

## **Taxonomy in Biomedical Resources of the Exclusive Economic Zone of India**

**Arun H. Parulekar**

National Institute of Oceanography, Dona Paula, Panaji.

Marine organisms as a group, possess considerably modified biosynthesis pathways to produce novel and dynamic metabolites, than do their terrestrial and limnetic counterparts (Attaway, 1978). Interest in marine biomedical research, as a lead for drugs, pharmaceuticals and other industrial materials, has been widespread, especially in the last three decades. The pioneering work aimed at tapping the biomedical potentials of marine organisms, was confined to the Pacific and the Atlantic Ocean as also, on a lesser scale, to the Caribbean and the Mediterranean Sea. However, no information about the biomedical potentials of Indian Ocean, was available, till the recent past.

Marine biomedical research is multidisciplinary and involves taxonomy, ecology, nutrition, physiology, pathology, ethnobiology, microbiology, medicine, pharmacology, chemistry of natural products, toxicology and biochemistry (Halstead, 1970). The taxonomic studies have an unique place, as the marine biomedical potential is species specific and unless the correct systematic position upto species level is known, the scope of resources for exploitation and utilization, will greatly be restricted.

### **Research in Marine Taxonomy in India**

India is one of the few countries, having long and glorious traditions of more than a century, in marine biological research. A review of relevant literature reveals that from the year 1875 to almost 1950, taxonomy, especially faunal, formed an important component of marine science research in India.

A large number of research contributions, pertaining to distribution and taxonomy of algae, phytoplankton, macrophytes, sponges, sea anemones, corals, polychaetes, crustaceans, molluscs, echinoderms, minor phyla, fishes and marine mammals from diverse ecosystems, like Okhamandal, Bombay, Karwar, Malabar and Travancore Coast, Gulf of Mannar, Madras, Pulicat Lake, Visakhapatnam, Chilka Lake, Port Canning, Hooghly estuary, Andaman Sea

and the Laccadive Archipelago, are on record. Though main emphasis of these studies was on the biota of easily accessible intertidal and shallow brackish water ecosystems, a few investigations on the open sea habitat, were also undertaken.

In the post-independence years, the emphasis on marine taxonomic research decreased considerably. During 1961-1965, thanks to International Indian Ocean Expedition (IIOE) programme, the taxonomy of plankton, mainly zooplankton, besides a few groups of nektonic and benthic organisms, received the most stimulating impetus, resulting in the generation of voluminous data, documented through several research papers, atlases and technical reports. During the last four decades or so, emphasis on the quantitative and/or applied aspects of marine biology and biological oceanography, with specific objective of assessment and evaluation of the potential and sustainable living resources, of the EEZ, assumed importance. Consequently, the marine taxonomic research got side-tracked and relegated to less importance.

With long traditions of marine taxonomic research, a number of research institutions and maritime universities have developed large holdings of marine biota, besides capabilities and expertise in identification of certain taxa of flora and fauna. Excluding planktonic and some of the interstitial taxa, bryozoans, insects, myriapods, birds and mammals, the marine survey division of the Zoological Survey of India, have estimated the total number of marine faunal species from seas around India, to be 12,000 (Table 1).

Table 1. Estimated Number of Marine Faunal Species of India

Taxa/Phyla	Number
Protozoa	2,000
Porifera	550
Coelenterata	480
Annelida	500
Echiura	28
Sipuncula	30
Pycnogonida	10
Mollusca	2,750
Echinodermata	700
Crustacea	3,000
Arachnida	2
Pisces	2,000
Others	14

Not included are planktonic and interstitial forms. Due to lack of authentic information, many marine faunal taxa have not been included. Thus the compilation is far from complete.

Source : Zoological Survey of India (1989)

Similarly, the number of species of marine algae, recorded from the Indian Coastline, is estimated to be 624 (Table 2).

**Table 2. Marine Algal Species of The Indian Coasts**

Taxa	Species	Genera	Family	Order
Chlorophyta	159	45	15	4
Phaeophyta	141	39	12	5
Rhodophyta	307	120	31	6
Cyanophyta	17	11	6	2

*Source* : List of Marine Algae From India, NIO Tech. Publ. 1983.

