Songklanakarin J. Sci. Technol.
33 (6), 633-640, Nov. - Dec. 2011

SJST SONGKLANAKARIN JOURNAL OF SCIENCE AND TECHNOLOGY
http://www.sjst.psu.ac.th

Original Article

Diversity and distribution of seaweed at Khanom-Mu Ko Thale Tai National Park, Nakhon Si Thammarat Province, Thailand

Anchana Prathep*, Supattra Pongparadon, Anuchit Darakrai, Bongkot Wichachucherd and Sutinee Sinutok

Seaweed and Seagrass Research Unit, Excellence Centre for Biodiversity of Peninsular Thailand (CBIPT), Department of Biology, Faculty of Science, Prince of Songkla University, Hat Yai, Songkhla, 90112 Thailand.

Received 18 March 2009; Accepted 4 October 2011

Abstract

Diversity and distribution of seaweeds at Khanom-Mu Ko Thale Tai National Park, Nakhon Si Thammarat Province, Thailand were carried out between October 2005 and May 2008 at five islets, Ko Taen, Ko Mut Sum, Ko Rab, Ko Wang Nai, and Ko Wang Nok. A total of 60 species were identified including 23 species of Chlorophyta, 19 species of Phaeophyceae in the Chromophyta, 16 species of Rhodophyta, and 2 species of Cyanobacteria. Of these, eight species are believed to be new records for the Thai marine flora. The number of species varied from site to site. Ko Tan had the highest diversity with 49 species and KoWang Nok had the lowest diversity with 22 species. This study provides a more complete species list for further comparative studies between the Gulf of Thailand and the Andaman Sea. We have intensively reviewed the seaweed literature of Thailand, which was very limited. However, recent work on population and community structure have increased from 2005, which helps providing a baseline for future, more complex ecological studies, as well as for coastal management and for the exploration of the seaweed's economic potential.

Keywords: seaweed, diversity, distribution, Khanom-Mu Ko Thale Tai National Park, Thailand

1. Introduction

Seaweeds are an ecologically and economically important component of marine ecosystems worldwide. They are primary producers and provide shelter, nursery grounds, and food sources for marine organisms. Around the world they are also used as foods and fertilizers, as well as for the extraction of valuable commercial products including cosmetics. Recent research has pointed to new opportunities, particularly in the field of medicine, associated with bioactive properties of molecules extracted from seaweeds, using them as a CO_2 sink (Muraoka, 2004) or even as bio-fuel (Bastianoni *et al.*, 2008). Most of these studies, however, have been carried out on the temperate shores of Europe, U.S.A., and Australia.

* Corresponding author.
Email address: anchana.p@psu.ac.th

Between 1990 and 2000, only a few investigations have been carried out on macroalgae in Thailand (Lewmanomont, 1994; Phang, 1994; Lewmanomont and Ogawa, 1995; Lewmanomont, 1997; Chirapart and Ruangchauy. 1999; Kawaguchi and Lewmanomont, 1999; Terada *et al.*, 1999; Tseng and Xia, 1999). These studies focused on *Gracilaria* taxonomy and cultivation. There is, therefore, a shortage of seaweed research in Thailand. Mayakun and Prathep (2005) carried out a diversity study of macroalgae at Ko Samui, Southern Thailand, and compiled a list of algae in Thailand (Lewmanomont *et al.*, 1995) providing a useful guide to seaweed biodiversity and distribution in Thailand. A recent study has reported nine new records of species at a small inter tidal coral reef at Sirinart Marine National Park in Phuket, Thailand (Thongroy *et al.*, 2007), suggesting that there are likely more macroalgae species in Thailand that have not been reported.

In this report we have intensively reviewed the seaweed research in Thailand, which provides useful information

for further seaweed study. We have also carried out a diversity and distribution study of seaweed at Khanom-Mu Ko Thale Tai National Park in Southern Thailand, which is known to be one of the sites of greatest seaweed diversity in the Gulf of Thailand.

2. Materials and Methods

An intensive literature review from various sources including journal publications, books, the internet, and personal communications, was carried out. The species list of algae found in Thailand was reviewed through www.algaebase.org, a nearly complete worldwide seaweed database; and *Algae in Thailand* (Lewmanomont *et al.*, 1995).

