

DISTRIBUTION OF MANGROVE PLANTS IN CON ONG TRANG, CA MAU CAPE NATIONAL PARK

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Abstract

Mangrove forest in Con Ong Trang, Ca Mau Cape National Park is an ecosystem formed in the natural process with the distribution of typical mangrove plant species. This study aimed to identify distribution types of plant species in communities and the impact of soil characteristics on plant distribution. The results showed that there are 11 true mangrove species belonging to 5 families in the study area, and most of these species distributed aggregately. The distribution of the three dominant species, namely *Avicennia alba*, *Rhizophora apiculata* and *Bruguiera parviflora*, in various tide inundations and soil types was analyzed. This provided database for mangrove ecosystem development, including forestation area planning and selection of mix communities for afforestation.

Keywords: Con Ong Trang, distribution, mangrove plant, Ca Mau Cape National Park.

PHÂN BỐ CỦA THỰC VẬT RỪNG NGẬP MẶN Ở CÒN ÔNG TRANG, VƯỜN QUỐC GIA MŨI CÀ MAU

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Tóm tắt

Rừng ngập mặn ở Cồn Ông Trang, Vườn Quốc gia Mũi Cà Mau là hệ sinh thái được hình thành theo tiến trình tự nhiên, với sự phân bố của nhiều loài thực vật ngập mặn đặc trưng. Nghiên cứu này nhằm mục đích xác định các kiểu phân bố của các loài thực vật ngập mặn trong quần xã và ảnh hưởng của đặc tính thổ nhưỡng đến sự phân bố của chúng. Kết quả nghiên cứu cho thấy có 11 loài ngập mặn thật sự thuộc 5 họ ở khu vực nghiên cứu, hầu hết các loài đều phân bố theo nhóm. Sự phân bố của 3 loài ưu thế bao gồm Mắm trắng (*A. alba*), Đước đôi (*R. apiculata*) và Vẹt tách (*B. parviflora*) theo mức ngập triều và thể nền khác nhau cũng được phân tích. Đây là cơ sở dữ liệu cho phát triển hệ sinh thái rừng ngập mặn, bao gồm công tác quy hoạch khu vực trồng rừng và lựa chọn các loài trồng hỗn giao với nhau.

Từ khóa: Cồn Ông Trang, phân bố, thực vật ngập mặn, Vườn Quốc gia Mũi Cà Mau.

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1. Introduction

Mangrove forest has ecological, economic and environmental functions in climate change adaptation and mitigation. This forest also helps in protecting sea dyke and alluvial soil, preventing erosion, limiting saline intrusion, regulating local climate, conserving biodiversity. Mangrove plants are found in two principal forms of distribution depending on structure of mangrove community. They are random distribution and aggregated distribution. There are various main ecological factors including rainfall, temperature, tide, salinity and soil determined zonification of mangrove forests and plant species distribution. The number of individuals, number of species and tree size are affected by temperature and precipitation (Phan Nguyen Hong and Hoang Thi San, 1993). Tidal inundation is the main factor affecting the mangrove plant distribution (Giesen *et al.*, 2007). Mangrove forests might occur on a variety of sediments, mud, coral reefs; however, they grow best on muddy soil with appropriate salinity about 5‰ - 30‰ (Lacerda *et al.*, 2001).

Vietnam's coastline stretches from the North to the South with the rich and diverse mangrove vegetation. Mangrove ecosystem in Ca Mau province has typical features of this ecosystem in Vietnam and Southeast Asia. The mangrove ecosystem in Ca Mau Cape is mainly formed from river alluvium. Con Ong Trang belonging to Ca Mau Cape National Park is a natural alluvial area including three sand dunes namely Con Trong, Con Ngoai and Con Moi that formed in Cua Lon river, Ong Trang estuary. This is a favorable area for research relating to the impacts of natural conditions on mangrove ecosystem because it is formed according to the primary succession without human influence. This study determined species composition of mangrove plants and their distribution on Con Ong Trang including types of distribution, the effects of soil characteristics on the species distribution. The results are the scientific background for selecting mangrove species in afforestation plan. That is of great significance for conservation and development of the mangrove ecosystem.

2. Research methods

Method of investigating quadrats: There are 92 quadrats (10 x 10 m²) located along transects. The direction of transects were Northeast – Southwest with 29 transect crossing the dunes. In each quadrat, scientific name of plants and growth indicators of tree, including morphological characteristics of species, and the number of individuals of each species were determined.