Recently, Bakus (1986), based on recommendations from active marine taxonomists from India and also on international opinion from the British Museum, London, Museum National D'Histoire Naturelle, Paris and the National Museum of Natural History of the Smithsonian Institution, Washington D.C., has critically assessed the capabilities and expertise in marine taxonomy in India. The search revealed that for some of the taxa, like, soft corals (alcyocea), zoantharia, gorgonians, sea pens, priapulids, pycnogonids and tanaids, no expertise is available in India. For some of the other groups, like sponges, actiniarians, stony corals, brachiopods, bryozoans, sipunculids, opisthobranch (including nudibranch) molluscs, isopods, nebaliceans, mysids, echinoderms, marine reptiles, sea birds and marine mammals, the expertise is limited to single individual. In the majority of marine taxa, the researcher works single handedly for two to three decades, and no induction of fresh manpower in the area of speciality, occurs. In other words, existing expertise, centres around a person rather than a team or group of specialists, and consequently, in the absence of fresh input of manpower, the expertise, developed over a long period of time, just dies off.

Further, a number of studies on taxonomy and biotic survey, remain unpublished, either in the form of thesis or technical reports, with restricted distribution. With relatively low prospects of employment for marine taxonomists, fresh graduates and post-graduates are reluctant to pursue research career in marine systematics.

### **Taxonomy of Marine Biomedical Resources**

Studies on the systematics of marine biota of India, with specific reference to biomedical resources, are of recent origin. In the year 1978, a R&D project on "Drugs From The Sea", as a collaborative venture between two CSIR Laboratories, namely the National Institute of Oceanography (NIO), Goa and the Central Drug Research Institute (CDRI), Lucknow, was initiated. One of the

critical objective of this project was to explore, investigate and taxonomically characterize the flora and fauna of exclusive economic zone (EEZ) of India, for bioactivity potential. Subsequently, in the year 1985, the project was expanded and diversified, under INDO-US collaboration programme, with financial assistance under PL-480 rupee funds. The redesigned bilateral project "Bioactive Substances From The Indian Ocean" gave tremendous impetus to marine biomedical research in India.

From 1978 to 1984, the exploration and taxonomic survey was confined to estuarine and intertidal marine biotopes along a small stretch of the central west coast of India, between Lat. (N) 18-13 and Long. (E) 72-75. However, since the year 1985 and thereafter, new dimensions in the form of : subtidal collections by SCUBA diving upto 30 meter depth; wider coverage of coastal ecosystems and intensive studies on taxonomy and chemical ecology of biomedically potential species, besides pharmacology and natural product chemistry, became effective.

Through 650 field days and 410 hours of SCUBA diving, a wide range of ecosystems — estuaries, lagoons, mangroves, seagrass meadows, coral atolls and reefs; submerged banks; continental islands, neritic and oceanic waters — along the northwest coast (Gulf of Kutch & Kathiawar); central west coast (Maharashtra, Goa & Karnataka); southwest coast (Kerala and west coast of Tamil Nadu); Lakshadweep Sea (Kavaratti, Minicoy, Agatti, Kiltun, Pitti,

Table 3. Exploration of Biomedical Resources of India - Species from Intertidal and Subtidal Ecosystems

Region & Geographical position	Number of sampling sites	Intertidal species (n)		Subtidal species (n)	
		Flora	Fauna	Flora	Fauna
Northwest coast (23-21 N ; 68-70 E)	6	24	39	-	-
Central west coast (18-13 N ; 72-75 E)	10	34	56	2	19
Southwest coast (11-8 N ; 74-77 E)	4	4	6	-	-
Lakshadweep Sea (12-7 N ; 72-74 E)	9	4	13	3	59
Southeast coast (11-8 N ; 78-80 E)	5	15	58	-	-
Northeast coast (22-19 N ; 85-88 E)	4	9	17	-	-
Andaman Sea (13-11 N ; 92-94 E)	5	11	30	-	3

Suheli, Bangaram & Kadamat); southeast coast (Tamilnadu); northeast coast (Orissa & West Bengal) and the Andaman Sea (South Andaman group of islands) have been explored, through repeated surveys (Table 3).