For the diversity and distribution study, seaweed specimens were collected from various sites in the cluster of islands of Khanom-Mu Ko Thale Tai National Park, Southern Thailand, specifically from Ko Taen, Ko Mut Sum, Ko Rap, Ko Wang Nai, and Ko Wang Nok (Figure 1). Field collections were carried out at various times between October 2005 and May 2008 during all seasons. Herbarium specimens, as well as those preserved in 4% seawater formalin and in silica gel, were deposited in the Phycology Research Group Herbarium, Gent University, Belgium, and in Princess Maha Chakri Sirindhorn Natural History Museum, Prince of Songkla University, Hat Yai, Thailand. Samples were examined for gross morphology as well as internal anatomy. The systematic arrangement follows the scheme of Lewmanomont and Ogawa (1995) and others such as Egerod (1971, 1974, 1975), Abbott (1988), Huisman (2000), and Littler and Littler (2000).

3. Results

3.1 Seaweed study in Thailand

There are fewer than 50 publications on the study of seaweed diversity and ecology since the first recorded study 150 years ago (Table 1). The very first report of marine algal

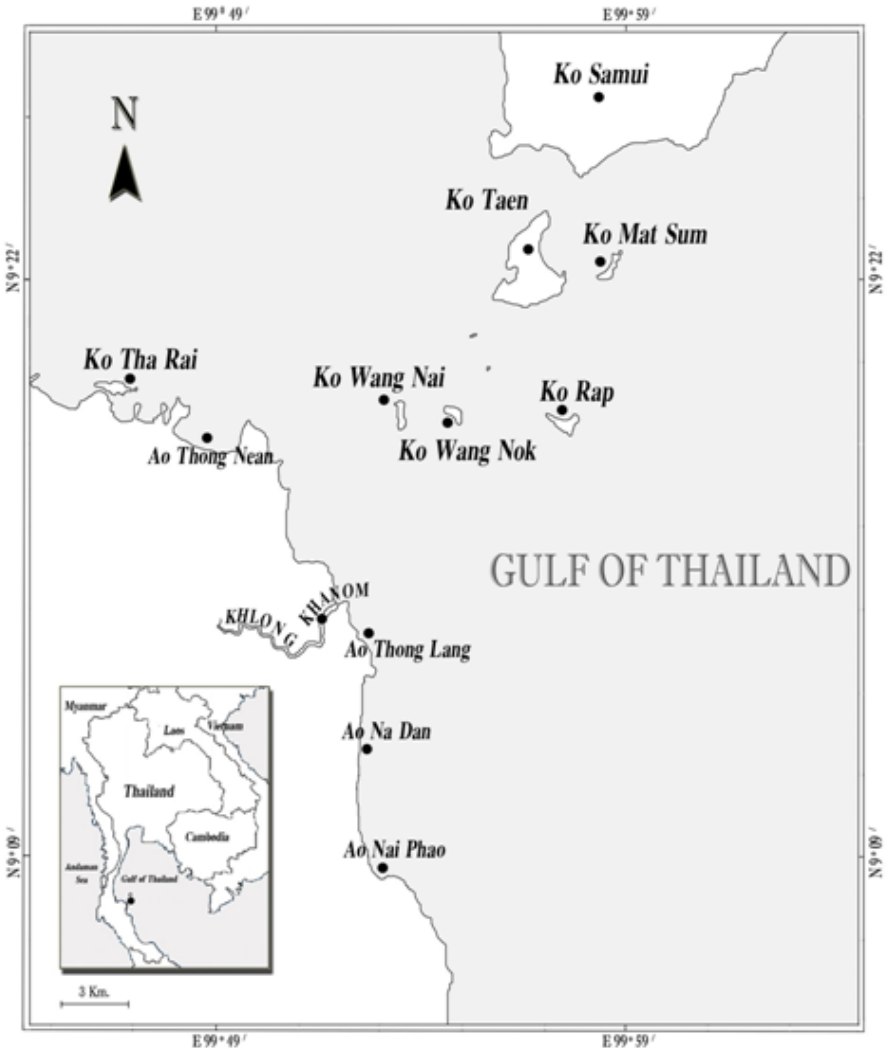

Figure 1. Study sites at Khanom-Mu Ko Thale Tai National Park, Nakhon Si Thammarat Province, Thailand.

