

## **SUMMARY OF THE THAI-DANISH BIODIVERSITY PROJECT ON THE ANDAMAN SEA CONTINENTAL SHELF AND SLOPE (1996–2000)**

**Somchai Bussarawit<sup>1</sup>, Ole SecherTendal<sup>2</sup>, Claus Nielsen<sup>2</sup> and Arne Redsted Rasmussen<sup>3</sup>**

*<sup>1</sup>Phuket Marine Biological Center, Phuket, Thailand*

*<sup>2</sup>Zoological Museum, University of Copenhagen, Denmark*

*<sup>3</sup>Royal Academy of Fine Arts, School of Conservation, Denmark*

**ABSTRACT:** The scientific cooperation programme on marine biodiversity in the Andaman Sea shelf and slope was conducted in connection with the supply of a marine research vessel by Danida, Ministry of Foreign Affairs, Denmark to Phuket Marine Biological Center, Department of Fisheries, Thailand during 1996–2000. A total of 114 stations from 12 transects were sampled at depths ranging from 20 to 1,020 m, including additional diving sampling. The activities included Thai, Danish and other international participants and experts; a national training course and workshop on starch gel electrophoresis, plus a national workshop on cladistics and phylogeny. Three international workshops on the biology of sea snakes, on biodiversity of polychaetes and on biodiversity of crustacea in the Andaman Sea were held. At least 200 new species of polychaetes and crustaceans were discovered and described from the collected materials under the SCP programme. The biodiversity research study of the collected deep water fauna will be published in a special volume including vertebrates and invertebrates. To replace the Danida supported programme (1996–2000) in the future a Danced project (2002–2006) with emphasis on marine biodiversity is discussed together with a plan to promote PMBC as a Center of Excellence for marine biodiversity research, education and training in the

region.

### **INTRODUCTION**

Knowledge of the diversity of organisms and communities is the foundation for understanding the structure and function of marine communities. Knowledge of the species is fundamental to work on predicting the role of human-mediated and natural processes that might change the oceanic ecosystem. Adequate understanding of what creates and maintains biological diversity must be the scientific underpinning for political decisions regarding pollutant and waste disposal, habitat alteration, fisheries management and the preservation of threatened or endangered species. However, data on biodiversity patterns and their causes are lacking for most marine ecosystems, and the

inability, at this time, to provide this information to policy makers has profound implications for the conservation of marine life.

The Andaman Sea is undersampled and underdescribed in terms of biological diversity. There are large numbers of undescribed species in familiar environments, such as coral reefs and the pelagic zone, and there are environments like the continental slope, which are so undersampled, that scarcely any knowledge exists.

The Biodiversity of the Andaman Sea Continental Shelf and Slope (BIOSHELF) project during 1996–2000 has been supported by the Scientific Cooperation Programme (SCP) between Denmark and Thailand in connection with the supply of the marine research vessel R/V “Chakratong Tongyai” from Danida to Phuket Marine Biological Center, Department of

Fisheries, Thailand.

The objectives of the project are to expand the general knowledge of the biodiversity of benthic fauna at depths down to 1,000 m within the Thai EEZ and to provide additional specimens to be deposited in the PMBC Reference Collection.

## **Background**

### **The Andaman Sea and the project goals**

The Andaman Sea is a closed basin with depths down to about 4,000 m, with the deepest connection to the Indian Ocean at 1,300–1,400 m between the Nicobar Islands and Sumatra. Covering roughly 800,000 km<sup>2</sup> and being at maximum about 600 km wide the sea is completely divided into the Exclusive Economic Zones of India, Myanmar, Thailand, Malaysia and Indonesia, and represents an obvious goal for future regional co-operative work in oceanographic sciences. The deepest part is within the Indian EEZ. The Thai EEZ, which has a maximum depth of about 2,400 m, covers roughly 110,000 km<sup>2</sup>, of which 94,000 lie between 100 and 600 m depth (Nishida and Sivasubramaniam 1986).