The exploration, so far carried out, is extensive, but, of course, not much intensive. However, it represents a systematic approach, to a new and highly potential area for the exploration, exploitation and utilization of marine living resources of the EEZ of India. Further, though certain areas, like, central east coast, the Andaman and Nicobar group of islands south of 11 N as well as the distant waters of EEZ have still not been explored, but it is for the first time in India, that full-fledged capabilities to explore and study the potential marine biomedical resources, have been developed.

So far, 283 species of marine flora and fauna have been collected, taxonomically confirmed and screened for biological evaluation (Table 4).

**Table 4.** Flora and Faunal Species, Identified and Screened for Biomedical Potentials of The EEZ of India.

Taxa	Species Identified & Screened (n)	Species With Biomedical Potential / Activity (n)
Chlorophyta	24	8
Phaeophyta	13	7
Rhodophyta	30	7
Cyanophyta	3	1
Mangroves	2	1
Seagrasses	5	-
Porifera	69	13
Coelenterata	78	24
Bryozoa	1	-
Mollusca	25	5
Arthropoda	7	-
Echinodermata	21	8
Urochordata	5	-

Out of 77 species of flora, identified and screened, so far, only 5 species were subtidal as against 73 out of 206 faunal species. One algal species (Untawale, Jagtap and Dhargalkar, 1980); nine species of soft corals (Alderslade, Sirvoiker and Parulekar, 1990 a) and six species of sponges (Alderslade, Sirvoiker and Parulekar, 1990 b) are new to science. Further, 6 floral species (Untawale, 1985; Deshmukhe and Untawale, 1985; Bhat and Untawale, 1987; Ambiye, 1987;

Ambiye, Chaugule and Untawale, 1989; Ambiye and Untawale, 1990, and 8 faunal species (Parulekar, 1981, 1990; Sirvoiker and Parulekar, 1987), have been reported, for the first time from India and/or new area records. A number of publications on the taxonomy, ecology and the regional inventory of macrophytes, sea anemones, corals, gastropods and distribution of floral and faunal taxa from the Gulf of Kutch, central west coast, Angria Bank (Arabian Sea), Orissa and the coral atolls in the Lakshadweep sea have been published (Parulekar, 1981, 1988, 1990; Untawale and Jagtap, 1984; Jagtap, 1987; Sirvoiker and Parulekar, 1988; Untawale and Ambiye, 1988; Untawale, Ambiye and Reddy, 1989).

The biological screening (carried out by CDRI, Lucknow) of 283 species of marine biota, explored through repeat samples in different seasons, revealed 13 major (Table 5) and 8 minor type of bioactivity potential.

**Table 5** Type and Incidence of Major Bioactivity Types in Biota of the EEZ of India

Type	Species (n)	
	Flora	Fauna
Antiviral	2	7
Antimicrobial	-	1
Antifertility/Anti-implantation	4	11
Antihistamine	-	1
Analgesic	1	-
CNS-Depressant	1	-
CNS-Stimulant	5	9
Diuretic	6	10
Hypoglycemic	-	3
Hypotensive	1	6
Spasmogenic	1	1
Spasmolytic	2	1
Toxic	1	8

Some of the interesting findings of the screening for biomedical potential, were :

- i. 100% antifertility/anti-implantation activity displayed by 4 species of seaweeds, 6 species of sponges and 5 species of soft and hard corals.
- ii. Characterization of other bioactivity potentials were, diuretic (16 spp.), CNS-stimulant (14 spp.), toxic & antiviral (9 spp. each), hypotensive

- (7 spp.), spasmolytic and hypoglycemic (3 spp. each) and spasmogenic (2 spp.).
- iii. Antimicrobial, antihistamine, analgesic and CNS – depressant activity was displayed by one species each.
- iv. 3 floral and faunal species, each, possess more than one type of bioactivity.

Another interesting finding was the important role of ecological and biological events (life cycle stages; feeding; breeding) in the type, quality and magnitude of biomedical potential in a species (Ambiye and Untawale, 1990; Parulekar and Sirvoiker, 1990). One of the major constraint in studies on the taxonomy of biomedically potential marine living resources, is in the inadequacy and, at times, total lack of expertise in identification. As seen from Table 6, out of 13 major taxa/phyla/groups studied, the lower invertebrate phyla, mainly Porifera and Coelenterata, posed maximum difficulties in confirming the species level identification.

