



Handbook of Mangroves in the Philippines - Panay

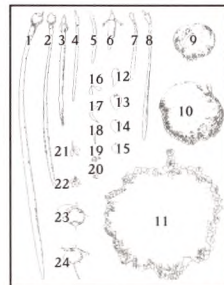


Jurgenne H. Primavera
Resurreccion B. Sadaba
Ma. Junemie H. L. Lebata
Jon P. Altamirano



**FRUITS
OF SOME
MANGROVE
SPECIES**

- | | |
|----------------------------------|---------------------------------------|
| 1. <i>Rhizophora mucronata</i> | 13. <i>Avicennia officinalis</i> |
| 2. <i>Rhizophora apiculata</i> | 14. <i>Avicennia rumphiana</i> |
| 3. <i>Bruguiera gymnorrhiza</i> | 15. <i>Avicennia marina</i> |
| 4. <i>Bruguiera parviflora</i> | 16. <i>Campostemon philippinensis</i> |
| 5. <i>Bruguiera cylindrica</i> | 17. <i>Aegiceras corniculatum</i> |
| 6. <i>Bruguiera sexangula</i> | 18. <i>Aegiceras floridum</i> |
| 7. <i>Ceriops decandra</i> | 19. <i>Scyphiphora hydrophyllacea</i> |
| 8. <i>Ceriops tagal</i> | 20. <i>Osbornia octodonta</i> |
| 9. <i>Xylocarpus moluccensis</i> | 21. <i>Lumnitzera racemosa</i> |
| 10. <i>Xylocarpus granatum</i> | 22. <i>Lumnitzera littorea</i> |
| 11. <i>Nypa fruticans</i> | 23. <i>Sonneratia alba</i> |
| 12. <i>Avicennia alba</i> | 24. <i>Sonneratia caseolaris</i> |



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Southeast Asian Fisheries Development Center Aquaculture Department
UNESCO Man and the Biosphere

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Cover (photo by J.P. Altamirano):

The mangrove plantation in New Buswang, Kalibo, Aklan is a favorite among local folks; the planted *Rhizophora* species are now surrounded by a natural band of *Sonneratia alba* trees.

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Southeast Asian Fisheries Development Center
AQUACULTURE DEPARTMENT
Tigbauan, Iloilo, Philippines

FOREWORD

As early as April 1996, the SEAFDEC Council had instructed its Aquaculture Department (AQD) to conduct studies on mangroves within the context of environment-friendly aquaculture. This was a proactive initiative in light of the negative environmental impacts linked to modern aquaculture, foremost among them the loss of mangroves to shrimp ponds. The five-year Mangrove-Friendly Aquaculture Project was implemented in 1998, which included the Mangrove-Friendly Aquaculture Planning Workshop convened in Iloilo City in early 2000. Following the Workshop recommendations, AQD has undertaken research on the capacity of mangroves to process nutrients from intensive shrimp culture ponds with funding from the Government of Japan. The Department also has European Commission-funded studies on aquasilviculture within pen systems where mud crab rearing is integrated with mangroves, and on mud crab fisheries in mangrove areas.

In the course of field activities, senior researchers of AQD and their colleagues from other institutions have built an impressive storehouse of information on mangroves in Panay and elsewhere in the Philippines. The generous financial support from UNESCO-Man and the Biosphere has made possible the documentation of such information.

It is therefore with pride that I welcome the publication of this valuable sourcebook that should prove useful to the general public and to technical people alike.


Rolando R. Platon
Chief



Regional Office for Science and Technology for Southeast Asia
Jakarta, Indonesia

FOREWORD

It is my great pleasure to recommend this 'Handbook of Mangroves in the Philippines – Panay' to all those interested in conservation and sustainable use of mangroves. The idea for such a handbook was first broached by Dr. J.H. Primavera during the Ecotone X MAB Regional Seminar on Sustainable Management of Coastal Ecosystems in November 2001. Because the dissemination of scientific information on mangroves was considered essential to mobilize a broader participation of society in mangrove conservation and rehabilitation, a formal project proposal was formulated for support under the UNESCO-MAB-ASPACO Project^{1,2}. At the start of 2004, Dr. Primavera and her colleagues have completed the work and now present to us the outstanding product.

The Handbook provides key information on more than 30 species of mangroves in Panay Island and surrounding areas. It is amazing to see the rich mangrove diversity in Panay, where almost no pristine mangroves remain owing to other development activities over the years. It is believed that the Handbook will help promote mangrove rehabilitation in Panay, and set a model for other areas in the Philippines as well. This handbook is well designed for non-specialist readers, with precise firsthand scientific data and illustrative descriptions as well as visual presentation. From only two pages devoted to each species, one can learn much about features, distribution, and traditional and economic uses of the species. To ensure user-friendliness, the draft manuscript was pretested by students and teachers.

We believe this Handbook will be very welcome by schools, local government officials, NGOs, and the general public. UNESCO hopes that the Handbook will be updated and eventually become available in electronic format, e.g. CD-ROM and on the Web, to reach a broader audience.

May I congratulate the authors for this excellent publication.

A handwritten signature in black ink, appearing to read "Han Qunli", written over a white background.

Han Qunli
Programme Specialist
for Environmental Science

¹MAB - Man and the Biosphere, ²ASPACO (Asia Pacific Co-operation for the Sustainable Use of Renewable Resources in Biosphere Reserves and Similarly Managed Areas) is an international project of MAB started in 2001 focusing on mangroves and coastal ecosystem management, with financial support from the Government of Japan to UNESCO

PREFACE

Through our many field studies, we have come to realize that few Filipinos are aware of mangroves. Often, coastal folk and environmental non-governmental organizations eager to rehabilitate degraded mangrove sites, and students interested in doing mangrove research cannot proceed for lack of basic information on local mangroves. We therefore aim to provide laypersons and researchers alike with a convenient guidebook for identifying species in the field based mainly on appearance and habitat. Unlike previous Philippine mangrove guides, we present detailed plant descriptions and available information on traditional uses.

For the realization of a long-cherished dream to write a mangrove handbook, our gratitude goes to the Man and the Biosphere ASPACO Project of UNESCO. Their funding provided photographic and other equipment and supported our numerous field trips. Thanks are due the SEAFDEC Aquaculture Department for vehicles and logistical support. We also acknowledge the cooperation of local government officials including Aklan Governor Florencio Miraflores and Bugtong Bato Barangay Captain Norberto Soliva; field assistance from Rose Sacal and Fred Sabido of Mindanao State University-Naawan, Jerryco Hadjerol and Mando Dalig of Sultan Kudarat Polytechnic College, May Sansait, Edgar Hortillosa and Rea Busaing of the University of the Philippines in the Visayas, Allan Traje of Ibajay, Aklan, and Sev Angara of Baler, Aurora; manuscript pretesting by Dr. Josette Biyo and Paz Kuhlmann with their respective classes at the Philippine Science High School in Iloilo and Aklan State University School of Fisheries and Marine Science; and layout and printing advice from Mila Castaños. We appreciate the meticulous comments and comprehensive suggestions from Emeritus Professor Colin Field of the University of Technology, Australia; Dr. Gordon Maxwell, FLS of the The Open University of Hong Kong; Dr. Norman Duke of The University of Queensland, Australia; Calixto Yao, Cebu City-based consultant formerly of the DENR; and Marta Vannucci, who are among the world's top mangrove experts. Finally, we acknowledge our families for bearing with the endless hours of field work away from home.

