Ecological Study of True Mangrove Structure along Andaman Coastline of Ranong, Thailand

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ABSTRACT

This research was conducted in a mangrove ecosystem in Ranong, Thailand with the aim of studying the real mangrove structure in terms of ecologically-based relative abundance and species diversity concepts. The Point Centered Quarter (PCQ) method and Shannon-Wiener's index were used to perform floristic inventory and quantify species diversity index values in three sampling sites. There were 11, 9 and 7 species of individuals found in Rachakrud, Bangben and Talaynog sites, respectively. *Avicennia marina, Rhizophora apiculata* and *Bruguiera parviflora* make up almost 84% of stand found in Rachakrud site. At Bangben site, we discovered two species, namely, *Ceriops decandra* and *Rhizophora apiculata* which comprised 69% of stand. Moreover, we found *Bruguiera parviflora* and *Rhizophora mucronata* assembled at 65% of stand located in Talaynog site. These mangrove species were classified as the most abundant species in each particular site. The mangroves in Rachakrud had the highest diversity index value (1.65) while the mangroves in Talaynog had the lowest diversity index value (1.51). This corresponded with their species richness at 11 and 7, respectively. The outcome from relative abundance and species diversity study of the true mangroves in Ranong particularly along the Andaman coastline would serve as baseline information on mangrove biodiversity, coastal ecosystem conservation and management.

Key words: relative abundance, species diversity, true mangroves, Ranong

INTRODUCTION

Mangroves are the characteristic coastal vegetation formations of tropical and subtropical sheltered coastlines (FAO, 1994; Sinfuego and Buot, 2008). They are dominated by several species of trees, shrubs and herbs capable of growth and reproduction in areas inundated daily by seawater (Aksornkoae *et al*., 1992; Smith and Smith, 2004). They serve as a unique habitat for selected aquatic fauna of economic and ecologic importance to human society (Buot, 1994; Othman, 1994; Doydee *et al*., 2008).

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Presently, the mangrove population in many provinces in Thailand including Ranong province is declining. The main reasons for mangrove loss and degradation include population pressure, wood extraction and mangrove land conversion to settlement and aquaculture as well as natural disaster (Macintosh *et al*., 2002; Ashton *et al*., 2003; Doydee *et al*., 2008).

Ranong mangrove forests are complex ecosystems which harbor a rich biodiversity and have an important role in enriching the coastal waters (Doydee, 2008). Urbanization and development of coastal shrimp farming have been the biggest threats to Ranong mangrove forests (Phillips *et at*., 1993; Macintosh, 1996). Ranong mangrove environments serve as a biological filter or biological wall against tsunami and other calamities (Doydee, 2008).

There are various benefits from the diversity of mangrove ecosystem, such as improving the quality of life of local people in the Ranong coastal zone, due to the presence of aquatic fauna that serves as a stable food and livelihood for them (Macintosh *et al*., 2002; Doydee *et al*., 2008). Furthermore, the diverse mangrove plant composition offers quality products such as lumber for use as structural material for construction, and charcoal used as cooking fuel (Macintosh *et al*., 2002; Doydee *et al*., 2008). Availability of medicinal plants and herbs is enhanced with a diverse mangrove plantation. The diversity in mangrove species also enriches ecological functions. It mitigates the negative effects of natural calamities such as soil erosion, typhoon and tsunami (Tri *et al*., 1998).

The ecological - based study of mangroves by applying relative abundance and species diversity was substantial for analysis and the result would serve fundamentally as baseline information for future development of planning and management approaches on mangrove biodiversity, utilization and conservation. This in turn will lead to sustainable development of the coastal environment.

MATERIALS AND METHODS

Study area

The study was conducted in Ranong. The province is located on the coast of the Andaman Sea, 568 km south of Bangkok. The study area (Fig. 1) was situated around 9°43′ N to 9°57′ N and 98°29′ E to 98°39′ E. Ranong receives 4,000-5,000 mm of /rainfall per year (Doydee *et al*., 2008), where the highest rainfall in Thailand has been recorded. It experiences rainfall for 190 days every year.

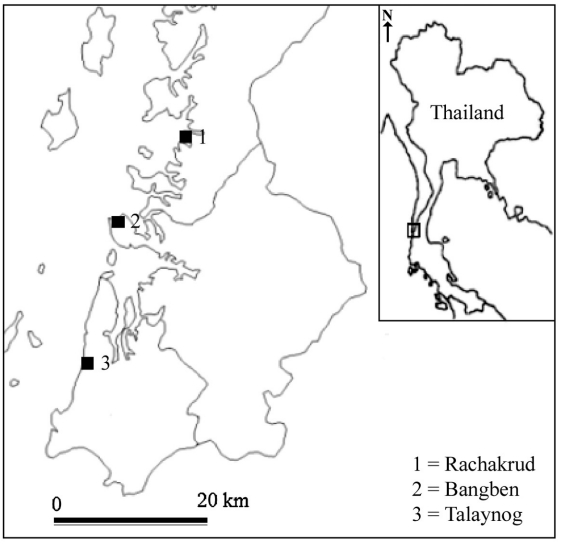

Figure 1. The study area and the three sampling sites (black squares) along the Andaman Sea coast

The area is characterized by two monsoon seasons. The dry northeast monsoon occurs from November to February and the wet southwest monsoon during Mayto mid - October. The tides at Ranong are predominantly semidiurnal with average amplitude at the river mouth of Klong Ngao of about 2.5 m and maximum range of over 4 m (Macintosh *et al*., 1991).