Table 6. Status of Identification

Taxa	Species Explored (n)	Identification To Be Confirmed (n)
Chlorophyta	24	1
Phaeophyta	13	-
Rhodophyta	30	-
Cyanophyta	3	-
Mangroves	2	-
Seagrasses	5	-
Porifera	69	11
Coelenterata	78	29
Bryozoa	1	-
Mollusca	25	-
Arthropoda	7	-
Echinodermata	21	2
Urochordata	5	-

Rather difficult groups are soft corals, gorgonians, and zoantharians, wherein the worldwide expertise, in relevant speciality, is scarce. In case of sponges and hard corals, only limited capabilities exist within the country and, hence,

identification gets delayed. Further, as pointed by Boronjevic *et al.* (1967), the taxonomy of lower invertebrates, like sponges, is quite complex and often new terminologies are proposed. Coincidental, the lower invertebrate phyla, like Porifera and Colenterata, hold high biomedical potentials (Table 4).

As reported by Marderosian (1970), out of 150 thousand faunal species in the marine environment, at least 10% species, by the law of averages, promise biomedical potential. Further, there are numerous species of marine flora, including microbes, who have promising bioactivity, so also, a multitude of minor phyla and chordates which still remain to be explored for "drugs from the sea".

The importance and relevance of taxonomy in the application oriented marine biological research, has offered new challenges to biologists, in the recent times. In the sphere of new vistas, encompassing the vast potentials of marine living resources in biotechnology, mariculture, drugs and pharmaceuticals, containment of pollution and biocontrol of deterioration, the taxonomic and ecological studies, have an important place, as the biomedical resources are species specific as also site specific and therefore, unless the correct systematic position upto species level is known, the scope for exploitation and economic use, will drastically be reduced.

It is, therefore, imperative to revive and strengthen the marine taxonomic research in India, as elsewhere. Though the overall scene is far from optimistic, hopefully in the next few years, the revitalization and sustained pursuit of this important line of marine biological research, would be taken up, vigorously. Coupled with taxonomic work, other complimentary studies to be pursued will be chemical ecology, rearing of organisms, and conservation of germplasm.

The classical taxonomy based on external morphology and anatomical features, when appropriately blended with modern and reliable techniques of DNA and amino acid manifestation; gene frequency data; the computer aided database and archival procedures, shall be an important component of future marine taxonomic research in India.

## References

- Alderslade, Phil, Sirvoiker, P. & Parulekar, A. H. 1990 a. On some new species of soft corals from Lakshadweep atolls, India. *J. nat. Hist. (In Press)*.
- Alderslade, Phil, Sirvoiker, P. & Parulekar, A. H. 1990 b. An account of some new species of sponges from India. *Bull. nat. Hist. Mus. Darwin (Australia) (In Press)*
- Ambiye, Vijaya 1987. *Spridia fasiformis* - New record along the West Coast of India. *Mahasagar - Bull. Natl. Inst. Oceanogr.* 20: 267-268
- Ambiye, Vijaya, Chaugule, B. B. & Untawale, A. G. 1989. *Neomeris Van-Bossea*, Howe - A new record along the Indian Coast. *Curr. Sci.*, 58(24) : 1363.
- Ambiye, Vijaya & Untawale, A. G. 1990. *Galaxaura rugosa* (Ellis et Sol) Lam. from India. *Seaweed Res Uln. (In Press)*
- Ambiye, Vijaya & Untawale, A. G. 1990b. Bio-ecology of an articulated coralline alga, *Amphiroa fragilisima*, along Anjuna, Goa (Central West Coast of India) In : *Bioactive Compounds In Marine Organisms*. (Ed) Mary-Francis Thompson. Oxford & IBI Publ., New Delhi. *(In Press)*.



