the *beche-de-mer* industry in India. *Proceedings of the National Workshop on Beche-de-mer, Bull. Cent. Mar. Fish. Res. Inst., 46:17-22.*

- JONES, S. AND M. KUMARAN 1980. *The fishes of the Laccadive Archipelago*. the Nature conser. and aquatic sciences, Trivandrum, pp. 760.
- KALIAPERUMAL, N., P. KALADHARAN AND S. KALIMUTHU 1989. Seaweed and Seagrass Resources. *Bull. Cent. Mar. Fish. Res. Inst.* 43:162-173.
- KATHIRVEL M., C. SUSEELAN AND P.V. RAO. 1988. Biology, population and exploitation of the Indian deep-sea spiny lobster, *Puerulus sewelli* Ramadan. *Fishing Chimes*, 8 (11) : 16-25.
- KENCHINGTON, R. 1988 *Coral Reef management hand book*. IUCN. Glans. pp. 123.
- KHOSHOO, T.N. 1983. Environmental guidelines for development of beaches. *Encology* 2 (2) :15-18.
- KIM, C.G., JEONG WOOLEE AND JOOSUCH PARK. 1994 Artificial reef designs for Korean coastal waters. *Bull, mar., Sci.* 55(2-3): 858-866.
- KRISHNAKUMAR. P.K. AND V.K. PILLAI. 1990 Mercury near a caustic soda plant at Karwar, India, *Marine Pollution Bulletin*, 21(6): 304-307.
- KRISHNAMURTHY, K. 1983 The conversion of mangrove land and waters to other uses. UNDP/UNESCO *Workshop on human population, mangrove resources, human induced stresses and human health*. Bogor (Indonesia) 1-12.
- KURATA, A. 1993 (Ed) *Data Book on World Lake Environment. 1. Asia and Oceania*, Inter, Nat. lake Environment Committee, Japan. pp. 770.
- MENON, N.G., M. SRINATH, Y.A. SASTRY, S.G. RAJE, P.U. ZACHARIAH AND M. FEROKHAN 1994. Stock assessment of marine catfishes of India. *Indian J. Fish.*, 39(1 & 2): 65-84 (1992).
- MERGNER, H AND G. SCHEER. 1974 The physiographic zonation and ecological conditions of some South Indian and Ceylon Coral reefs. *Proc. II nd. Inter. Natl. Symp. Coral Reefs. Australia* 2:2-30.

- MIQUEL, J.C. 1984. Shrimps and prawns. In: W. Fischer and G. Bianchi (Eds), *FAO Species Identification sheets for fishing purposes, Western Indian Ocean (Fishing Area 51), vol. 5 (unpaginated)*. FAO Rome.
- MONTEMAYOR, J.R. 1990 A review off development of artificial reefs for fishery enhancement in the Philippines, *IPFC Symp. Colombo, May 1990: 229-243*.
- MUNIYANDI, K. 1985 Studies on mangroves of Pichavaram (South east coast of India) *Ph.D. thesis, Annamalai Univ., Chidambaram, Tamilnadu*.
- MURTY, V.S.R., K.A. NARASIMHAM AND W. VENUGOPAL, 1979 Survey of windopane oyster (*Placenta placenta*) resources in the Kakinada Bay. *Indian J. Fish.*, 26(1 & 2) : 125-132.
- MURTY, V.S.R., T. APPARAO, M. SRINATH, E. VIVEKANDANDAN, K.V.S. NAIR, S.K. CHAKARABORTHY, S.G. RAJE AND P.U. ZACHARIAH. 1994. Stock assessment of threadfin breams (*Nemipterus spp*) of India. *Indian J. Fish* 39(1 & 2) : 9-41 (1992)
- MURTY, V.S.R., M. SRINATH, P. LIVINGSTON.Y.A. SASTRY AND SREENIVASARENGAN. 1994(b). Stock assessment of siverbellies of India with particular reference to Andhara Pradesh and Tamilnadu. *Indian J. Fish.*, 39 (1 & 2) : 42-64 (1992).
- MYERS, N. 1979. *The sinking Ark*. Pragman Press, Oxford.
- NAIR, P.V.R. AND C.S.G. PILLAI 1972. Primary productivity of some coral reefs in Indian seas. *Proc. 1st. Inter natl. Symp Corals reefs India. pp. 33 - 42*.
- NAIR P.V.R AND C.P. GOPINATHAN 1983. Primary production in coastal waters. In: *Mariculture Potential of Andaman- Nicobar Islands- an indiactive survey, Bull. Cent. Mar. Fish. Res. Inst.*, 34 (4) : 29-32.
- NAIR, R.R. AND S.Q. QASIM 1978. Occurrence of banks with living corals off the southwest coast of India. *Indian J. Mar. Sci.* 7:55-58.