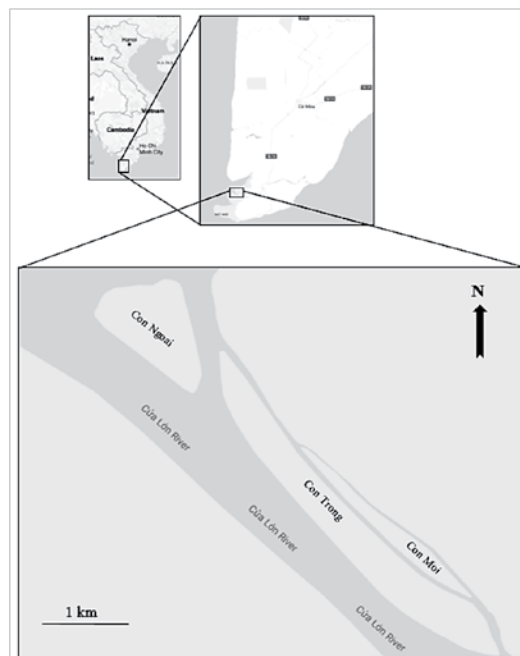


Figure 1. Three sites of study areas

Method of species identification: identifying scientific name of species according to morphological comparison method based on main documents, including Cay co Viet Nam (Pham Hoang Ho, 1999-2003), Rung ngap man Viet Nam (Phan Nguyen Hong *et al.*, 1999), and Mangroves of the Kien Giang biosphere reserve Vietnam (Duke, 2012).

Methods of environmental parameters survey: classification of soil according to Decision 5365/QD-BNN-TCLN of Ministry of Agriculture and Rural Development. Tidal inundation was identified by combination data of measuring level of tides in quadrats and tidal table of National Centre for Hydrometeorological Forecasting.

Data analysis: Software used in data analysis including Microsoft Excel 2016, Statgraphics Centurion XVI. In addition, Biodiversity Pro 2.0 was used to identify types of spatial distribution of mangrove trees; Primer 6.1.6 was used for analyzing clusters of different species and effects of tides and soil types on distribution of dominated species.

3. Results and discussion

3.1. Mangrove plant species composition in Con Ong Trang

Mangrove forest in Con Ong Trang had 11 true mangrove species belonging to 5 families. Of which, there were 4 species found outside the quadrats including *Acanthus ilicifolius* L. (belonging to Acanthaceae), *Xylocarpus moluccensis* (Lam.) M. Roem. (Meliaceae), *Rhizophora mucronata* Poir. in Lamk. (Rhizophoraceae), and *Nypa fruticans* Wurmb. (Arecaceae).

Table 1. Composition of mangrove plant at Con Ong Trang

Family	Species	Sites		
		Con Trong	Con Ngoai	Con Moi
Acanthaceae	<i>Acanthus ilicifolius</i> L.	*		*
	<i>Avicennia alba</i> Blume	+	+	+
	<i>Avicennia officinalis</i> L.	+	+	+
Arecaceae	<i>Nypa fruticans</i> Wurmb		*	
Rhizophoraceae	<i>Bruguiera cylindrica</i> (L.) Blume	+	+	+
	<i>Bruguiera parviflora</i> (Roxb.) Wight & Arn. ex Griff.	+	+	+
	<i>Ceriops zippeliana</i> Blume	re	+	-
	<i>Rhizophora apiculata</i> Blume	+	+	+
	<i>Rhizophora mucronata</i> Poir. in Lamk.	*		
Lythraceae	<i>Sonneratia alba</i> J.E.Smith	+	+	-
Meliaceae	<i>Xylocarpus moluccensis</i> (Lam.) M. Roem.	*		

Note: re, regeneration; +, presence; -, absence; *, found outside quadrats.

There are four species with 1324 individuals belonging to Rhizophoraceae accounting for 52.04% in the study area. Following by Acanthaceae with two species, the total number of individuals was 1191 trees (46.82%). The Lythraeae had only one species with 27 individuals in Con Trong and 2 individuals in Con Ngoai.

The composition of mangrove plants has differences among areas. In the North of Vietnam, there are 15 true mangrove species recorded at Dong Rui commune, 12 species at Xuan Thuy National Park and 9 species at Hau Loc district. Of which, dominant species were *Avicennia marina* (Forsk.) Vierh., *Aegiceras corniculatum* (L.) Blanco, *Bruguiera gymnorrhiza* (L.) Lam., *Rhizophora stylosa* Griff., *Sonneratia caseolaris*

(L.) Engler and *Kandelia obvata* Sheue, Liu & Yong (Tinh and Tuan, 2016). Another study at Ca Mau Cape National Park identified 10 species of mangrove plants belonging to five families (Tinh *et al.*, 2009). In which, there were four species, namely *A. alba*, *A. officinalis*, *B. parviflora* and *R. apiculata* also recorded in this research. The difference of species composition resulted from natural conditions, environment factors and soil characteristics. However, species of Acanthaceae and Rhizophoraceae were dominant in the mangrove forest.