Table 1. Summary of seaweed diversity and ecology study in Thailand from 1866 to 2008 in peer review publications. I = International publication, N = National publication, P = proceeding.

	Subject	Author (year)
1	Species list	Aungtongya and Liao (2002) [I]
		Dawson (1954) [I]
		Egerod (1971) [I]
		Egerod (1974) [I]
		Egerod (1975) [I]
		Hodgson *et al.* (2004) [I]
		Lewmanomont (1976) [P]
		Lewmanomont (1978) [N]
		Martens (1866) [I]
		Nateewathana *et al.* (1981) [I]
		Ogawa and Lewmanomont (1981) [N]
		Ogawa and Lewmanomont (1984) [N]
		Silva *et al.* (1996) [I]
		Tseng and Xia (1999) [I]
		Velasquez and Lewmanomont (1975) [N]
		Weber van Bosse (1913) [I]
2	Taxonomy	Abbott (1988) [I]
		Ajisaka (2002) [I]
		Ajisaka and Lewmanomont (2004) [I]
		Chirapart and Lewmanomont (2002) [I]
		Chirapart and Ruangchauy (1999) [I]
		Kamiya *et al.* (2003) [I]
		Kawaguchi and Lewmanomont (1999) [I]
		Kawaguchi *et al.* (2002) [I]
		Leliaert and Coppejans (2004) [I]
		Lewmanomont (1994) [I]
		Lewmanomont (1997) [I]
		Lewmanomont and Chirapart (2004) [I]
		Lewmanomont and Kawaguchi (2002) [I]
		Noiraksar *et al.* (2006) [I]
		Noiraksar and Ajisaka (2008) [I]
		Olsen-Stojkovich (1985) [I]
		Phang (1994) [I]
		Schmidt (1900-1916) [I]
		Terada *et al.* (1999) [I]
		West *et al.* (2006) [I]
3	Ecology	Prathep (2005) [I]
		Prathep and Tantiprapas (2006) [I]
		Prathep *et al.* (2007a) [I]
		Prathep *et al.* (2007b) [I]
		Prathep *et al.* (2008) [I]
		Prathep *et al.* (2009) [I]
		Thongroy *et al.* (2007) [I]
4	Biogeography	Phillips (1995) [I]

flora in Thailand was published in 1866 in "Die Preussische Expedition nach Ost-Asien" (Martens, 1866). Long after this was followed by "Flora of Koh Chang" (Schmidt, 1900-1916) and "List des Algues du Siboga" (Weber van Bosse, 1913-1928). Then not until much later in the 1970's were there a few reports of studies of marine algae as those of Egerod (1971, 1974, 1975), Velasquez and Lewmanomont (1975), and Lewmanomont (1976, 1978). Then the number of studies declined (Powtongsook, 2000) until the research activity began increasing again from 2005 with a new focus on population and community studies of common species or those from high diversity sites, such as in Phuket and Ko Samui (Prathep, 2005; Thongroy *et al.*, 2007; Mayakun and Prathep, 2005). This review has focused on the peer review publications, and has not included reports and postgraduate research theses, which can be found in Powtongsook (2000).

3.2 Diversity of Seaweeds in Khanom-Mu Ko Thale Tai National park, Southern Thailand

A total of 60 species were identified including 23 species of Chlorophyta, 19 species of Phaeophyceae in the Ochrophyta, 16 species of Rhodophyta and 2 species of Cyanobacteria (Table 2). Of these, 8 species are believed to be new records for the Thai marine flora. They include *Parvocaulis clavalus, Parvocaulis parvulus, Monostroma* sp., *Asparagopsis* sp. (*Falkanbergia stage*), *Ceratodictyon spongiosum, Dasya* sp., *Chnoospora* sp., *and Leveillea jungermannioides.*

The number of species varied from site to site. Ko Tan had the highest diversity with 49 species and KoWang Nok had the lowest diversity with 22 species; Ko Mat Sum had 27 species and Ko Wang Nai and Ko Rab were home to 25 species (Table 2). The 14 species common at all five sites were *Caulerpa racemosa, Halimeda macroloba, Rhipidosiphon javensis, Ceratodictyon spongiosum, Gelidiella acerosa, Laurencia nidifica, Peyssonnelia* sp., *Canistrocarpus cervicornis, Leveillea jungermannioides, Lobophora variegata, Padina australis, Turbinaria conoides, Turbinaria decurrens,* and *Sargassum polycystum.*

It is also worth noting that there were great variations in *R. javensis* and *L. variegata*. A greater amount of calcium carbonate accumulation on *R. javensis* was found in the specimens from Ko Wang Nai and Ko Wang Nok. There was variation in color and degree of softness of L. *variegata* from orange to brown and very soft to hard texture. *Turbinaria* spp. and *Hypnea pannosa* were abundant and grew over the corals in the shallow subtidal reefs of Ko Taen.