We hope this small volume will contribute to the preservation, conservation and sustainable management of Philippine mangroves. We dedicate it to present and future generations of Filipinos (among them Ysmael Primavera Tirol of Aklan, northern Panay) so they will learn to respect and appreciate this important ecosystem, and be captivated by its diversity and beauty.

JHP, RBS, MJHLL and JPA

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INTRODUCTION

True mangrove species are those found exclusively or almost exclusively in intertidal habitats, whereas mangrove associates may be distributed above the high-water line in beach forests close to mangroves or beyond the inner landward boundary of mangroves. These mangroves total around 70 species belonging to 20 families worldwide, of which around 60 are found in the Indo-Pacific region and some 35-40 in the Philippines (Table 1). The high species diversity of Philippine mangroves can be seen in a small 72-ha patch mangrove in Bugtong Bato-Naisud, Ibabay, Aklan which features 27 species.

Mangroves are higher plants – trees, shrubs, palms, herbs or ferns – which (a) predominantly grow in the intertidal areas of tropical and subtropical shorelines, (b) exhibit marked tolerance to high salt concentrations and oxygen-poor soil, and (c) have propagules able to survive dispersal by seawater. The term may also refer to the wider mangrove community. Mangroves are found in warm $>24^{\circ}\text{C}$ waters. Although most are facultative (rather than obligatory) halophytes, meaning they do not require salt water to survive, other species appear to need



TIM COX

Mangroves can be thoroughly enchanting, as shown by pristine stands of mixed communities. The highly diverse Philippine flora comprise at least 35 of a total ~70 species of true mangroves worldwide.

TABLE 1**Species of true mangroves^a in the Philippines^b and Panay**

| Family | Philippine Species | Panay |
|-----------------------|---------------------------------------|--------------|
| A. Acanthaceae | 1. <i>Acanthus ebracteatus</i> | ✓ |
| | 2. <i>A. ilicifolius</i> | ✓ |
| | 3. <i>A. volubilis</i> | ✓ |
| B. Avicenniaceae | 4. <i>Avicennia alba</i> | ✓ |
| | 5. <i>A. officinalis</i> | ✓ |
| | 6. <i>A. marina</i> | ✓ |
| | 7. <i>A. rumphiana</i> | ✓ |
| C. Bombacaceae | 8. <i>Camptostemon philippinensis</i> | ✓ |
| D. Combretaceae | 9. <i>Lumnitzera littorea</i> | ✓ |
| | 10. <i>L. racemosa</i> | ✓ |
| E. Euphorbiaceae | 11. <i>Excoecaria agallocha</i> | ✓ |
| F. Lythraceae | 12. <i>Pemphis acidula</i> | ✓ |
| G. Meliaceae | 13. <i>Xylocarpus granatum</i> | ✓ |
| | 14. <i>X. moluccensis</i> | ✓ |
| H. Myrsinaceae | 15. <i>Aegiceras corniculatum</i> | ✓ |
| | 16. <i>A. floridum</i> | ✓ |
| I. Myrtaceae | 17. <i>Osbornia octodonta</i> | ✓ |
| J. Palmae | 18. <i>Nypa fruticans</i> | ✓ |
| K. Plumbaginaceae | 19. <i>Aegialitis annulata</i> | ✗ |
| L. Rhizophoraceae | 20. <i>Bruguiera cylindrica</i> | ✓ |
| | 21. <i>B. gymnorrhiza</i> | ✓ |
| | 22. <i>B. parviflora</i> | ✓ |
| | 23. <i>B. sexangula</i> | ✓ |
| | 24. <i>Ceriops decandra</i> | ✓ |
| | 25. <i>C. tagal</i> | ✓ |
| | 26. <i>Kandelia candel</i> | ✗ |
| | 27. <i>Rhizophora apiculata</i> | ✓ |
| | 28. <i>R. x. lamarckii</i> | ✓ |
| | 29. <i>R. mucronata</i> | ✓ |
| 30. <i>R. stylosa</i> | ✓ | |
| M. Rubiaceae | 31. <i>Scyphiphora hydrophyllacea</i> | ✓ |
| N. Sonneratiaceae | 32. <i>Sonneratia alba</i> | ✓ |
| | 33. <i>S. caseolaris</i> | ✓ |
| | 34. <i>S. ovata</i> | ✓ |
| O. Sterculiaceae | 35. <i>Heritiera littoralis</i> | ✓ |
| Total no. of species | | 33 |

^aBased on Tomlinson (1986), excluding *Acrostichum* spp.^bSources: Brown and Fischer, 1920; Arroyo, 1979; Fernando and Pancho, 1980; Tomlinson, 1986; Spalding et al., 1997; Yao, 1999; Primavera 2000a, 2002.

some salt to survive and reproduce. High salinity reduces competition from other salt-intolerant species and allows mangroves to thrive, although they are relatively slow-growing plants. Mangroves survive by keeping salt away from the metabolically active region (cytoplasm) of the cells. This they do by excluding salt at the roots, excreting salt through glands located in leaves and roots, and storing salt in older leaves, bark and wood. The extent of mangroves depends on how far tidal flow can disperse propagules or seedlings. Their growth is most extensive in the sandy mud of deltas, lagoons, bays and estuaries, but they also survive in sandy, coral-line (calcareous) and peat substrates. However, such physically extreme sediments may also be water-logged and anaerobic (or oxygen-poor).

To cope with these harsh conditions and to support above-ground biomass, mangroves have developed a variety of root types such as prop/stilt roots in *Rhizophora*, pencil/finger-like pneumatophores in *Avicennia*, and cone-like pneumatophores in *Sonneratia* that have large lenticels to allow for free exchange of gases. To survive desiccation and conserve water, leaves may have thick epidermis, waxy cuticle, stomata on the lower surface, and succulent blades. Mangroves also thrive in shallow protected shores where seedlings can be established. Interestingly, some mangrove seeds are viviparous (*Rhizophora*, *Aegiceras*, *Avicennia*) meaning they germinate while still on the parent plant. This facilitates seedling establishment under extreme conditions.

Mangroves may be classified according to location as fringing along



Filipino children – whether in or out-of-school – readily appreciate and enjoy the beauty and diversity of mangroves, away from polluted highways and crowded shopping malls.



Extensive lateral cable roots of *Avicennia marina* provide effective anchorage and protection against wind and wave action in seaward habitats.

shorelines, overwash on small islands (where they are completely washed over by the tides), riverine along the banks of estuarine rivers and creeks, and inner or back mangroves which are rarely reached by tidal flushing. Location within an estuary may be upstream, intermediate or downstream. Intertidal position may be low, middle or high. A striking feature of mangroves is zonation – the presence of stands of one or two species, depending on intertidal position and location within an estuary.

Boat travellers are greeted by the dominant *Avicennia marina*-*Sonneratia alba* zone as they approach small islands in Panay and elsewhere in the country – *A. marina* has shorter trees, often with golden foliage in contrast to the taller, dark green appearance of *S. alba*. Other zone-forming species are *Rhizophora* spp. in the low intertidal, and *Bruguiera cylindrica* and *Ceriops decandra* in the mid- to high intertidal zones. *Lumnitzera racemosa*, *Xylocarpus* spp., *Heritiera littoralis* and *Excoecaria agallocha* are upper inter-tidal species. *Pemphis acidula* also forms stands on rocky shores and the upper beaches beyond the *A. marina*-*S. alba* zone of fringing mangroves. This general pattern will have exceptions, and zonation may not be present in disturbed mangroves and in narrow strips that do now allow the full development of zonation.