3.2. Mangrove plant distribution in Con Ong Trang

3.2.1. Types of distribution of plant species in Con Ong Trang

Species in Con Ong Trang had two types of distribution, random and aggregated (Table 2). While *A. alba* and *R. apiculata* distributed aggregately all sites, most individuals of *B. cylindrica* and *B. parviflora* have aggregated types, *A. officinalis* distributed randomly at high elevation area. Consequently, distribution

in group is the general trend of mangrove plant at the study area although this trend depends on species and environment conditions. Specifically, *B. parviflora*, *B. cylindrica*, *S. alba* distributed aggregately in generally; however, individuals of these species also presented randomly in area with unfavorable conditions.

Table 2. Types of distribution of plant species in the study area

Species	Con Trong	Con Ngoai	Con Moi	Con Ong Trang
<i>A. alba</i>	Aggregated	Aggregated	Aggregated	Aggregated
<i>A. officinalis</i>	Random	Random	Random	Random
<i>B. cylindrica</i>	Aggregated	Random	Aggregated	Aggregated
<i>B. parviflora</i>	Aggregated	Aggregated	Random	Aggregated
<i>C. zippeliana</i>	-	Aggregated	-	Aggregated
<i>R. apiculata</i>	Aggregated	Aggregated	Aggregated	Aggregated
<i>S. alba</i>	Aggregated	Random	-	Aggregated

Note: -, species outside quadrats.

Random distribution is common in new species entering the communities. When the changes of environmental factors, including tide and soil characteristics, become suitable for the growth of these species, they dominate in the communities. *B. parviflora*, *B. cylindrica*, *A. officinalis* are scattered in the low-lying areas while they distribute in cluster at higher terrain.

3.2.2. Distribution of mangrove species in communities of Con Ong Trang

The result of similarity coefficient analysis showed that the coefficient of *A. alba* and *R. apiculata* was the highest. At the similarity of 40%, there was only a group that included *R. apiculata* and *A. alba*. At the similarity of 20%, the species of the mangrove forest in Con Ong Trang were divided into 3 groups, and only *S. alba* did not belong to any group. There are 3 groups of two species in the cluster diagram including *R. apiculata* and *A. alba*, *B. cylindrica* and *B. parviflora*, *A. officinalis* and *C. zippeliana* with high similarity coefficients. The groups of two mangrove species having high similarity coefficients were *B. parviflora* and *C. tagal*;

B. parviflora and *R. apiculata* in Ca Mau Cape National Park (Huynh Quoc Tinh *et al.*, 2009), *C. zippeliana* and *L. racemosa*, *R. apiculata* and *S. alba*, *A. officinalis* and *C. tagal* in Can Gio mangrove forest (Vien Ngoc Nam *et al.*, 2016).

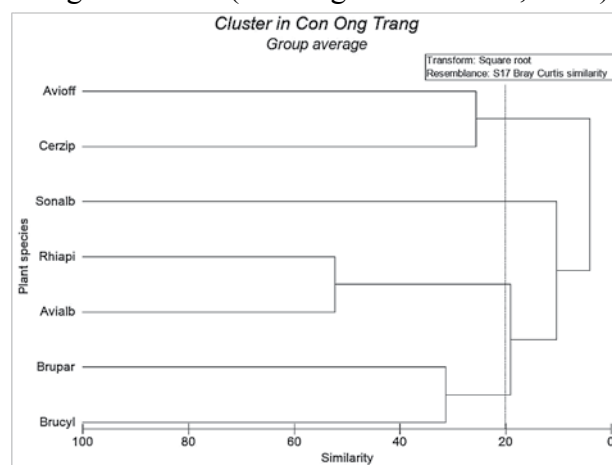


Figure 2. Species cluster in Con Ong Trang

(Note: Avioff, *A. officinalis*; Cerzip, *C. zippeliana*; Sonalb, *S. alba*; Rhiapi, *R. apiculata*; Avialb, *A. alba*; Brupar, *B. parviflora*; Brucyl, *B. cylindrica*).