- Anon 1983. List of Marine Algae from India. *NIO Tech. Paper*; pp : 42 (Mimeo).
- Attaway, David H. 1978. Food and drugs from the sea : A perspective from the National Sea Grant Programme. In : *Drugs And Food From The Sea - Myth or Reality ?* (Eds.) P. N. Kaul & C. J. Sindermann : 78-81 (The University of Oklahoma, Norman, Oklahoma).
- Bakus, G. J. 1986. Survey of Indian Taxonomists (Marine Biology) : pp. 28 (Mimeo)
- Bhat, S. R. & Untawale, A. G. 1987. *Bruguiera cylindrica* (L) BL (Rhizophoraceae) : A new locality record from the West Coast of India. *Curr. Sci.*, 56(12) : 604-605.
- Boronjević, R., Fry, W. G., Jones, W. G., Levi, C., Rasmont, C., Sara, M & Vacquet, J. 1967. A reassessment of the terminology for sponges. *Bull. Mus. Nat. Hist.*, 39: 1224-1235
- Deshmukhe, G & Untawale, A. G. 1985. *Coeloseira compressa*. Hollenb (Champraceae-Rhodophyta). A new marine algal species from Goa, India, *Indian J. mar. Sci.*, 15(1) : 37-41
- Halstead, Bruce W. 1970. Recommendations to the President's Commission on marine science, engineering and resources for a national program in marine biomedicine. In : *Foods - Drugs From The Sea, Proceedings 1969*. 11-21, (Ed.) H. W. Youngken Jr.
- Jagtap, T. J. 1987. Distribution of algae, seagrasses & coral communities from Lakshadweep Islands, Eastern Arabian Sea. *Indian J. mar. Sci.*, 16(4) : 256-260.
- Marderosian, A. H. der. 1970. Drugs from the sea - An Overview. In : *Food - Drug From The Sea, Proceedings 1969*, 211-253, (Ed.) H. W. Youngken Jr.
- Parulekar, A. H. 1981. Marine fauna of Malvan - Central West Coast of India. *Mahasagar Bull. natl. Inst. Oceanogr.*, 14(1) : 33-44.
- Parulekar, A. H. 1988. Bioecology of the Gulf of Kutch. In : *Marine Archaeology Of The Indian Ocean Countries*, 127-132, (Ed.) S. R. Rao.
- Parulekar, A. H. 1990. Actinarian Sea Anemone Fauna of India. In : *Marine Biofouling And Power Plants*, (Eds.) : K.V.K. Nair and V.P. Venugopalan : 218-228. Bhabha Atomic Research Centre, Bombay.
- Parulekar, A.H. & Sirvoiker, P. 1990. Bioactivity and chemical ecology of some intertidal animals. In : *Bioactive Compounds In Marine Organisms*, (Ed.) Mary-Francis Thompson. Oxford & IBH Publ., New Delhi. (In Press)
- Sirvoiker, P. & Parulekar, A.H. 1987. A new distributional record for the sea cucumber, *Holothuria (Semperothuria) cinerascens* (Brandt) from Goa. *Mahasagar - Bull. natl. Inst. Oceanogr.*, 19(4) : 279-281.
- Sirvoiker, P. & Parulekar, A.H. 1988. Gastropod fauna off Dwarka Beyt in the Gulf of Kutch. In : *Marine Archaeology of The Indian Ocean Countries*, 136-140, (Ed.) S.R. Rao.
- Untawale, A.G. 1985. The occurrence of red alga, *Bangia fuscopurpura* (Dillwyn) Lungbye (Bangiales, Rhodophyta) from the Malvan coast (Maharashtra), India. In : *Marine Plants Symp. Proc. SRUA. Goa* : 99-102
- Untawale, A.G. & Jagtap, T.G. 1984. Marine macrophytes of Minicoy (Lakshadweep) coral atoll of the Arabian Sea. *Aqua. Bot.*, 19:97-103
- Untawale, A.G. & Amblye, Vijaya 1988. Flora of Shankhodhar in the Gulf of Kutch. In *Marine Archaeology of the Indian Ocean Countries*. 139-142, (Ed.) S.R. Rao.
- Untawale, A.G., Jagtap, T.G. & Dhargalkar, V.K. 1980. *Dichotomosiphora salina* sp. nov. - A new marine algal form from Goa estuary, India. *Mahasagar - Bull. natl. Inst. Oceanogr.*, 13(1) : 73-76
- Untawale, A.G., Amblye, Vijaya & Reddy, C.R.K. 1989. Marine algal flora of submerged Angria Bank (Arabian Sea). *Indian J. mar. Sci.*, 18(3) : 207-209