To study mangrove community structure, these U.P. Visayas majors ignore mud and mosquitoes, unlike other marine biology students who prefer coral reefs and seagrasses.

ABOUT PANAY

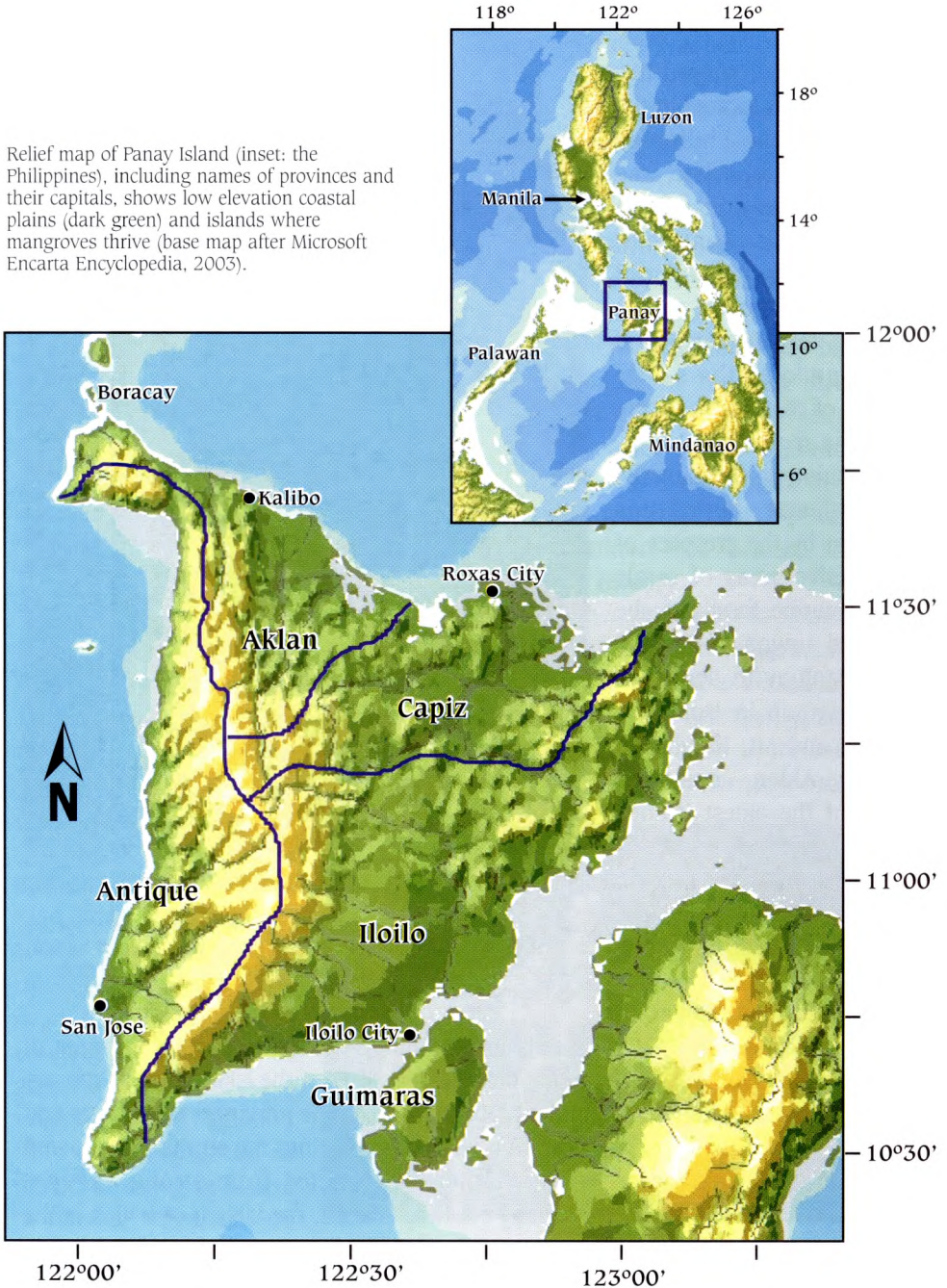
Panay Island, shaped like a triangle, is located in the center of the Philippine Archipelago. When the country was still part of the Asiatic continent, Panay was an integral portion of Luzon to the north, and Palawan and Mindanao to the south. Most of the island, except for the mountain ranges, was submerged during the interglacial period as shown by the presence of extensive areas of corals and marine fossils in the inland towns of Dueñas and Janiuay in Iloilo, Mt. Panagaraon in Dumalag, Capiz and Mt. Kambig in Ibajay, Aklan. Considered one of the oldest islands in the archipelago, Panay is around 150 million years, dating back to the Cretaceous Period of the Mesozoic Era.

Panay is the sixth largest of more than 7,000 islands in the Philippines, with a total land area of around 1,239,400 ha. Covering the biggest part (42%) of the island, Iloilo Province is a plain whose highest mountains separate it from the provinces of Antique and Capiz, and whose rivers drain through wide estuaries into the straits of Iloilo and Guimaras. The irregular Iloilo coastline is protected from strong *habagat* (southeast monsoon) winds by many offshore islands, the largest of which is the island-province of Guimaras. This wide protected expanse of lowlands with meandering tidal inlets used to be lush mangrove swamps covering 12,400 ha in



Low intertidal stands of *Rhizophora apiculata* and its sister species, collectively called *bakhaw*, have given mangroves the local name *bakhawan*; the other common name *katunggan* is derived from *tungog*, referring to the back mangrove species *Ceriops tagal*.

Relief map of Panay Island (inset: the Philippines), including names of provinces and their capitals, shows low elevation coastal plains (dark green) and islands where mangroves thrive (base map after Microsoft Encarta Encyclopedia, 2003).



1951. Now, endless box-like fishponds cover the landscape and only a few scattered mangrove trees can be seen along the creeks and riverbanks (300 ha remaining in 1988).

On the western side, the province of Antique is isolated from the rest of the island by steep mountain ranges that descend almost down to the coast forming a rocky shoreline with very little coastal plain. This narrow plain and a long dry season mean that Western Panay has limited mangrove distribution. On the northeastern side lies Capiz, whose wide protected plains and large valley basin formed by four major interconnecting rivers are suitable for mangrove settlement. The native Sulod-Bukidnon called one of these rivers Mapanhay, meaning calm. The whole island was eventually called by this name, now shortened to Panay, after the first Spanish settlement was established near the mouth of the river in Banica, Capiz. The rugged and mountainous province of Aklan to the northwest has five major rivers. One of the largest is the Aklan River which drains into a delta, site of the successful Buswang, Kalibo mangrove reforestation project described in a later section. Our major collecting site was the 72-ha Bugtong Bato-Naisud primary patch mangroves that straddle the Naisud River in Ibajay. The high mangrove diversity – 33 species in Panay – can be traced to the relatively old age of this island and its earlier mainland connections to Luzon and the rest of the archipelago. The slow pace of ‘development’ in Aklan has left untouched some forests, including mangroves, which need to be protected from conversion to aquaculture ponds and other illegal cutting. For the purposes of field trips and replanting activities, readers can find species-by-species information on locations of monospecific groves and the biggest existing trees in Table 2.