The results of this study suggest that mix community of *A. alba* and *R. apiculata* brings higher efficiency than others in afforestation plan in case of similar natural conditions.

3.2.3. Effects of tides and soil types on mangrove plants distribution in Con Ong Trang

a. Effects of tidal inundation on mangrove plants distribution in Con Ong Trang

Table 3. Percentage of quadrats in different tides in Con Ong Trang

Tidal inundation	Con Trong	Con Ngoai	Con Moi	Con Ong Trang
	%	%	%	%
Frequent flooding	20	45	44	34
Low tide flooding	40	23	44	35
Medium tide flooding	40	32	12	31

The frequency of salt water by tides and fresh water in the Cua Lon river influence on the mangrove species in Con Ong Trang. The distribution of species regarding to tidal inundation was presented as follows: *A. alba* mostly distributed in areas with frequent flooding and low-tide flooding; *R. apiculata* adapted to areas with low and medium tidal inundation; and *B. parviflora* mainly distributed in areas flooded by medium tides.

With low elevation and located at estuarine, the number of quadrats in Con Ong Trang flooded by tides were high. The results showed that 34% of the area was frequently flooded with tides, 35% inundated by low tides (Table 3).

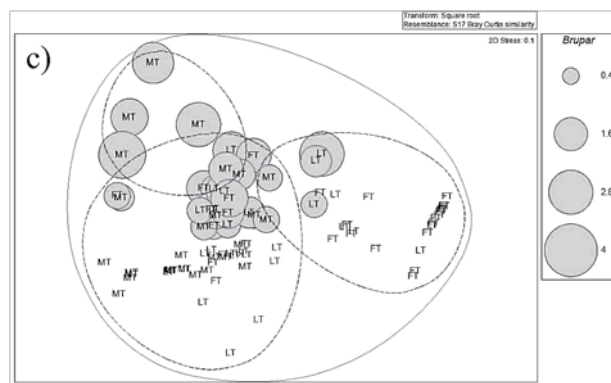
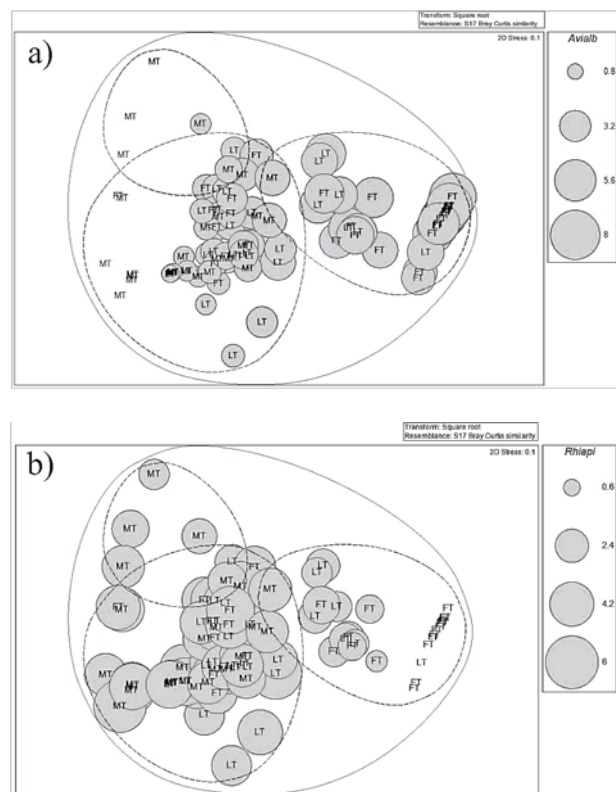


Figure 3. Distribution of a) *A. alba* (Avialb), b) *R. apiculata* (Rhiapi), c) *B. parviflora* (Brupar) in different tidal inundation

Note: FT, Frequent flooding; LT, Low tide flooding; MT, Medium tide flooding.

b. Effects of soil types on the mangrove plant distribution in Con Ong Trang

The solid mud and soft clay had a large proportion in the study area. Solid mud and soft mud accounted for high ration in Con Trong. The percentage of fluid mud and soft clay in Con Ngoai were 32% and 35%, respectively. The fluid-mud type was not found in Con Moi while the proportion of soft clay was 50% proving that soil was rather tight. The proportion of soil types was different among the sites due to the location of the islets, the effects of Cua Lon river flows and tides.