- NAIR R.V., R.S. LAL MOHAN AND K. SATYANARAYANA RAO.
1975. The Dugong, *Dugong dugon*, *Bull. Cent. Mar. Fish. Res. Inst.* 26:1-42.
- NARASIMHAM, K.A. 1991. Present status of Clam fisheries of India. *J. mar. biol. Ass. India.* 33 (1 & 2): 76-88.
- NARASIMHAM K.A., G.S.D. SELVARAJ AND S. LALITHA DEVI.
1984. The molluscan resources ecology of Kakinada Bay. *Mar. Fish., Infor. Serv. T & E Ser.*, 59;1-16.
- NARASIMHAM, K.A, V. KRIPA AND K. BALAN. 1995. Molluscan shellfish resources of India - An over view. *Indian J. Fish.* 40(1 &2): 112 - 121 (1993).
- NAYAR, K.N. AND K.K. APPUKUTTAN 1983. Turbo and Trochus resources. *Bull. Cent. Mar. Fish. Res. Inst.*, 34 : 81-84.
- NAYAR K. NAGAPPAN, K. RAMADOS,, C.T. RAJAN AND K. SUNDARAM. 1984 Molluscan resources of Kali river estuarine system in Karnataka. *Mar. Fish. Infor. Ser. T & E. Serv.*, 59: 1-16.
- NORRIS, E.A. (Ed.). 1993. *Global Biological diversity. A study for building conservation into decision making.* Island Press. Washington D.C. pp 383.
- OFFICE OF ENVIRONMENTAL POLICY AND PLANNING (OEPP).
1994. The environmental management of coastal aquaculture. An assessment of shrimp, culture in southern Thailand. Prepared for the office of Environmental Policy and Planning by the Network of Aquaculture Centres in Asia-Pacific (NACA), Bangkok, Thailand.
- PARKER, R.O. 1979. Artificial reefs off Murreless Inlet, South Carolina, *Mar. Fish., Rev.*, Sept. 1979: 12-24.
- PATEL, M.I. 1985. Calcareous sand mining from beaches and littoral areas in the Gulf of Kutch, Gujarat and their possible deleterious effects on marine biota. *Proc. Symp. Endangered marine animals and Marine Parks. Mar. Biol. Ass. India, Cochin:* 483-486.

- PATTERSON, I.J.K., M. MURUGAN AND K. AYYAKKANNU. 1994. Landing data and meat trade with *Chicorens ramosus* and *Pleuroploca trapezium* in the Gulf of Mannar and Palk Bay, south eastern coast of India. *Phuket mar, biol. cent. spec. publ.* 13: 37-42.
- PILLAI, C.S. GOPINADHA 1971. Distribution of Corals on a reef at Mandapam Palk Bay. *J. Mar. Biol. Ass. India.* 11:62-72.
- PILLAI, C.S. GOPINADHA 1971 a. Composition of coral fauna of the southeastern coast of India and the Laccadives. *Proc. Symp. Zool. Soc. London.* 28: 302- 327.
- PILLAI, C.S. GOPINADHA 1973. Coral resources of India with special reference to Palk Bay and Gulf of manar. *Proc. Living Resources of the seas around India.* CMFRI : 700- 705.
- PILLAI, C.S. GOPINADHA 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. GOPINADHA 1977. The structure formation and species diversity of south Indian reefs. *Proc. 3rd Inter. nat. Symp. Coral reefs.* Miami vol. 1: 47 - 53.
- PILLAI, C.S. GOPINADHA 1983. The coral environs of Andaman and Nicobar Islands with a check list of species. *Bull. Cent. Mar. Fish. Res. Inst.*, 34: 33-43.
- PILLAI, C.S. GOPINADHA 1985. Ecological crisis in the coastal Marine habitats. In : *Indian Environment Crisis and Response.* Nataraj pub. Dehradun. Reprinted in *Environmental Geopgraphy.* Vol. 10, Heritage pub. New Delhi. 120 - 130.
- PILLAI, C.S. GOPINADHA 1986. Recent corals from southeast coast of India. In. *Recent advances in Marine Biology.* Today and Tomorrow pub. New Delhi. 107-201.
- PILLAI, C.S. S. GOPINADHA AND S. JASMINE. 1989. The coral fauna of Lakshadweep. *Bull. cent. Mar. Fish. Res. Inst.*, 43 : 179 - 195.