TABLE 2

Locations of rare species, biggest/tallest specimens and monospecific stands of mangroves in Panay Island, central Philippines

| Species | Location | Remarks |
|------------------------------------|--|--|
| <i>Aegiceras floridum</i> | Taklong Is., Guimaras | limited distribution |
| <i>Avicennia alba</i> | Carles and Ajuy in Iloilo Makato River and Ibajay, Aklan Pan-ay, Capiz | monospecific stands |
| <i>Avicennia officinalis</i> | Bugtong Bato, Ibajay, Aklan Makato River, Aklan | biggest trees (20 m ht, 1 m DBH) |
| <i>Avicennia rumphiana</i> | Bugtong Bato, Ibajay, Aklan | biggest trees (20 m ht, 2.5 m DBH) |
| <i>Bruguiera gymnorrhiza</i> | Makato River, Aklan Zaldivar, Pandan, Antique | solitary trees monospecific grove |
| <i>Bruguiera parviflora</i> | Makato River, Tangalan, and New Washington in Aklan Ivisan, Capiz | distribution limited to Aklan and Capiz |
| <i>Bruguiera sexangula</i> | Lipata, Culasi, Antique Bugtong Bato, Ibajay, Aklan | monospecific groves, limited distribution |
| <i>Camptostemon philippinensis</i> | Makato River, New Washington, and Ibajay in Aklan | biggest tree (15 m ht, 30-60 cm DBH) |
| <i>Ceriops decandra</i> | Bugtong Bato, Ibajay, Aklan | monospecific stand, colonizing grassland |
| <i>Ceriops tagal</i> | Naisud, Ibajay, Aklan | 20 yr-old plantation of 500 sq m |
| <i>Excoecaria agallocha</i> | Centro Weste, Libertad, Antique Belen, Banate, Iloilo | biggest tree (15 m ht, 60 cm DBH) big tree (12 m ht, 40 cm DBH) |
| <i>Heritiera littoralis</i> | Bugtong Bato, Ibajay, Aklan | biggest trees (20 m ht, 50 cm DBH) |
| <i>Lumnitzera littorea</i> | Jawili, Tangalan, Aklan | biggest trees (10-12 m ht, 30-60 cm DBH), occur in stands |
| <i>Lumnitzera racemosa</i> | Taklong Is., Guimaras Manlot Is., Carles, Iloilo | monospecific stands monospecific stands |
| <i>Osbornia octodonta</i> | Taklong Is., Guimaras Jawili, Tangalan, Aklan | biggest trees (6 m ht, 10-15 cm DBH) monospecific grove |
| <i>Pemphis acidula</i> | Anini-y, Antique Cabilao Grande, Carles, Iloilo Taklong Is., Guimaras | monospecific stands, distribution limited |
| <i>Rhizophora apiculata</i> | Makato River and New Washington in Aklan Palasiawan, Btac. Viejo, Iloilo | big trees (15-20 m ht, 20-40 cm DBH) big trees, monospecific stands |
| <i>Rhizophora x lamarckii</i> | Taklong Is., Guimaras | single specimen found |
| <i>Scyphiphora hydrophyllacea</i> | Jawili, Tangalan, Aklan Makato River, Aklan | tallest tree (12 m ht, 20 cm DBH) |
| <i>Sonneratia caseolaris</i> | Makato River, Aklan | biggest trees (20 m ht, 40-50 cm DBH) |
| <i>Sonneratia ovata</i> | Pawa, Pan-ay, Capiz New Buswang, Kalibo, Aklan Iloilo River | limited distribution |
| <i>Xylocarpus granatum</i> | Centro Weste, Libertad, Antique Makato River, Aklan | biggest tree (17 m ht, 70 cm DBH) |

Note: 1) Commonly occurring species such as *Avicennia marina* and *Sonneratia alba* are not included.
 2) Height (ht) is estimated; diameter at breast height (DBH) is measured.
 3) Coordinates are available from the records of the senior author.

HOW TO USE THIS HANDBOOK

This guide is a user-friendly presentation of technical botanical descriptions – terms are defined in the Glossary – and illustrations of Philippine mangrove species in Panay Island, Guimaras and Aurora Province. Vegetative and reproductive structures readily observed in the field are emphasized and presented in photographs and as graphic icons. Other relevant features have been included to make identification easier.

We did field work for this book from late 2002 through the 2003 flowering-fruiting season, but our observations date back to the 1980s. We concentrated our efforts on Aklan because of its high mangrove diversity. The Panay species data in this book may apply to other areas in the Philippines, and even Southeast Asia. For most species, we collected samples from at least 3 sites, with 5 plants per species and 10 samples per plant, for a maximum total of 150 samples for a given plant part. We had enough samples for leaves, but less for flowers and fruits due to the short reproductive season and relative rareness of some species. Means and ranges of sizes are given.

Description of Species

A. Text and photographs

1. **Taxonomy:** family, scientific and local names in Hiligaynon (or Visayan Ilonggo) unless otherwise specified, the latter documented in the field and from the literature. Common names published but no longer in use have been omitted.
2. **General:** information on species occurrence as to: a) muddy, sandy, sandy-muddy, etc. substrate; b) low, mid- or high intertidal location; c) associated plant species; and d) distribution in Panay and Guimaras whether widespread or limited.
3. **Form/habit** (with photograph): majority of the species in this handbook are tree-forming, some are predominantly shrubby. Average and maximum height, and diameter at breast height (DBH) are also included.
4. **Leaves** (photo): described according to the following: a) leaf type, b) leaf arrangement, c) blade shape, d) margin, e) apex (tip), f) base, g) color (upper surface and undersurface), h) texture, i) size range (length and width), and j) other distinguishing features like presence of salt crystals, insect bites, etc. Note that the layers wrapping the buds of Rhizophoraceae are technically called interpetiolar stipules (but sometimes referred to as leaf sheaths).
5. **Flowers** (photo): described according to the following: a) type of flower, b) arrangement of flowers, c) type of inflorescence (cluster), d) petals - color, number, size and, e) calyx or sepals - number, color, etc.
6. **Fruits, or propagules** (for Rhizophoraceae) (photo): described according to: a) shape, b) color when mature, c) texture, and size range.

7. **Above-ground roots** (photo): prop/stilt, buttress, plank, surface, pneumatophores including specialized peg/cone and knee roots.
8. **Special features** (photo): interesting and characteristic features of the species, e.g., traditional uses, characteristic bark, over-all appearance and color.
9. **Uses** (past and present): included in species description text, and based on our field surveys and published literature, with emphasis on traditional or folk uses.