4. Discussion

Publications in Thailand are still limited, despite the rich diversity, ecological importance, and economic potential of seaweeds. Although Powtongsook (2000) has reported more than 285 studies of macroalgae, only a few were published in peer review journals. Thus, it is important to encourage postgraduate students to publish and more researchers are needed to provide better information and over-

Table 2. Species list of seaweeds at Khanom-Mu Ko Thale Tai National Park, Nakhon Si Thammarat Province,Thailand.

Algae Taxa	Study sites				
	Ko Taen	Ko Mat Sum	Ko Wang Nok	Ko Wang Nai	Ko Rap
Division Cyanobacteria					
Brachytrichia quoyi (C. Agardh) Bornet & Flahault	+				
Symploca hydnoides (Harvey) Kützing	+				+
Division Chlorophyta					
Parvocaulis clavalus (Solms-Laubach) S. Berger *et al.*	+		+	+	
Parvocaulis parvulus (Solms-Laubach) S. Berger *et al.*	+		+	+	
Avrainvillea erecta (Berkeley) A. Gepp & E.S. Gepp		+			
Avrainvillea lacerata Harvey ex J. Agardh	+				+
Avrainvillea obscura (C. Agardh) J. Agardh		+			
Boergesenia forbesii (Harvey) J. Feldmann	+				+
Boodlea composita (Harvey) F. Brand	+				
Bryopsis pennata Lamouroux	+	+		+	+
Caulerpa peltata J.V. Lamouroux	+			+	
Caulerpa racemosa (Forsskål) J. Agardh	+	+	+	+	+
Caulerpa serrulata (Forsskål) J. Agardh	+	+	+		
Caulerpa taxifolia (Vahl) C. Agardh	+	+		+	+
Chaetomorpha linum (O.F.Müller) Kützing					
Chaetomorpha crassa (C. Agardh) Kützing)	+				
Dictyosphaeria cavernosa (Forsskål) Børgesen	+			+	
Dictyosphaeria versluysii Weber-van Bosse	+			+	
Halimeda macroloba Decaisne	+	+	+	+	+
Monostroma sp. *		+			
Rhipidosiphon javensis Montagne	+	+	+	+	+
Udotea flabellum (J. Ellis & Solander) M.A. Howe	+	+			
Udotea glaucescens Harvey ex J. Agardh				+	
Ulva intestinalis Linnaeus	+				
Valonia aegagropila C. Agardh					+
Valoniopsis sp.	+				
Division Rhodophyta					
Acanthophora spicifera (M. Vahl) Børgesen	+	+	+	+	+
Actinotrichia fragilis (Forsskål) Børgesen	+		+		
Amphiroa sp.	+				
Asparagopsis sp. (*Falkanbergia stage*) *	+				
Bostrychia tenella (J.V. Lamouroux) J. Agardh *(Bostrychia binderi* Harvey		+			
Ceratodictyon spongiosum Zanardini	+	+	+	+	+
Champia sp.	+				
Chondrophycus cartilagineus (Yamada) Garbary & Harper	+		+	+	+
Dasya sp. *		+			
Gelidiella acerosa (Forsskål) Feldmann *et* G. Hamel	+	+	+	+	+
Gelidiopsis intricata (C. Agardh) Vickers		+	+		
Gracilaria salicornia (C. Agardh) Dawson	+				
Hypnea pannosa J. Agardh	+	+			
Jania sp.	+				
Laurencia nidifica J. Agardh	+	+	+	+	+
Peyssonnelia sp.	+	+	+	+	+
Class Phaeophyceae					
Chnoospora sp. *	+				
Canistrocarpus cervicornis (Kützing)					