- PILLAI, C.S. GOPINADHA AND S. JASMINE (in press) Report on the scleractinia from the erstwhile travancore coast. *J. mar. biol. Ass. India.*
- PILLAI, C.S.G. AND MADAN MOHAN. 1986. Observtions on the lobsters of Minicoy. *Indian J. Fish.* 23 (1): 112 - 122.
- PILLAI, P.P. (in press). An overview of the present status and future prospectus of pelagic finfish resources of India. *Indian J. Fish.*
- PRADO, J. 1990. Some consideration of surface and midwater FADs Technology and utilisation. *IPFC Sym. Colombo. 1990 : 258-263.*
- PRESTON. 1990. Fish aggregating devices in the Pacific Islands region. *IPFC Symp. Colombo. 1990. 279 - 294.*
- QASIM, SIZ. 1980 Proposal for the development of Marine Parks at Malvan (Maharashtra). *Report, N I O pp 27.*
- QURESHI, J.M. 1957. Botanical siviculture features of mangrove forests of Bombay State. *Proc. Mangrove Symp., Calcutta, 20 - 26.*
- RAJAGOPALAN, M. 1984. Value of sea turtles to India, *CMFRI Spl. Pub. 18: 49-57.*
- RAJAN, J.B. 1994. Appraisal of Artificial reef programme in Pozhiyoor. In: *Programme for community organisation Seminar, Trivandurni. June 1994.*
- RAMAKRISHNAN, K. 1994. *Tecnological change and Development of Marine Fishing Industry in India - A case study of Kerala.* Daya publishing house, New Delhi. pp. 338.
- RAO, G.S. P.S. KURIAKOSE, N. RAMACHANDRAN, M.M, MEIYAPPAN, G.P.K. ACHARY, D. NAGARAJA AND H.S. SHIVANNA. 1989. Atlas of clam resources of Karnataka. *CMFRI Spl. pub., 46: 1-56.*
- RAO, P.V. AND V.S.R. MURTY. 1993 Complexities of Management of inshore Fishery Resources of India. *Fishing chimes. 13(8) : 5-10.*

- RAO, T.A., R.S. LALMOHAN. S.K. CHAKBABORTHY. V.S.R. MURTY, K.V.S. NAIR, E. VIVEKANANDAN AND S.G. RAJE 1994. Stock assessment of Corakers. *Indian J. Fish.*, 39(1 & 2): 85-103. (1992)
- RASHID, M.A. 1988. Gujarat's Gulf of Kutch - A marine Paradise. *Proc. Symp. Endangered Marine animals and Marine Parks*. Mar. Biol. Ass. India, (1985). 467-474.
- RUSSEL, B.C. F.H. TALBOT AND S. DOMM. 1974 Patterns of colonisation of artificial reef fishes. *proc. II nd Inter. Nat. Coral Reef Symp. Brisbane*. Vo. 1 : 207 - 214.
- SACLAUSO., C.A. 1989. Brackish water aquaculture - threat to the environment . *NAGA ICLARM Quarterly*. 12(3) : 6-8.
- SAENGER, P., E.J. HEGERL AND J.D.S. DAVIS (Eds). 1983. Global status of mangrove ecosystems. *The Environmentalist*, 3, suppl. 3.
- SAENGER, P. AND N.A. SIDDIQUE. 1983. Mangrove afforestation programme of Bangladesh. *Ocean and Coastal Management*. 20(1) : 23-37.
- SAMPSON MANICKAM, P.E., M.R. ARPUTHARAJ AND P. VEDAVYASA RAO. 1989. Exploitation of juveniles of Green Tiger Prawn, *Penaeus semisulcatus* along Palk bay and its impact on the prawn fishery of the region. *Bull. Cent. Mar. Fish. Res. Inst.*, 44 part 1 : 137 - 145.
- SCHORDER, P. 1992. UNEP-s Regional programme and UNCED's future. *Ocean and coastal Management*. 18 (1) : 101- 111.
- SIDHU, S.S. 1963. Studies on the mangroves of India. *Indian Forester*. 89:337 - 351.
- SILAS, E.G., P. PARAMESWARAN PILLAI, M.H. DHULKHED, C. MUTHIAH AND G. SYDA RAO. 1980. Purse seine fishery - imperative need for regulation. *Mar. Fish. Infor. Serv. T & E. ser.*, 24: 1-9.
- SILAS. E.G. (Ed.) 1984. Sea turtle research and conservation. *Bull. Cent. Mar. Fish. Res. Inst.*, 35: pp 82.