B. Icons

For quick reference in the field, the icons or symbols for the most commonly observed plant characters are illustrated and described below. The use of icons was patterned after Kitamura et al. (1997):

FORM AND ROOT TYPE



Palm



Shrub - low woody plant with several major branches, no distinct trunk



Tree - higher woody plant, usually with one major trunk; icon also denotes simple surface roots



Prop/stilt - adventitious roots that form on the stem above ground



Buttress - flattened projections from lower trunk which join lateral roots to stem



Plank - ribbon-like and vertically flattened lateral extensions



Pneumatophores - pencil- or cone-shaped aerial roots arising from lateral roots; spongy/corky



Cone/peg - aerial roots shaped like a cone, shorter and more woody than pneumatophores



Knee - aboveground roots shaped like a knee

FLOWER ARRANGEMENT



Terminal - flowers borne at the end or apex



Axillary - flowers arise from the axil

INFLORESCENCE



Solitary - flowers borne singly



Raceme - unbranched inflorescence with stalked flowers arranged along sides of common peduncle



Spike - elongated, unbranched inflorescence like a raceme, but flowers are sessile



Catkin - with many small, sessile flowers on a spike-like axis, usually pendulous



Panicle - inflorescence whose primary branches are racemose, flowers pedicellate



Cyme - compound inflorescence whose inner or center flowers open first; flat or convex



Umbel - umbrella-like inflorescence with pedicels arising from common base

LEAF TYPE



Simple - single, undivided piece



Compound - leaf divided into 2 or more leaflets

LEAF ARRANGEMENT



Alternate - one leaf per node



Opposite - two leaves per node on opposite sides of stem

LEAF SHAPE



Ovate - egg-shaped, with broader end downward



Obovate - inversely egg-shaped, with broader end upward



Elliptic - oval-shaped, usually with pointed apex and base



Lanceolate - much longer than wide with broad base tapering to the apex

LEAF MARGIN



Entire, Smooth - undivided, margin not wavy



Entire, Undulate - undivided, wavy margin



Entire, Serrate - undivided, with regular pointed teeth, like a saw



Lobed - divided

LEAF APEX



Round



Acute - sharply pointed (forming $<90^\circ$ angle), sides not incurved but straight or nearly so



Obtuse - blunt; forming $>90^\circ$ angle



Apiculate - ending as an abrupt tip which is not stiff



Mucronate - apex usually broad, terminated by short stiff point called mucro



Acuminate - tapering to the apex, the sides more or less concave or incurved



Emarginate - with shallow notch at the apex

LEAF BASE



Round



Acute - sharply pointed (forming $<90^\circ$ angle), sides not incurved but straight or nearly so



Sessile - directly attached to stem, without petiole

Each species page (except *Acanthus* species) is presented with the following information:

Taxonomic family
Scientific name
Local name(s)

Icons for form,
roots & flowers

Icons for leaf
characteristics

Family **Bombacaceae**

Camptostemon philippinensis (Vidal) Becc.

Local name: *gapas-gapas*



Also called *Camptostemon philippinensis*, this species has small to medium sized trees reaching 15 m tall and 50 cm DBH along rivers and tidal creeks. The leaves are crowded at the end, thick, and covered with fine scales like the buds and fruits. Surface roots emanate from the base of the trunk and spread out around mature trees - both the knobby roots and lower trunk have many lenticels and give the species a distinctive gnarled appearance. The capsule shaped fruits have seeds covered by numerous thick white threads, hence the local name *gapas-gapas* meaning cotton (see opposite page, bottom left photo). The ground in a *C. philippinensis* grove appears white from the cottony threads of newly-fallen seeds. In Panay, the wood is used for fuel and elsewhere in the Philippines, for making household utensils and carvings.



General
Substrate: muddy
Tidal level: low, middle
Found with: *C. decandata*, *A. rombosata*

Form
Shape: tree
Height: 5-15 m
DBH: 10-50 cm
Bark: rough, brown-gray, irregular flakes, lenticellate
Aerial roots: surface, gnarled, swirling, with lenticels

Sampling sites
● Benitez Nuevo, Iloilo
● Carles, Bohol
● Makabo River, Aklan
● Ibaan, Aklan



FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D



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Leaves
Arrangement: simple, alternate, spirally
Blade shape: ovate
Margin: entire, smooth
Apex: round to emarginate
Base: acute
Upper surface: leathery, dark green
Undersurface: smooth, light green, with small scales
Size: 8-15.9 cm long, 5-9.7 cm wide
Other: like salt crystals on leaves

Flowers
Inflorescence: cyme, terminal
Petals: 5, white to reddish brown
Sepals: 5, green
Size: 1-1.3 cm diameter
Others: 3-4 flowers per cluster

Fruits
Shape: rounded, dehiscent
Color: green to brown
Location: cottony inside
Size: 1-2 cm long, 7 cm diameter
Others: attractive to big red ants



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Description & uses
of the species

Photo of whole
plant (habit)

Flowering & fruiting
months

Photo of
leaves

Photo of
flowers

Photo of
fruits

Photo of
roots and/or trunk

Intertidal location

Sampling sites

Photo of special
characters
or use

C. FLOWERING AND FRUITING

Mangrove reproduction may be year-round in more or less simultaneous batches within the same plant or the same stand (e.g., *Rhizophora*, *Bruguiera* and other Rhizophoraceae), or flowers and fruits are continuously present but not in batches (e.g., *Sonneratia*). Other species have seasonal reproduction which can be a short period over a few days (e.g., *E. agallocha*), or extended over weeks or months (e.g., *Avicennia* species). During extended dry seasons as in *El Niño* years, the start of flowering may be delayed.

D. TIDAL RANGE

Mangrove location within the intertidal range may be low (e.g., *A. marina*, *S. alba*), middle (*A. corniculatum*, *C. decandra*, *S. hydrophyllacea*, *X. granatum*) or high (*P. acidula*, *B. sexangula*, *S. ovata*, *H. littoralis*). This is graphically shown on the tidal range indicator (after Kitamura et al., 1997) on each species page (except *Acanthus* spp.) with reference to the mean high water at spring tide (MHWS).

E. COLLECTION SITES

Collecting sites of samples for measurements are listed – the colored dots correspond to the actual locations in Panay and Guimaras, and Luzon for *Kandelia candel*, as shown on the map on each species page (except for *Acanthus* spp.). Note that the actual range/distribution is much wider, except for a few species such as *Rhizophora x lamarckii* and *Bruguiera sexangula* which were observed in only 1-2 sites.

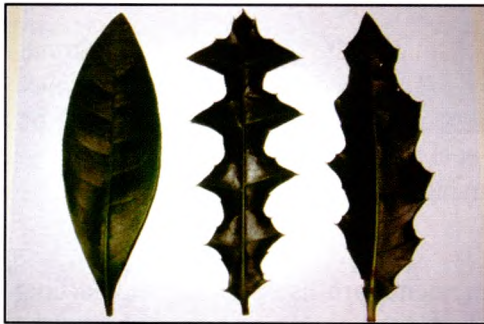


Writing a mangrove guidebook means 18-hour days of travel-field collection while there is light, then processing and measuring samples deep into the night.

Family Acanthaceae
Acanthus spp.



Characteristic ground flora of mangroves, *Acanthus ebracteatus*, *A. ilicifolius* and *A. volubilis* may form extensive shrubs up to 1.5 m high which are initially erect but recline with age, for the latter two. The closely related species are found in soft muds of the upper to middle reaches of estuarine rivers and creeks, and firm muds of back mangroves. Undergrowth is dense in open sunlight along forest margins, less so in partial shade and on mud lobster mounds.



Typical leaf forms (from left): *Acanthus volubilis*, *A. ebracteatus* and *A. ilicifolius*

Leaves are elliptic to oblong, simple and decussate, with short petiole and a pair of spines at each leaf insertion or node – armed species have spiny leaves and stems. Flowers form a terminal spike up to 20 cm long. Oton, Iloilo folks boil the dried flowers and drink the water to relieve cough. Fruit capsules are dark green and slightly flattened. Often found together, these 3 are sometimes treated as a single variable species indicating the need for more field work on *Acanthus* eco-genetics. Presently, they are distinguished by the appearance of the leaves, flowers and fruits.