Table 2. Continued

Algae Taxa	Study sites				
	Ko Taen	Ko Mat Sum	Ko Wang Nok	Ko Wang Nai	Ko Rab
De Paula & De Clerck	+	+	+	+	+
Dictyota bartayresiana/ciliolata?	+	+	+		+
Dictyota sp.				+	
Ectocarpus sp.	+				
Hormophysa cuneiformis (J.F. Gmelin) P.C. Silva					+
Hydroclathrus clathratus (C. Agardh) M.A. Howe	+				
Leveillea jungermannioides (K. Hering & G. Martens) Harvey	+	+	+	+	+
Lobophora variegata (Lamouroux) Womersley ex Oliveira	+	+	+	+	+
Padina australis Hauck	+	+	+	+	+
Padina sanctae-crucis Børgesen					+
Padina sp.	+				
Turbinaria conoides (J. Agardh) Kützing	+	+	+	+	+
Turbinaria decurrens Bory de Saint-Vincent	+	+	+	+	+
Turbinaria ornata (Turner) J. Agardh					+
Sargassum oligocystum Montagne *(Sargassum binderi* Sonder*)*	+				
Sargassum cristaefolium C. Agardh	+		+		
Sargassum polycystum C. Agardh	+	+	+	+	+
Sargassum swartzii C. Agardh	+				

* New record for Thailand.

all understanding of seaweed biodiversity and ecology in Thailand and in the region. The increased numbers of publications on population and community structure of seaweeds in Thailand (Prathep, 2005, Prathep and Tantiprapas, 2006, Prathep *et al.*, 2007a, 2007b, 2008, 2009), have broadened the scope of studies providing a baseline for future more complex ecological studies, but also for informing coastal management and exploring seaweed potential practical uses.

Although there were 60 species found in this study, this is less diversity compared to the report of Thongroy *et al.* (2007). Since the study area was much greater in this study on the 1.5 km shore of Sirinart Marine National Park. However, both sites have differences in habitat. Khanom-Mu Ko Thale Tai National Park is a shallow subtidal coral dominated habitat compared to the rocky intertidal shore of the Sirinart Marine National Park. Coral can compete for space by limiting the settlement of macroalgal spores and fertilized eggs. Coral/algae interactions are known to be a very competitive (McCook *et al.*, 2001, Jompa and McCook, 2003). However, once the macroalgae become abundant, they may occupy a larger space and can inhibit growth and settlement of other algae (Worm and Chapman, 1996, McCook and Chapman, 1992).

The two times greater diversity at Ko Tan compared to the other islands, might be due to its greater coastline. However, since all the islands are close together it is likely that the spores and zygotes should be able to disperse with equal abundance and success. Ko Samui, another nearby tourist destination with a long coastline, has a lower diversity (Mayakun and Prathep, 2005). Development and tourism of Ko Samui could have negative effects on the diversity of marine life including macroalgae and also could eventually influence the nearby offshore islands. Thus, dispersal abilities, habitat variations and anthropogenic disturbance undoubtedly play important roles affecting the diversity and distribution of macroalgae in the area. The information from these studies indicate that the offshore islets could provide a good study site for understanding the small scale biogeography of seaweeds within the Gulf of Thailand. Also, this study provides a more complete species list for further comparative studies between the Gulf of Thailand and the Andaman Sea.

Acknowledgement

We are indebted to E. Coppejeans and K. Lewmanomont for identification of specimens, and the workshops on seaweed and seagrass biodiversity, using Khanom Mu Koh Thalay Tai National Park as an area study. We are indebted to L.B. Liddle for manuscript improvement. Special thanks to the Seaweed & Seagrass Research Unit Team for field assistance. This work was supported by TRF/BIOTEC Special program for Biodiversity Research and Training grant BRT R_149020, TOTAL E&P Thailand, and TOTAL Foundation of France.

References

Abbott, I.A. 1988. Some species of *Gracilaria* and *Polycavernosa* from Thailand. In Taxonomy of economic seaweeds with reference to some Pacific and Caribbean species Vol. II, I.A Abbott, editor. California Sea Grant College System, La Jolla, California, pp. 137-150.

Ajisaka, T. 2002. *Sargassum* specimens from Singapore and Malaysia in the Herbarium of the Bishop Museum. In Taxonomy of Economic Seaweeds with reference to some Pacific species. Vol. VIII, I.A. Abbott and K.J. Mcdermid, editors. California Sea Grant College System, La Jolla, California, pp. 77-88.