With the establishment of the Phuket Marine Biological Center in 1971 the Department of Fisheries and the Thai community got first hand access to information on the biocomplexity of local benthic ecosystems, such as coral reefs, mangroves and sea grass beds as well as on hydrography, productivity and other subjects. From the onset, most biological projects investigated species and communities in shallow water bottoms (<100 m depth), where most of the commercial fishery activity takes place. Interest in deep-water benthos came later, prompted by the extension of the EEZ and the search for exploitable demersal populations. Facilities for more comprehensive biodiversity studies came about with the inauguration of a new building for the Reference Collection at PMBC in 1983. With the delivery in November 1995 of the Danish-built R/V “Chakratong Tongyai” a modern research vessel of suitable size and capacity for work all over the Andaman EEZ was put at disposal for the PMBC, potentially adding new dimensions in regional scientific and educational efforts.

In connection with the supply of the research vessel, the 5-years Thai-Danish Cooperation Project 1996–2000 was formulated and launched. The Reference Collection Subdivision got responsibility for two individual benthos projects:

A. Biodiversity and Biomass of Demersal Invertebrates on the Shelf of the Andaman Sea off Phuket (BIOSHELF).

B. Biodiversity and Biomass of Demersal Invertebrates in deep Water beyond the Shelf of the Andaman Sea off Phuket (BIODEEP).

During the first cruise of 1999 it became evident that due to technical difficulties it was not possible to work in the deepest parts of the EEZ. The co-operation partners then agreed to concentrate the open sea efforts to the areas down to the 1,000 m depth contour. Because of the special topography of the shelf edge region it was decided to consider investigation of this and the upper part of the slope as an extension of the BIOSHELF project. When future economic circumstances allow for it a BIODEEP project in the part of the EEZ deeper than 1,000 m should be formulated and carried through by the Reference Collection.

The immediate objectives of BIOSHELF, as formulated in the contract of 1996 between The Zoological Museum (University of Copenhagen) and Danida, are to improve the knowledge of the structure, diversity and biomass of the benthic invertebrate communities on the margin (originally:shelf) of the Andaman Sea east of the 1,000 m (originally: 100 m) depth contour. Particular emphasis is on:

- A future assessment of potential fisheries resources,
- An examination of the geographical distribution of the biomes of invertebrates according to depth and type of sediment, and
- An examination of the biodiversity of invertebrates according to depth and type of sediment.

### **Early investigations of the bottom fauna of the Andaman Sea**

Only a few of the renowned expeditions visited parts of the Andaman Sea, viz. the Austrian

‘Novara’ (1857–1859), the German ‘Valdivia’ (1898–99) and the Danish ‘Dana’ (1928–30) and ‘Galathea’ (1950–52). They took few and scattered samples, adding only little to the knowledge of the fauna as a whole. More comprehensive sampling, mainly in Indian (around the Andaman Islands) and Burmese waters, was made between 1874 and 1925 by the two Royal Indian Marine ships both named ‘Investigator’, under the leadership of “the surgeon-naturalist” (Alcock, 1902; Rice, 1986; Sewell, 1954), but still the accounts of the bottom fauna were scarce and no proper regional picture emerged. A general view on the origin and distribution of the fauna was presented by the “surgeon-naturalist” R.B.S. Sewell, who filled this post from 1910 to 1925, when in a review of the supposed tertiary–quaternary development of the Andaman Sea and its connections to other seas he concluded (1925, p. 22): “These various channels have permitted the entry into the basin of the rich shallow-water fauna of both Indian and Pacific Oceans, whereas the deep fauna must have been derived from ancestors capable of living in moderate depths of less than 800–900 fathoms, who had already succeeded in establishing themselves in the Bay of Bengal, or else by recent migration of shallow water forms downwards into the deep waters of the basin.”