TABLE 3

Characters differentiating *Acanthus* species in Panay, central Philippines

| | <i>Acanthus ebracteatus</i> | <i>Acanthus ilicifolius</i> | <i>Acanthus volubilis</i> |
|----------------|--|--|--|
| Form | erect shrubs | shrubs low, sprawling | semi-erect to sprawling, climbing |
| Stems | thick, stiff; nodes (leaf insertions) with sharp spines | thick, stiff; spiny nodes | slender; nodes unarmed or with 2 small spines |
| Leaves | called mangrove thistle or sea holly because leaves serrate, deeply lobed with sharp spines; dark green, shiny | mangrove thistle or sea holly, serrate margins, slightly lobed with sharp spines; pale to yellow green, glossy | margins usually smooth in younger leaves, older ones may have small spines; dark green |
| Flowers | petals white; shorter inflorescence | petals light blue with purple hue; longer inflorescence | petals white; shorter inflorescence |

Family Acanthaceae

Acanthus ebracteatus Vahl.



Local names: *lagiwliw*, *ragoyroy*

Leaves

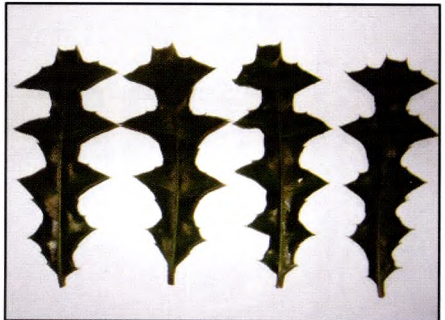
Arrangement: simple, opposite, decussate
Blade shape: elliptic to oblong
Margin: deeply lobed, serrate with sharp spines
Apex: acute
Base: acute
Upper surface: dark green, shiny
Undersurface: dark green
Size: 10-20 cm long, 4-6 cm wide
Others: stiff, salt crystals present

Flowers

Inflorescence: spike, terminal
Petals: white to brownish with age
Size: 2-3 cm long

Fruits

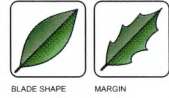
Shape: capsule, slightly flattened
Color: green to dark green
Texture: smooth
Size: 2-3 cm long, ~1 cm diameter



Family Acanthaceae

Acanthus ilicifolius L.

Local name: *lagiwliw, ragoyroy*



Leaves

Arrangement: simple, opposite, decussate

Blade shape: elliptic to oblong

Margin: slightly lobed, serrate with sharp spines

Apex: acute

Base: acute

Upper surface: pale green with yellowish tinge, smooth

Undersurface: green

Size: 18-22 cm long, 6-7 cm wide

Others: stiff



Flowers

Inflorescence: spike, terminal

Petals: light blue with purple hue

Size: 2-3 cm long

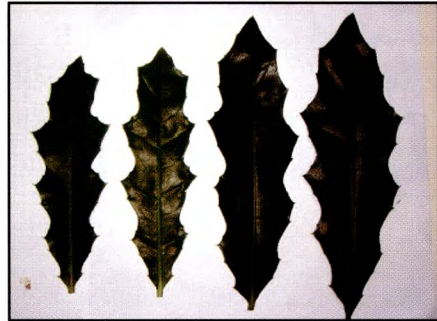
Fruits

Shape: capsule, slightly flattened

Color: green

Texture: smooth

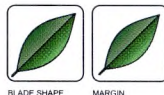
Size: 2.5-3 cm long,
1-1.5 cm diameter



Family Acanthaceae

Acanthus volubilis Wall.

Local name: *lagiwliw, ragoyroy*



Leaves

Arrangement: simple, opposite, decussate
Blade shape: elliptic to lanceolate
Margin: entire - smooth, rarely serrate
Apex: acute to acuminate
Base: acute
Upper surface: dark green, smooth
Undersurface: dark green
Size: 15-18 cm long, 4-6 cm wide
Others: younger (higher on stem)
- wider, margin often smooth
older (lower on stem)
- narrower, with small spines

Flowers

Inflorescence: spike, terminal
Petals: white to brownish with age
Size: ~2 cm long

Fruits

Shape: capsule, slightly flattened
Color: green to dark green
Texture: smooth
Size: ~2 cm long, ~1 cm diameter



Family Myrsinaceae

Aegiceras corniculatum (L.) Blanco

Local names: *saging-saging, tayokan, kawilan* (Visayan),
tinduk-tindukan (Tagalog)



Shrubs to small trees typically 2-3 m tall but may reach 5 m. The species grows in isolated clumps never forming extensive stands along tidal creeks and river mouths. Widely distributed in Panay but has never been found together with its sister species *A. floridum* (see following). Substrate is sandy to compact mud. The leaves are often notched and have a prominent midrib on the undersurface which merges with the pinkish petiole. The strongly curved fruits hang in clusters like small bananas (hence the local names referring to banana varieties) and are pale green to pinkish-red. In Panay, the species is used for firewood and the bark for tanning and fish poison. Elsewhere in the Philippines, the wood is made into knife handles.



General

Substrate: sandy, compact mud
Tidal level: middle
Found with: *A. marina, B. cylindrica, C. philippinensis, S. alba*

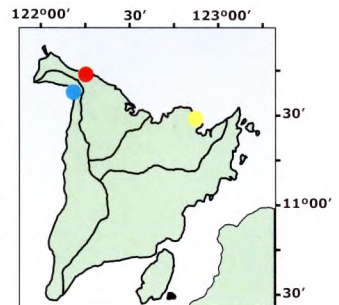
Form

Shape: shrub to small tree
Height: 2-5 m
Bark: dark brown to black;
lenticellate
Aerial roots: surface, small
adventitious

Sampling sites: ● Pandan, Antique
● Ibajay, Aklan
● Pan-ay, Capiz

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

- Arrangement: simple, alternate (rarely opposite), spiral
- Blade shape: obovate
- Margin: entire - smooth
- Apex: round to emarginate
- Base: acute
- Upper surface: smooth, dark green
- Undersurface: brownish green, prominent midrib
- Size: 7 (5-12) cm long, 5 (3-7) cm wide
- Others: salt crystals present

Flowers

- Inflorescence: umbel, terminal
- Petals: 5, white, folded outward
- Sepals: 5, green
- Stamens: 5, orange to brown
- Size: 0.6-0.7 cm long, 0.8-1.0 cm diameter
- Others: scented

Fruits

- Shape: cylindrical, strongly curved, pointed tip
- Color: light green to purple
- Texture: smooth
- Size: 6 (4-8) cm long, 0.4-0.6 cm diameter
- Others: cryptoviviparous



Family Myrsinaceae

Aegiceras floridum Roem. and Schult.

Local names: *saging-saging*, *katuganung*, *kwasay* (Visayan); *tinduk-tindukan* (Tagalog)



Small trees (4 m tall) on sandy or rocky substrate that tolerate higher salinities. More limited in distribution than *A. corniculatum*, this species has been observed on Taklong Is. in Guimaras, and Carles and Pedada Bay, Ajuy in Iloilo. Although similar in appearance, *A. floridum* has smaller leaves, white flowers on branched flower stalks, and fruits that are smaller, slightly curved and brighter red compared to *A. corniculatum*. Leaves are also characterized by salt crystals on the upper surface, and insect bites. This and the previous species are cryptoviviparous, i.e., the germinating seed remains hidden within the intact fruit wall while still attached to the parent plant (see opposite page, bottom left photo). The wood is used for fuel and the bark has a small amount of tannin.



General

Substrate: sandy, rocky
 Tidal level: middle, high
 Found with: *O. octodonta*, *P. acidula*, *Rhizophora* spp.