Ajisaka,T. and Lewmanomont, K. 2004. Variations in the Basal System and Stolons of *Sargassum stolonifolium* in the Andaman Sea. In Taxonomy of Economic Seaweeds with reference to the Pacific and other locations Vol. IX, I.A. Abbott and K.J. McDermid, editors. California Sea Grant College System, La Jolla, California, pp. 57-72.

Aungtonya, C. and Liao, L.M. 2002. Marine flora (algae and seagrasses) in the reference collection of the Phuket Marine Biological Centre, Thailand Phuket Marine Biology Center Research Bulletin. 64, 65-80

Bastianoni, S., Coppola, F., Tiezzi, E., Colacevich, A., Borghini, F. and Focardi, S. 2008. Biofuel potential production from the Orbetello lagoon macroalgae: A comparison with sunflower feedstock. Biomass and Bioenergy. 32(7), 619-628.

Chirapart, A. and Lewmanomont, K. 2002. A different flattened species of *Gracilaria* from Thailand. In Taxonomy of Economic Seaweeds with reference to some Pacific species. Vol. VIII, I.A. Abbott and K.J. Mcdermid, editors. California Sea Grant College System, La Jolla, California, pp. 237-243.

Chirapart, A. and Ruangchauy, R. 1999. A new record of *Gracilaria, G. rubra* C.F. Chang et B.M. Xia from Thailand. In Taxonomy of Economic Seaweeds with reference to some Pacific species Vol. VII, I.A. Abbott, editor. California Sea Grant College System, La Jolla, California, pp. 137-143.

Dawson, E.Y. 1954. Note on tropical Pacific marine algae. Bulletin, Southern California Academy of Sciences, Vol. 53, 7 p.

Egerod, L. 1971. Some marine algae from Thailand. Phycologia. 10(1), 121-142.

Egerod, L. 1974. Report on the marine algae collected on the Fifth Thai-Danish Expedition of 1966, Chlorophyceae. Botanica Marina. 17, 130-157.

Egerod, L. 1975. Marine algae of the Andaman Sea Coast of Thailand: Chlorophyceae. Botanica Marina. 18(1), 41-66.

Hodgson, L.M., Pham Huu Tri, Lewmanomont, K. and McDermid, K.J. 2004. Annotated checklist of species of *Caulerpa* and *Caulerpella* (Bryopsidales, Caulerpaceae) from Vietnam, Thailand and the Hawaiian Islands. In Taxonomy of Economic Seaweeds with reference to the Pacific and other locations Vol IX. I.A. Abbott and K.J. McDermid, editors. California Sea Grant College System, La Jolla, California, pp. 21-38.

Huisman, J.M. 2000. Marine plants of Australia. University of Western Australia Press, Western Australia. pp. 300.

Jompa, J. and McCook., L. 2003. Coral-algal competition: macroalgae with different properties have different effects on coral. Marine Ecology Progress Series. 258, 87-95.

Kamiya, M., Zuccarello, G.C. and West, J.A. 2003. Evolutionary relationships of the genus *Caloglossa* (Delesseriaceae, Rhodophyta) inferred from large-subunit ribosomal RNA gene sequences, morphological evidence and reproductive compatability, with description of a new species from Guatemala. Phycologia. 42, 478-497.

Kawaguchi, S. and Lewmanomont, K. 1999. Morphology and culture study of a red alga, *Halymenia dilatata* Zandardini, from Vietnam and Japan. In Taxonomy of Economic Seaweeds with reference to some Pacific species Vol. VII, I.A. Abbott, editor. California Sea Grant College System, La Jolla, California, pp. 147-161.

Kawaguchi, S., Lewmanomont, K. and McDermid, K.J. 2002. Morphology of *Halymenia maculata* J. Agardh from Vietnam. In Taxonomy of Economic Seaweeds with reference to some Pacific species Vol. VIII. I.A. Abbott and K.J. McDermid, editors. California Sea Grant College System, La Jolla, California, pp. 259-266.

Leliaert, F. and Coppejans, E. 2004. Crystalline cell inclusions: a new diagnostic character in the Cladophorophyceae (Chlorophyta). Phycologia. 43, 189-203.