### **Investigations in the Thai EEZ prior to the BIOSHELF programme**

The first comprehensive invertebrate biodiversity study on invertebrates along the Thai coast of the Andaman Sea was initiated through Thai-Danish cooperation after the Second Worldwar. While the first four expeditions under the cooperation programme were largely limited to botanical work, the Fifth Thai-Danish Expedition in 1966 included marine sampling from the Burmese border in the north to the Malaysian border in the south. The expedition had at its disposal the research vessel “Dhanarajata”, and during January and February close to 600 samples were taken from the shoreline to 80 m depth. The main gear for macrofauna was the Smith-McIntyre grab of 1/10 m<sup>2</sup> (420 samples), the contents of which were washed through a 2 mm sieve. At each

sampling locality ten grabs were taken, supplemented by 2 Muus-sampler (“the mouse-trap”, Muus, 1964) samples of 150 cm<sup>2</sup> for meiofauna. To these quantitative samples were added 30 triangle dredge samples, 30 trawl catches and nearly 40 shore-collected stations (Seidenfaden *et al.*, 1968).

The preliminary main conclusions were: 1) As to number of species, the Thai Andaman coast is one of the richest known. 2) The majority of these species are members of the epifauna. 3) Sandy–muddy bottoms are inhabited by a large number of species each represented by only a few specimens. 4) The biomass (wet weight) is low compared to Northern waters. 5) Sandy bottoms are markedly richer both in species and individuals than muddy bottoms. 6) There are indications that the productivity along the coast is comparatively low. 7) The numbers of animals decrease with increasing depth, a tendency evident from about 10 m depth (Seidenfaden *et al.*, 1968).

After the establishment of the Phuket Marine Biological Center Reference Collection, Biodiversity studies were continued, especially during 1980s (literature list in Aungtonya *et al.*, 2000, Hylleberg, 2001), including a quantitative programme (Chatanathawej and Bussarawit, 1987). In deeper waters, a few investigations have been performed down to about 400 m. They partly aim at potential natural resources, which for the invertebrates include species of prawns and deep-sea lobsters such as appeared in the Bay of Bengal Programme (Nishida and Sivasubramaniam, 1986), and at oceanographic conditions on fishing grounds in the Thai-Japanese Joint Oceanographic and Fisheries Survey in 1981 (Takahashi and Ruangsvakul, 1983) and the Southeast Asian Fisheries Development Center (SEAFDEC) studied in 1987 (Ananpongsuk, 1989).

### **Cruise activities**

Quantitative and qualitative samples have been taken during 7 BIOSHELF cruises (see Aungtonya *et al.*, 2000 for station list). The actual operation days of the R/V “Chakratong Tongyai” during the five years were:

Cruise 1996; 16 Apr.–10 May 1996 (21 days)

*Scientific Cooperation Programme Concluding Conference*

Cruise 1997; 8–23 Apr. 1997 (26 days)

Dec.1998 (5 days)

Cruise 1998;16–28 Feb. 1998 (13 days), 1–5

Cruise 1999; 22 Jan.–13 Feb. 1999 (23 days), 8–21 Nov. 1999 (14 days)

During the cruises the following types of gear were used in each year:

Gears	Years				
	1996	1997	1998	1999	2000
Olsen box corer	X	X			X
Smith-McIntyre grab		X		X	X
Ockelmann sledge	X	X	X	X	X
Pierce-Rothlisberg hyperbenthic sledge				X	X
Triangular dredge	X	X	X	X	X
Rectangular dredge				X	X
Beam trawl			X		
Agassiz trawl				X	X
Otter trawl	X	X	X	X	X

**Cooperative staff**

Reference Collection, Phuket Marine Biological Center:

Mr. Somchai Bussarawit, Chief of Reference Collection Unit

Ms. Charatsee Aungtonya, Marine Biologist

Ms. Vararin Vongpanich, Marine Biologist

Mr. Santisuk Thaipal, Marine Biologist

Ms. Ratchanee Sirivejhabandhu, Technical Curator

Ms Teunjai Srisawad, Technical Assistant

Ms. Nittaya Thaiklang, Technical Assistant

Mr. Sahet Utsaha, Worker

Mr. Patairat Singdom, Artist

Ms. Duangjan Srisuwan, Database Assistant

Dr. Andrew Davison, Database Consultant

Copenhagen, Denmark

Dr. Tomas Cedhagen, Department of Marine Ecology, Aarhus University, Denmark

Dr. Arne Redsted Rasmussen, Royal Academy of Fine Arts, Copenhagen, Denmark

**Junior Scientific Assistants (JSA):**

Dr. Monica Niklasson, Department of Marine Ecology, Aarhus University

Ms. Grete Dinesen, BIOCONSULT, Denmark

Mr. Torben Kristensen, Zoological Museum, Copenhagen, Denmark

Mr. Teunis Jansen, Zoological Museum, Copenhagen, Denmark

Mr. Tom Schiotte, Zoological Museum, Copenhagen, Denmark

Ms Marie Eiland, Zoological Museum, Copenhagen, Denmark

**Senior Scientific Assistants (SSA):**

Dr. Danny Eibye-Jacobsen, Zoological Museum, Copenhagen, Denmark

Dr. Niel L. Bruce, Primary Industry Department, Queensland, Australia

Dr. Matz Berggren, Kristineberg Marine Station, Gothenburg, Sweden

Dr. Ole Secher Tendal, Zoological Museum,

**Training Courses and Workshops**

1. Training Course and Workshop on Starch Gel Electrophoresis. Place: Phuket Marine Biological Center, Duration: 13–18 October 1996.

2. Workshop on Cladistics and Phylogeny. Place: Phuket Marine Biological Center, Duration: 18–22 December 1996.

**International Workshops**

1. International Workshop on Biodiversity of Polychaetes in the Andaman Sea Place: Phuket Marine Biological Center, Duration: 1 June–31 August 1997.

2. International Workshop on Biodiversity of Crustaceans in the Andaman Sea Place: Phuket Marine Biological Center, Duration: 20 November–20 December 1998.

3. International Workshop on Biology of Sea Snakes in the Andaman Sea Place: Phuket Marine Biological Center, Duration: 18–22 January 1998.

**Additional manuscripts for publication in PMBC Research Bulletin**

The SCP collected samples of polychaetes and crustaceans during 1999–2000 which will be studied by the previous group of experts and are planned to be published in the regular Phuket Marine Biological Center Research Bulletin.

**The Database of the Reference Collection**

The Reference Collection database was set up with support from Danida by hiring staff (Dr. Andrew Davison, computer consultant, Asia Institute of Technology, Bangkok, and Dungjan Srisawad, database staff), which started from September 1997. The project activities covered a 2 years period terminating in August 1999. The computerized database of the contents in the PMBC Reference Collection (RC) with information about scientific name and individual specimens is updated and register catalogues of all groups are planned to be published on a regular basis in PMBC Research Bulletin.

**Academic education****MSc scholarship**

Ms. Vararin Vongpanich was funded by Danida to study for a Master of Science in the International Program on Marine Science, Aarhus University, Denmark, for 2 years during February 1997- January 1999. She did the thesis study under supervision of Assoc. Prof. Jorgen Hylleberg on the topic “Systematics of the bivalve mollusc family Mactridae”.

**PhD scholarship**

Mr. Somchai Bussarawit was funded by Danida to study for a PhD in the International Programme on Marine Sciences at Aarhus University, Denmark, under supervision of Assoc. Prof. Dr. Tomas Cedhagen enrolled from 1 September till 31 August 2002. A total of 12 months travel to Denmark was supported by the Danida Fellowship Center for mandatory courses and supervision. The thesis topic was “Systematics of Oysters (Family Ostreidae and Gryphaeidae) of Thailand (Gulf of Thailand and the Andaman Sea).