- SILAS .E.G. (Ed). 1988. *Proceedings of the Symposium on Endangered Marine Animals and Marine Parks*. Mar. Biol. Ass. India, Cochin, 1985. pp. 505.
- SIMRAD. F. 1990. Two examples of artificial reefs in Japan. *IPFC Symp. Colombo*. 1990: 314 - 339.
- STODDART. D.R. AND F.R. FOSBERG. 1972. South Indian sand Cays. *Atol Res. Bull., Wash.* 161: 1-16.
- SUBBA RAO, N.V. 1991. Mollusca. *Animal Resources of India*. 125-147.
- SUNIL KUMAR, R. AND A. ANTONY. 1994. An action plan for restoration and conservation of mangroves of Cocin backwaters, *Proc. Indian national Conf. on Harbour and Ocean Engineering*. Puna 1-10.
- SUSEELAN, C. 1987. Impact of environmental changes and human interference on the prawn fishery resources. *Mar. Fish. Infor. Serv. T & E Ser.*, 73: 1-5.
- SUSEELAN, C. AND K.P. NAIR. 1994. Endangered, vulnerable and rare estuarine shellfishes of India. In: *Threatened fishes of India*. NATCON Publication - 4: 237-251
- SUSEELAN C., K.N., RAJAN AND G. NANDAKUMAR. 1989. The Karikadi fishery of kerala. *Mar. Fish. Infor. Serv., T & E Ser.*, 102 : 4-8.
- SUSEELAN, C. AND N.N. PILLAI 1995. Crustacean fisheries Resources of India - An overview. *Indian J. fish.*, 40(1 & 2) : 104 - 111 (1993).
- THOMAS, P.A. AND RANI MARY GEORGE. 1987. Gorgonid resources of India. *Mar.Fish. Infor. Serv., T & E Ser.*, 74: 1-13.
- TIENSONGRUSMEE, B. 1995 Environmental issues of shrimp farming, South East Asian Experience. INDAQUA 95-MPEDA.
- TURNER, C.H. 1969. Man-made reef ecology. *Calif. dept, Fish Game, fish. Bull.*, 146.

- VARMA, R.P. 1961. Flora of the pearl beds off Tuticorin. *J. mar. biol. Ass. India.* 2: 221-225.
- WAFER, M.V.M. 1986. Corals and coral reefs of India. *Proc. Indian Acad. Sci (Animal sciences) supp.* Nov. 19-43.
- WELLS, S.M. 1988. Coral reefs of the world. Vol. 2. Indian Ocean, Red Sea and Gulf. IUCN.: 77-94.
- WILLMANN, R. 1990. Economic and social aspects of Artificial reefs and FAD s. *IPFC Sump.* Colombo. 1990: 384 - 391.
- WONG.E.F.H. 1990. Artificial reef development and management in Malaysia. *IPFC Symp.* Colombo. 1990 : 392 - 422.
- WOODHEAD., W.J.P., JEFFRERY H PARKER AND IVER W. DUEDALL. 1982. The coal waste artificial reef programme. A new resource potential for fishing reef construction. *Mar. Fish., Rev.,* 44: 6-7.