Lewmanomont, K. 1976. Algae flora of the mangrove area. Proceeding of the First National Seminar on Ecology of Mangrove. National Research Council of Thailand. 1(2), 202-213 (in Thai).

Lewmanomont, K. 1978. Some edible algae of Thailand. The Kasetsart Journal. 12(2), 119-129.

Lewmanomont, K. 1994. The species of Gracilaria from Thailand. In Taxonomy of economic seaweeds Vol. IV, I.A. Abbott, editor. California Sea Grant College System, La Jolla, California, pp. 135-148.

Lewmanomont, K. 1997. Species of *Hypnea* from Thailand. In Taxonomy of Economic Seaweeds Vol. VI, I.A. Abbott, editor. California Sea Grant College System, La Jolla, California, pp. 179-191.

Lewmanomont, K. and Chirapart, A. 2004. Additional records of *Gracilaria* from Thailand. In Taxonomy of Economic Seaweeds with reference to the Pacific and other locations Volume IX, I.A. Abbott and K.J. McDermid, editors. California Sea Grant College System, La Jolla, California, pp. 201-210.

Lewmanomont, K. and Kawaguchi, S. 2002. Foliose *Halymenia* (Halymeniaceae, Cryptonemiales, Rhodophyta) from Thailand. In Taxonomy of Economic Seaweeds with reference to some Pacific species. Vol. VIII, I.A.

Abbott and K.J. Mcdermid, editors. California Sea Grant College System, La Jolla, California, pp. 267-277.

Lewmanomont, K. and Ogawa, H. 1995. Common Seaweeds and Seagrasses of Thailand, Faculty of Fisheries, Kasetsart University, Bangkok. pp.154.

Lewmanomont, K., Wongrat, L. and Supanwanid, C. 1995. Algae in Thailand. Integrated Promotion Technology Co., Lts. Thailand. pp 334.

Littler, D.S. and Littler, M.M. 2000. Caribbean reef plants. Offshore Graphics, Inc., Washington, D.C., U.S.A., pp. 542.

Martens, G. von 1866. Die Tange. In Die Preussische Expedition nach Ost-Asien. Nach amtlichen Quellen. Botanischer Theil. editors, Verlag de Königlichen Geheimen Ober-Hofbuchdruckerei, Berlin, pp. 152.

Mayakun, J. and Prathep, A. 2005. Seasonal variations in diversity and abundance of maroalgae at Samui Island, SuratThani Province, Thailand. Songklanakarin Journal Science Technology. 27, 653-663.

McCook, L.J. and Chapman, A.R.O. 1992 Vegetative regeneration of *Fucus* rockweed canopy as a mechanism of secondary succession on an exposed rocky shore. Botanica Marina. 35, 35-46.

McCook, L.J., Jompa, J. and Diaz-Pulido, G. 2001. Competition between corals and algae on coral reefs: a review of evidence and mechanisms. Coral Reefs. 19, 400-417

Muraoka, D. 2004. Seaweed resources as a source of carbon fixation. Bulletin of Fisheries Research Agency Supplement. 1, 59-63.

Nateewathana, A., Tantichodok, P., Busarawich, S. and Sirivejabandhu R. 1981. Marine organisms in the reference collection. Phuket Marine Biological Center Research Bullentin. 28, 43-82.

Noiraksar, T and Ajisaka, T. 2008. Taxonomy and distribution of *Sargassum* (Phaeophyceae) in the Gulf of Thailand. Journal of Applied Phycology. 20, 963-977.

Noiraksar, T., Ajisaka, T. and Kaewsuralikhit C. 2006. Speices of *Sargassum* in the east coast of the Gulf of Thailand. Science Asia. 32 (Suppl. 1), 99-106

Ogawa, H. and Lewmanomont, K. 1981. Economic seaweeds of Thailand I. The Genus *Hypnea* in the vicinity of Si Racha, Chon Buri Province. Kasetsart University Fishery Research Bulletin No, 12. 14 p.

Ogawa, H. and Lewmanomont, K. 1984. The red algae subclass Bangiophycidae of Thailand. Kasetsart University Fishery Research Bulletin No. 15, 21 p.

Olsen-Stojkovich, J. 1985. A systematic study of the genus *Avrainvillea* Decaisne (Chlorophyta, Udotaceae). Nova Hedwigia Band. 41, 1-67.