Ms. Charatsee Aungtonya was funded by Danida to study for a PhD in the University of Copenhagen, Denmark, under the supervision of Dr. Danny Eibye-Jacobsen, Zoological Museum, enrolled from 1 March 2000 till February 2003. A total of 12 months travel to Denmark was supported by the Danida Fellowship Center for mandatory courses and supervision. The thesis topic was “The phylogeny and systematics of Sigalionidae (Annelida; Polychaeta) with a taxonomic study of the species found in the Andaman Sea of Thailand”.

**Regional Danida project on Sea snakes**

Sea snakes are the most common and widely spread poisonous reptiles in the world. Sea snakes occur in the tropical and subtropical areas of the Indian Ocean and in the Pacific Ocean, with most species concentrated in the Bengal Bay, the Indo-Malaysia area, the China Sea, Indonesia and the Australian region. Most species are found in shallow waters around islands, mouths of rivers and along coastlines. Sea snakes are related to terrestrial elapids (e.g. cobra, mamba coral snakes, and Australian poison snakes) and are called proteroglyph snakes because of the position of the fang in front of the maxillary bone.

The investigation of the venom of sea snakes using “LD50” toxicity tests shows that sea snakes have one of the most poisonous venom’s found in snakes. The typical victim is a fisherman, sorting out fish from a bag-net, or on board a trawling boat or using a pull-net in a river mouth. Although we know that sea snakes can be very numerous locally and that sea snake bites occur

frequently, our knowledge about the biology and epidemiology is very limited.

Research on monovalent and polyvalent serum against snakebite shows that only monovalent serum neutralises the venom effectively. It is therefore of great importance that the species can be distinguished from each other during serum production and during the treatment of a victim.

Sea snakes have been collected and used commercially over the last 70 years. In the Philippines some populations have disappeared since the early 80 because of overexploitation and in most areas of the Indian and the Pacific Oceans snake fisheries are not reported on in the literature and are beyond control of local governments.

### **Goal**

To solve some of the above mentioned problems a collaborative project was started in 1996 with cross-disciplinary scientists from Great Britain, India, Indonesia, Philippines and Thailand (PMBC); later on also scientists from Cambodia and Vietnam participated. The main goals were to produce a monograph on sea snakes, to get the necessary knowledge on taxonomy and biology to produce serum against bite, and to obtain a sustainable exploitation of the sea snakes.

In co-operation with partners from the involved institutions sea snake specimens have been collected and examined in Cambodia, India, Indonesia, Philippines and Thailand. Lectures on sea snake biology for students at local universities have been given together with partners. Local reference collections have been started, and sea snake literature is now available in the institutes of the collaborative partners together with identification guides, including slides. To get an idea about incidence of sea snake bites local hospitals have been contacted and the information has been gathered.

### **Future cooperation project in marine biodiversity under Danced (2002-2006)**

The updated Danced assistance to Thailand (letter dated 21 February 2001) specifies priority areas for the new country programme

2002–2006 (CP III). One of the four priorities listed is “Protection of biodiversity”.

Projects so far have e.g. targeted on the Convention on Biological Diversity, the Convention on International Trade of Endangered Species (CITES) and the Ramsar Convention. Danced proposes a focused thematic approach with specific emphasis on implementation of the Convention on Biological Diversity; the Ramsar Convention; the Washington Convention and giving priority to regional co-operation on international conventions. This includes development of policies and regulations as well as implementation of obligations; and sector integration. Support to implementation of international conventions and agreements have high Danced priority as emphasized by the Danish Parliament. Many ecosystems are under threat in Thailand and full implementation of a range of international conventions is still lacking. One example is the Biodiversity Convention signed by Thailand in 1992 but not yet ratified after 9 years.