Soil characteristics also contributed decisively to the distribution of mangrove species. The result showed that *A. alba* adapted to mud soil; *R. apiculata* mainly distributed where ground

Table 4. Percentage of quadrats in different soil types in Con Ong Trang

Site	Fluid mud	Soft mud	Solid mud	Soft clay	Clay
Con Trong	7%	30%	42%	21%	0%
Con Ngoai	32%	10%	23%	35%	0%
Con Moi	0%	5%	17%	50%	28%
Con Ong Trang	14%	19%	30%	32%	5%

types were solid mud and soft clay. Soft clay was also appropriate for the growth of *B. parviflora*. The mud areas were favorable conditions for most mangrove plant growth, especially in Southeast Asia where soil characteristics were suitable for species of Rhizophoraceae and Avicenniaceae (Giesen *et al.*, 2007).

4. Conclusion

Mangrove flora in Con Ong Trang consisted of 11 true mangrove species belonging to 5 families; of which Acanthaceae and Rhizophoraceae were dominant families. Aggregation was the main distribution types in the study area. The coefficients of *A. alba* and *R. apiculata* were higher than other species proved the close relationship of the two species. With various inundation and soil types, the plant composition and dominant species were different.

The study suggested that in this area and others with similar conditions, *A. alba* and *R. apiculata* should be selected for mix community in afforestation plan. In addition, *A. alba* could be planted in areas with frequent flooding, low tide flooding and mud soil; *R. apiculata* in areas with low and medium tidal inundation, solid mud and soft clay; *B. parviflora* in areas flooded by medium tides and soft clay.

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Appendix Table 1. Composition of mangrove plants in different areas

Species	Sites				
	Con Ong Trang ¹	Protected zone of Ca Mau Cape National Park ²	Dong Rui ³	Xuan Thuy ³	Hau Loc ³
Acanthaceae					
<i>Acanthus ilicifolius</i> L.	+	-	+	+	+
<i>Avicennia alba</i> Blume	+	+	-	-	-
<i>Avicennia marina</i> (Forsk.) Veirh	-	+	+	+	+
<i>Avicennia officinalis</i> L.	+	+	-	-	-
Aizoaceae					
<i>Sesuvium portulacastrum</i> L.	-	-	+	+	+
Arecaceae					
<i>Nypa fruticans</i> Wurmb	+	-	-	-	-
Combretaceae					
<i>Lumnitzera racemosa</i> (Gaud.) Presl.	-	-	+	+	-
Euphorbiaceae					
<i>Excoecaria agallocha</i> L.	-	+	+	+	+
Lythraceae					
<i>Sonneratia alba</i> J.E.Smith	+	-	-	-	-
<i>Sonneratia apetala</i> Buch-Ham	-	-	+	+	-
<i>Sonneratia caseolaris</i> (L.) Engl.	-	-	+	+	+
Malvaceae					
<i>Thespesia populnea</i> (L.) Soland. Ex. Correa	-	+	-	-	-
Meliaceae					
<i>Xylocarpus granatum</i> Koen.	-	-	+	-	-
<i>Xylocarpus moluccensis</i> (Lam.) M. Roem.	+	+	-	-	-
Myrsinaceae					
<i>Aegiceras corniculatum</i> (L.) Blanco	-	-	+	+	+
Pteridaceae					
<i>Acrostichum aureum</i> L.	-	-	+	+	+
Rhizophoraceae					
<i>Bruguiera cylindrica</i> (L.) Blume	+	-	-	-	-
<i>Bruguiera gymnorhiza</i> (L.) Lam.	-	-	+	+	-
<i>Bruguiera parviflora</i> (Roxb.) W. & Arn. ex Griff.	+	+	-	-	-
<i>Bruguiera sexangula</i> (Lour.) Poir	-	+	-	-	-
<i>Ceriops zippeliana</i> Blume	+	-	-	-	-
<i>Ceriops tagal</i> (Perr.) C.B. Rob.	-	+	-	-	-
<i>Kandelia obovata</i> Sheue Liu&Yong	-	-	+	+	+
<i>Rhizophora apiculata</i> Blume	+	+	-	-	-
<i>Rhizophora mucronata</i> Poir. in Lamk.	+	-	-	-	-
<i>Rhizophora stylosa</i> Griff.	-	-	+	+	+
Rubiaceae					
<i>Scyphiphora hydrophyllacea</i> Gaertn. F.	-	-	+	-	-
Sterculiaceae					
<i>Heritiera littoralis</i> Dry.	-	-	+	-	-

Note: +, presence; -, absence;

¹This study, ²Huynh Quoc Tinh et al. (2009), ³Phạm Hồng Tính và Mai Sỹ Tuấn (2016)