Phang, S.M. 1994. Some species of *Gracilaria* from Peninsular Malaysia and Singapore. In Taxonomy of Economic Seaweeds with reference to some Pacific and Caribbean species Vol. IV, I.A. Abbott, editor. California Sea Grant College System, La Jolla, California, 125-134.

Phillips, N. 1995. Biogeography of *Sargassum* (Phaeophyta) in the Pacific basin. In Taxonomy of Economic Seaweeds Vol. V, I.A. Abbott, editor. California Sea Grant College System, La Jolla, California, pp. 107-145.

Powtongsook, S. 2000. Seaweed: research and development potential for using seaweed in Thailand. Thailand Research Fund, Bangkok, 356 p.

Prathep, A, Lewmanomont, K and Buapet, P. 2009 Effects of wave exposure on population and reproductive phenology of an algal turf, *Gelidium pusillum* (Gelidales, Rhodophyta), Songkhla, Thailand. Aqautic Botany. 90, 179-183

Prathep, A. 2005. Spatial and temporal variations in diversity and percentage cover of macroalgae at Sirinart Marine National Park, Phuket Province, Thailand. Science Asia. 31, 225-233.

Prathep, A. and Tantiprapas, P. 2006. Preliminary report on the diversity and community structure of macroalgae before and after the 2004 Tsunami at Talibong Island, Trang Province, Thailand. Coastal Marine Science. 30(1), 189-195.

Prathep, A., Darakrai, A., Tantiprapas, P., Mayakun, J., Thongroy, P., Wichachucherd, B. and Sinutok, S. 2007a. Diversity and community structure of macroalgae at Koh Taen, Haad Khanom-Mu Koh Tale Tai, Marine National Park, Nakhon Si Thammarat Province, Thailand. Marine Research Indonesia. 32(2), 153-162.

Prathep, A., Mayakun, J., Tantiprapas, P. and Darakrai, A. 2008. Can macroalgae recover 13 months after the 2004 Tsunami? A case study at Talibong Island, Trang Province, Thailand. Journal of Applied Phycology 20 (5), 907.

Prathep, A., Wichachucherd, B. and Thongroy, P. 2007b. Spatial and temporal variations in density and t hallus morphology of *Turbinaria ornata* in Thailand. Aquatic Botany. 86, 132-138.

Schmidt, J. 1900-1916. Flora of Koh Chang. Contributions to the vegetation in the Gulf of Siam, Copenhagen, 444 p.

Silva, P.C., Basson, P.W. and Moe, R.L. 1996. Catalogue of the benthic marine algae of the Indian Ocean. University of California Publications in Botany. 79, 1-1259.

Terada, R., Yamamoto, H. and Muraoka, D. 1999. Observations on an adelphoparasite growing on *Gracilaria salicornia* from Thailand. In Taxonomy of Economic Seaweeds with reference to some Pacific species Vol. VII, I.A. Abbott, editor. California Sea Grant College System, La Jolla, California, pp. 121-129.

Thongroy, P., Liao, L.M. and Prathep, A. 2007. Diversity, abundance and distribution of macroalgae at Sirinart Marine National Park, Phuket Province, Thailand. Botanica Marina. 50, 88-96.

Tseng, C.K. and Xia, B.M. 1999. On the *Gracilaria* in the western Pacific and southeastern Asia region. Botanica Marina. 42, 209-218.

Velasquez, G.T. and Lewmanomont, K. 1975. A checklist on the study of the benthic marine algae of Thailand. Kasetsart University Fishery Research Bulletin No. 18, 25 p.

Weber van Bosse, A. 1913-1928. Siboga Expeditie, List Des Algues gu Siboga, Vol. 59, Part I, Myxophyceae, E. J. Brill, Leiden. 1-45.

West, J.A., Zuccarello, G.C., Hommersand, M., Kasrsten, U. and Görs, S. 2006. Observations on *Bostrychia radicosa* comb. nov. (Rhodomelaceae, Rhodophyta). Phycological Research. 54, 1-14.

Worm, B. and Chapman, A.R.O. 1996. Interference competition among two intertidal seaweeds; Chondrus crispus strongly affects survival of *Fucus evanescens* recruits. Marine Ecology Progress Series. 145, 297-301.

www.algaebase.org. 14 December 2008.