The PMBC Reference Collection unit plan to propose activities under future Danced support projects as follows;

1. Biodiversity research and monitoring of marine fauna and flora of the Andaman Sea coast of Thailand with emphasis on important groups in different habitats, such as coral reefs, mangroves, seagrass beds, sandy beaches, muddy beaches, rocky shores, soft bottoms, hard bottoms, and deep water fauna.
2. Expand PMBC Reference Collection which was donated by Danida in 1983 on occasion of Ratanakosin Bicentennial Celebration to be a Center of Excellence of marine reference materials and research and monitoring training for the region.
3. Organize training courses on marine biodiversity research for the next generation and public by PMBC staff.
4. Arrange workshops on marine biodiversity on different taxonomic groups including genetic biodiversity research for young biologists in Thailand and in the region by inviting international experts as resource persons.
5. Capacity building for young marine biodiversity biologists in Thailand, Denmark and network

countries in the Asean region under Danced/Danida cooperative project.

6. Launch a biodiversity media and poster campaign for protection information, sustainable use and conservation.

### ACKNOWLEDGEMENTS

We would like to thank Danida and PMBC for supporting the BIOSHELF project and

organizing the SCP closing conference in February 2001. Thanks to all participants and experts who participated in the SCP cruises onboard R/V “Chakratong Tongyai” and the coastal research vessel “Boonlert Phasuk” and/or in the workshops. A special thank to Monica Niklasson, Danny Eibye-Jacobsen, Niel Bruce, Matz Berggren, Charatsee Aungtonya and the staff of the Reference Collection; without their support the activity under the BIOSHELF project would not have been successful,

### REFERENCES

- Alcock, A. 1902: A naturalist in Indian Seas or, four years with The Royal Indian Marine survey ship ‘Investigator’. J. Murray, London, 328 p.
- Ananongsuk, S. 1989. Report on some offshore demersal resources of the Andaman Sea. Training Department, Southeast Asian Fisheries Development Center. Research Paper Series No. 20, 30 p.
- Aungtonya, C., S. Thaipal and O. Tendal 2000: A preliminary report on the Thai-Danish BIOSHELF surveys (1996–2000) of the West Coast of Thailand, Andean Sea. Phuket marine biological Center Research Bulletin **63**: 53–76.
- Chatanathawej, B. and S. Bussarawit. 1987: Quantitative survey of the macrobenthic fauna along the west coast of Thailand in the Andaman Sea. Phuket marine biological Center Research Bulletin **47**: 1–23.
- Hylleberg, J. 2001: Biodiversity studies at Phuket Marine Biological Center (PMBC): Polychaetes, Sipunculans, Amphipods, Echinoderms and Molluscs. pp. 48-49. **In**: Centenary Celebration of Thai-Danish Co-operation in Biodiversity. Queen Sirikit Botanical Garden, Chiang Mai, Thailand, 10-11 February 2001. 71 p.
- Muus, B. 1964: A new quantitative sampler for meiobenthos. *Ophelia* **1**: 209–216.
- Nishida, T. and K. Sivasubramaniam. 1986: Atlas of deep water demersal fishery resources in the Bay of Bengal. Bay of Bengal Programme. Marine Fishery Resources Management, Colombo. 49 p.
- Pokapun, W., J. Tantivala and A. Munprasit. 1983. Some deep-sea fishes in the Andama Sea. Exploratory Fishing Division, Department of Fisheries, Bangkok Thailand. No. 14, 70 p.
- Rice, A.L. 1986: British oceanographic vessels 1800–1950. The Ray Society, London, vol 157: 1–193.
- Sewell, R.B.S. 1925. Geographic and oceanographic research in Indian waters. Part I. The geography of the Andaman Sea basin. *Memoirs of the Asiatic Society of Bengal* **9**: 1–26.
- Sewell, R.B.S. 1954. Deep-sea oceanographic exploration in Indian waters. *The Journal of the Bombay Natural History Society* **50**: 705–717.
- Takahashi K. and N. Ruangsivakul. 1983: A comprehensive study on the oceanographic conditions of trawl fishing grounds in the Andaman Sea off the southwest coast of Thailand. Training Department, Southeast Asian Fisheries Development Center. Current Technical Paper **23**: 148–182.
- Seidenfaden, G., T. Smitinand and G. Thorson. 1968. Report on the Fifth Thai-Danish Expedition 1966. *Natural History Bulletin of the Siam Society* **22**: 245–261.