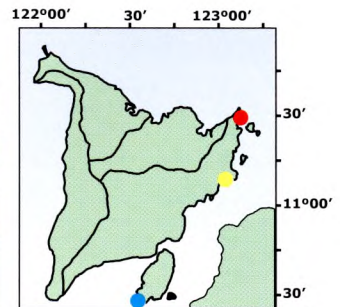
Form

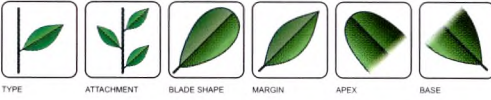
Shape: small trees
 Height: 3-4 m
 DBH: 6-12 cm
 Bark: dark brown, mottled; lenticellate
 Aerial roots: surface

Sampling sites: ● Taklong Is., Guimaras
 ● Carles, Iloilo
 ● Ajuy, Iloilo

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

Arrangement: simple, alternate, spiral
 Blade shape: obovate
 Margin: entire - smooth
 Apex: round to emarginate
 Base: acute
 Upper surface: smooth, light green
 Undersurface: smooth, whitish green
 Size: 4 (3-6) cm long,
 2 (1-3) cm wide
 Others: salt crystals present,
 insect bites



Flowers

Inflorescence: raceme, terminal
 Petals: 5, white to brown
 Sepals: 5, green
 Stamens: 5
 Size: 1 cm long, 0.7 cm diameter



Fruits

Shape: cylindrical, straight,
 like small bananas
 Color: pink to bright red
 Texture: smooth
 Size: 2-3 cm long,
 0.4-0.5 cm diameter
 Others: cryptoviviparous



Family Avicenniaceae

Avicennia alba Blume

Local names: *bungalon, api-api, miapi*



Medium-sized trees reaching 12 m high, which tolerate high salinity and colonize the soft, muddy banks of rivers and tidal flats. This species can be found interspersed among the more widely distributed stands of *A. marina*. Small monospecific groves of *A. alba* are found in Pan-ay, Capiz; Batan, Aklan and Makato River, Aklan. The whitish undersides of leaves give the canopy a silvery-white appearance from a distance, differentiating it from the green to golden canopy of *A. marina*. *A. alba* differs from the latter by its elongated leaves, conical or chili-like fruits, and relatively dark, sooty trunk (see opposite page, bottom left photo). The wood is used for fuel and the leaves for forage. Past uses include a resinous secretion for birth control, bark as astringent, and an ointment from seeds to relieve smallpox ulceration. Table 4 summarizes the characters used to separate the four *Avicennia* species.



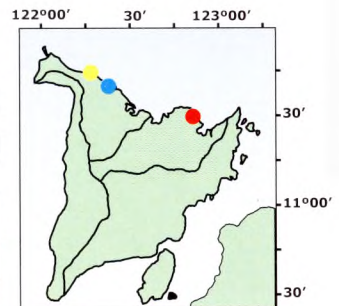
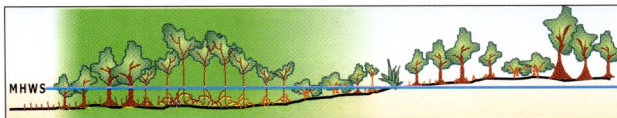
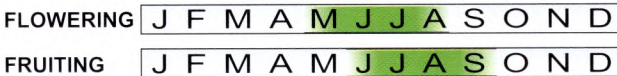
General

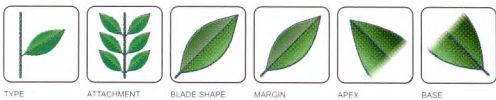
- Substrate: soft mud
- Tidal level: low, middle
- Found with: *A. marina*

Form

- Shape: tree
- Height: 5-12 m
- DBH: 10-25 cm
- Bark: finely rough, dark brown to black
- Aerial roots: pencil-like pneumatophores

Sampling sites: ● Makato River, Aklan
 ● Pan-ay, Capiz
 ● Ibajay, Aklan





Leaves

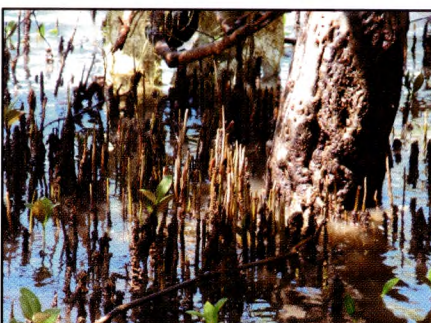
Arrangement: simple, opposite, decussate
 Blade shape: elliptic
 Margin: entire - smooth
 Apex: acute
 Base: acute
 Upper surface: smooth, green
 Undersurface: smooth, silvery
 Size: 10 (7-15) cm long,
 4 (2-5) cm wide

Flower

Inflorescence: spike, terminal/axillary
 Petals: 4, light yellow-orange
 Sepals: 4, light green, fused
 Stamens: 4, yellow
 Size: 0.5-0.6 cm diameter
 Others: slightly scented

Fruits

Shape: conical, chili-like form
 Color: light green
 Texture: finely hairy
 Size: 3-5 cm long,
 1-2 cm wide



Family Avicenniaceae

Avicennia marina (Forsk.) Vierh.

Local names: *bungalon, api-api, miapi, bayabason* (Iloilo)



The most widely distributed mangrove species, it colonizes muddy, sandy and even coralline rock substrates in fringing mangroves – forming stands, often with *S. alba* – and along river banks and on higher ground. It is also found as shrubs in mudflats and abandoned fishponds. Leaves are highly variable, and often exhibit leaf curling. The yellow green leaves give the stand a golden appearance in sunlight. The bark is mottled, light green to brown and flaky. Pneumatophores are pencil-shaped. Coastal dwellers plant this species to protect their homes from typhoons (see opposite, bottom left photo). *A. marina* is preferred for firewood because it coppices, i.e., produces new branches after cutting. The smoke of dried branches acts as mosquito repellent. Leaves are fed to livestock. Newly-sprouted *Avicennia* seedlings are cooked as vegetables. Christmas trees built from branches are sold along Roxas Blvd. in Manila.



General

Substrate: sandy, muddy, coralline
 Tidal level: low, middle
 Found with: *A. alba*, *S. alba*,
Rhizophora spp.

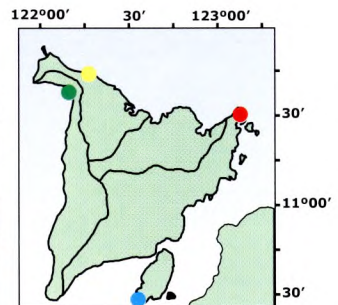
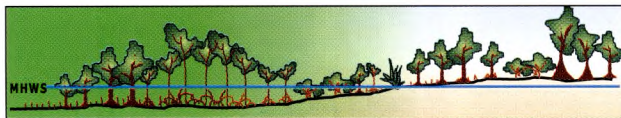
Form

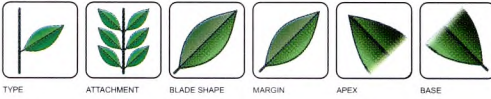
Shape: tree
 Height: 2-10 m
 DBH: 10-70 cm
 Bark: smooth with thin flakes,
 greenish brown
 Aerial roots: pencil-like
 pneumatophores

Sampling sites: ● Taklong Is., Guimaras
 ● Carles, Iloilo
 ● Ibajay, Aklan
 ● Pandan, Antique

FLOWERING: J F M A M J J A S O N D

FRUITING: J F M A M J J A S O N D





Leaves

Arrangement: simple, opposite, decussate
 Blade shape: elliptic
 Margin: entire - smooth
 Apex: acute to round
 Base: acute
 Upper surface: smooth, green to yellow-green
 Undersurface: smooth, green to yellow-green
 Size: 7 (4-11) cm long,
 3 (2-6) cm wide
 Others: numerous insect bites, curling
 and rolling, highly variable



Flowers

Inflorescence: spike, terminal/axillary
 Petals: 4, yellow-orange, brown margin
 Sepals: 4, light green, fused
 Stamens: 4, yellow; very short
 Size: 0.5-0.7 cm diameter
 Others: 1 short pistil, yellow



Fruits

Shape: heart-shaped, short beak
 Color: light green
 Texture: pubescent
 Size: 2-3 cm long,
 2-3 cm wide



Family Avicenniaceae

Avicennia officinalis L.