Three sampling sites, namely, Bangben, Rachakrud and Talaynog were selected based on accessibility, size of mangrove patches and associated elements such as canal and distance. Based on satellite image data by Doydee (2008), Rachakrud site has the biggest number and size of mangrove patches. Bangben has a large mangrove area but with few patches, while medium patch size was found in Talaynog site. *Avicennia* sp. was the most dominant species in Rachakrud, while *Rhizophora* species existed mostly in both Bangben and Talaynog (Doydee, 2008).

Data collection and analysis

The Point Centered Quarter (PCQ) method by Mueller-Dombois and Ellenberg (1974) was used to profile the mangrove species and to establish the structure of the mangrove community. Each sampling site was composed of 80 mangrove trees. The transect lines ran from the Andaman coastline or channel inward with 20 points, with a 20 m space between points. In each point, four mangrove trees nearest to the four cardinal directions were identified (Fig. 2). For each sampling site, the position was determined using a Global Positioning System (GPS) receiver with an estimated accuracy of 10 m or better. Geo-referencing techniques were applied to revalidate the positions.

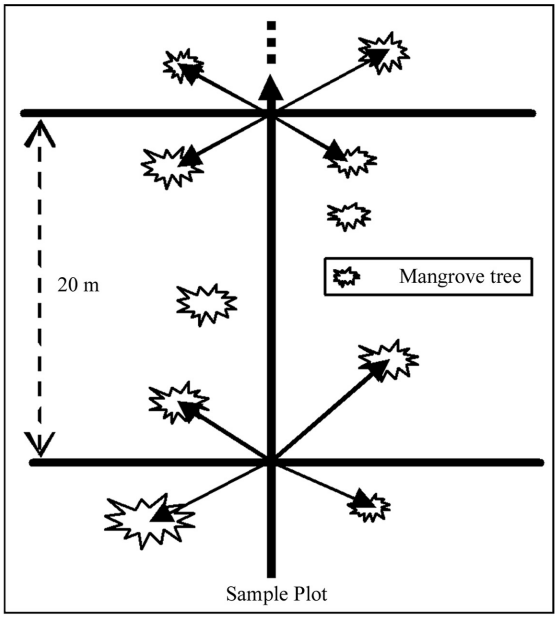

Figure 2. The diagram of the Point Centered Quarter method

The relative abundance of mangrove species was analyzed and characterized by counting each mangrove tree in the sample plots and determining what percentage each contributes to the total number of individuals of all species (Smith and Smith, 2004).

Mangroves species diversity was analyzed and evaluated using the Shannon-Wiener's index of diversity H (Shannon and Wiener, 1963) and calculated according to the following equation:

$$H = -\sum_{i=1}^{S} (p_i)(\ln p_i)$$

where, H is the measure of species diversity, S is the number of species and p_i is the proportion of all individuals in the sample which belongs to species i. The value of the Shannon-Wiener Index usually lies between 1.5 and 3.5 for ecological data (Smith and Smith, 2004).

RESULTS AND DISCUSSION

The structure of true mangroves in Bangben, Rachakrud and Talaynog sampling sites are presented in Table 1. There were a total of 18 mangrove species in the 3 sampling sites, with 11 species in Rachakrud. *Avicennia marina* had the highest percentage of stand (37.50%). The three most abundant species were *Avicennia marina*, *Rhizophora apiculata* and *Bruguiera parviflora*, which comprised 83.75% of stand. The next three most abundant mangrove species - *Bruguiera cylindrica*, *Xylocarpus moluccensis* and *Sonneratia alba* – ranged from 2.50-3.75%, while the five remaining species each represented 1.25% of stand (Table 1).

Table 1. Structure of true mangroves in Rachakrud, Bangben and Talaynog

Species	Rachakrud		Bangben		Talaynog	
	Number	**%Stand**	**Number**	**%Stand**	**Number**	**%Stand**
Avicennia marina	30	37.50	1	1.25	0	0
Rhizophora apiculata	21	26.25	23	28.75	12	15.00
Bruguiera parviflora	16	20.00	0	0	35	43.75
Bruguiera cylindrica	3	3.75	0	0	0	0
Xylocarpus moluccensis	3	3.75	0	0	1	1.25
Sonneratia alba	2	2.50	0	0	0	0
Avicennia alba	1	1.25	0	0	0	0
Avicennia officinalis	1	1.25	0	0	7	8.75
Bruguiera gymnorrhiza	1	1.25	0	0	0	0
Rhizophora mucronata	1	1.25	0	0	17	21.25
Xylocarpus granatum	1	1.25	4	5	1	1.25
Ceriops tagal	0	0	0	0	7	8.75
Ceriops decandra	0	0	32	40.00	0	0
Scyphiphora hydrophyllacea	0	0	8	10.00	0	0
Lumnitzera recemosa	0	0	7	8.75	0	0
Excoecaria agallocha	0	0	2	2.50	0	0
Lumnitzera littorea	0	0	2	2.50	0	0
Heritiera littoralis	0	0	1	1.25	0	0
Total	**80**	**100**	**80**	**100**	**80**	**100**

The sample in Bangben consisted of nine species with *Ceriops decandra* as the most abundant with the highest percentage of stand (40.00%). *Ceriops decandra* and *Rhizophora apiculata* were the two most abundant composing 69% of stand. The next three most abundant mangrove species – *Scyphiphora hydrophyllacea*, *Lumnitzera racemosa* and *Xylocarpus granatum*–ranged from 5.00-10.00% and the four remaining species cumulatively represented 7.50% of stand. Two single occurrence mangrove species namely *Avicennia marina* and *Heritiera littoralis* were observed (Table 1).

Talaynog site had seven species, with *Bruguiera parviflora* and *Rhizophora mucronata* as the two most abundant species composing 65.00% of stand. The next three most abundant species – *Rhizophora apiculata*, *Avicennia officinalis* and *Ceriops tagal* – ranged from 8.75-15.00 %, while the two remaining species cumulatively represented 2.5% of stand (Table 1).

All sampling sites of mangrove forest communities illustrated a pattern of a few common species (2 - 3 species) associated with many rare ones. These three forest communities differ in their species diversity. Species diversity relates to both the number of species (species richness) and how individuals are apportioned among the species (species evenness) (Smith and Smith, 2004). The mangrove forest community in Rachakrud has both greater species richness and greater species evenness than those in Bangben and Talaynog. According to Macintosh *et al.* (1991), the most common species in the Ranong mangrove ecosystem were *Rhizophora apiculata*, *R. mucronata*, *Bruguiera cylindrical*, *B. parviflora*, *B. gymnorhiza*, *Ceriops tagal*, *Xylocarpus granatum*, *X. moluccensis*, *Excoecaria agallocha*, *Acrostichum aureum* and *Acanthus ilicifolius*.

The distribution of mangrove species differs according to topography, relief, soil and the frequency of tidal inundation. The dominant species in all areas were found in stands which are infrequently inundated. They are often found in solid stands in the interior of the mangrove forest, mostly in firm mud flats. Substrates include consolidated mud, sand, calcareous sand, and brackish and hypersaline soils (Giesen *et al.*, 2007). The three sampling sites have more or less the same topography, relief and tidal inundation but differed in soil characteristics. The soil in Rachakrud was black and brown in color, had silt and a clay texture, and a pH value of 5.95. Whereas in Bangben the soil was yellow and brown, and had a clay texture and pH value of 6.36. The soil in Talaynog was bright brown, and had sand and clay texture with a pH value of 7.57 (Doydee, 2008).

The species diversity of mangroves in Ranong coastal area had diversity indeces of 1.65, 1.61 and 1.51 for Rachakrud, Bangben and Talaynog respectively (Table 2).

Table 2. Species diversity of mangrove vegetation using Shannon-Wiener's index

Sampling Site	Number of Species	Shannon-Wiener diversity index (*H*)
Rachakrud	11	1.65
Bangben	9	1.61
Talaynog	7	1.51

The Shannon-Wiener diversity index (*H*) is one measure which could be used to draw information from samples in the field (Buot, 1994; Macintosh *et al*., 2002; Ashton *et al*., 2003). It can be related to the abundance of mangrove resources for human consumption and utilization. Rachakrud site had both the highest number of mangrove species and highest *H* values (Table 2). The mangrove plant composition in this area was greater in species number (11) and this made the location an important site for habitat conservation. However, this site could not yet be declared as the most diverse since there are still some mangrove trees which were not yet identified in the whole area of Rachakrud.

The close relationship obtained between species Shannon-Wiener diversity index, *H* and mangrove structure is reflected in the following: the high value of *H* (>3) means greater species and less abundance, while low value of *H* (<1) means less species but greater abundance. Thus, the mangrove structure in the three sampling sites have moderate species diversity and moderate abundance in general as the value of *H* ranged from 1-3 (Table 2). This study improved the understanding of true mangrove structure and its diversity which is important for the livelihoods of the local people dwelling in the mangrove ecosystem.

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