Local names: *api-api*, *miapi*, *bungalon*



Medium to large trees up to 20 m on firm mud of the upper intertidal in estuarine areas. The species has a crooked trunk and shiny, dark green leaves with spreading crown. Among the four *Avicennia* species, *A. officinalis* has the biggest flowers (1.5 cm wide), fruits (4 cm long) and leaves (14 cm long x 7 cm wide) with conspicuous salt crystals (see opposite, bottom left photo), and rarely forms monospecific stands. In addition, the orange flowers have the darkest shade and strongest scent. Ashes of branches are placed in a funnel through which seawater is filtered. The filtrate is evaporated by boiling to obtain a solid lump of salt. In the past, the wood was used to smoke fish and build rice mortars and pestles. Fruits were used as astringent, bark and roots as aphrodisiac, and seeds and roots as poultice to treat ulcers, etc.



General

Substrate: firm mud
 Tidal level: middle, high
 Found with: *A. rumphiana*,
B. cylindrica

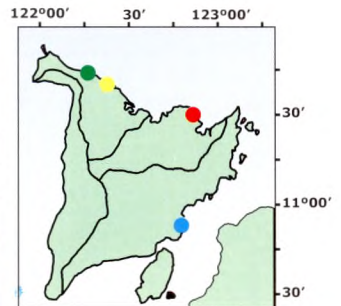
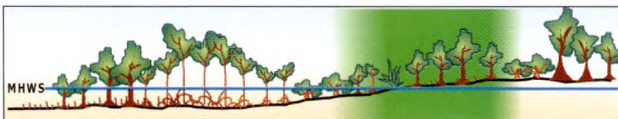
Form

Shape: tree
 Height: 5-20 m
 DBH: 20-80 cm
 Aerial roots: pneumatophores
 pencil-like, often
 stilt roots on trunk
 Bark: rough, dark brown
 Others: trunk not straight,
 branches irregular

Sampling sites: ● Barotac Nuevo, Iloilo
 ● Pan-ay, Capiz
 ● Makato River, Aklan
 ● Ibajay, Aklan

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

| | |
|----------------|--|
| Arrangement: | simple, opposite, decussate |
| Blade shape: | elliptic to oblong |
| Margin: | entire - smooth |
| Apex: | round |
| Base: | acute |
| Upper surface: | shiny, dark green |
| Undersurface: | glabrous, yellow-green |
| Size: | 10 (6-14) cm long, 5 (3-7) cm wide |
| Others: | with salt crystals; appear slightly convex as sides bent downwards |

Flowers

| | |
|----------------|--|
| Inflorescence: | spike, terminal/axillary |
| Petals: | 4, dark yellow-orange |
| Sepals: | 4, light green, fused |
| Stamens: | 4, yellow |
| Size: | 0.9-1.5 cm diameter |
| Others: | most aromatic among <i>Avicennia</i> spp. |

Fruits

| | |
|----------|---|
| Shape: | heart-shaped, elongated, pointed tip |
| Color: | yellowish green |
| Texture: | rugose, finely hairy |
| Size: | 3-4 cm long, 2-3 cm wide |



Family Avicenniaceae

Avicennia rumphiana Hall. f.

Local names: *api-api*, *miapi*, *bungalon*



Formerly referred to as *Avicennia lanata*, this species forms medium to large trees. They grow on firm mud of middle to high intertidal areas. *Avicennia rumphiana* forms an almost monospecific grove of dozens of old, big trees in Bugtong Bato, Ibajay, Aklan with maximum 20 m height, 2.5 m diameter and 8 m circumference (see opposite page, bottom left photo). It differs from other *Avicennia* species by the brownish color and woolly hairs of fruits and undersurface of leaves. The canopy of an *A. rumphiana* stand looks light brown from a distance, in contrast to the silvery white appearance of *A. alba*. Sometimes *A. rumphiana* occurs with *A. officinalis*, but its young leaves and branches are typically upright, whereas those of *A. officinalis* point in all directions. Also used as fuelwood and for furniture-making with its fine-grained wood.



General

- Substrate: muddy
- Tidal level: middle, high
- Found with: *A. officinalis*,
B. cylindrica
- Others: seedlings abundant but
saplings & smaller trees
rare

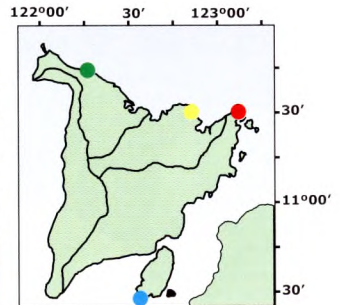
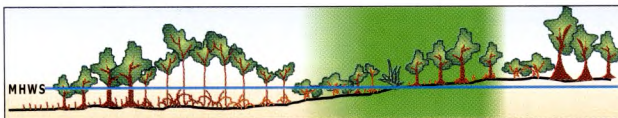
Form

- Shape: tree
- Height: 5-20 m
- DBH: 0.5-2.5 m
- Bark: slightly rough, brown
- Aerial roots: pencil-like
pneumatophores

Sampling sites: ● Taklong Is., Guimaras
● Carles, Iloilo
● Pan-ay, Capiz
● Ibajay, Aklan

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

Arrangement: simple, opposite, decussate

Blade shape: elliptic

Margin: entire - smooth

Apex: round

Base: acute

Upper surface: smooth, dark green

Undersurface: densely pubescent,
yellow green

Size: 8 (5-11) cm long,

4 (3-5) cm wide

Flowers

Inflorescence: spike, terminal/axillary

Petals: 4, yellow-orange

Sepals: 4, light green, fused

Stamens: 4, yellow

Size: 0.5-0.7 cm diameter

Fruits

Shape: heart-shaped, rounded,
blunt tip

Color: yellow-green

Texture: woolly

Size: 1-3 cm long,

1-2 cm wide



TABLE 4Comparison of characters of *Avicennia* species in Panay Island, central Philippines

| | <i>Avicennia alba</i> | <i>Avicennia marina</i> | <i>Avicennia officinalis</i> | <i>Avicennia rumphiana</i> |
|-----------------------------------|---|---|--|---|
| Location | low intertidal, marine | low to mid-intertidal, marine to intermediate estuarine | mid-intertidal to back mangrove, also near upstream estuarine creeks | mid-intertidal to back mangrove, also near upstream estuarine creeks |
| Leaves | pointed, slender, underside whitish to silver | smaller, dark green to yellow, blades flat to curly | large, rounded, shiny, dark green | rounded, undersurface brownish and hairy, terminal leaves point upwards |
| Leaf L:W ratio^a | 2.6 | 2.0-2.1 | 2.3 | 2.2-2.3 |
| Flowers | small, light orange, subtle scent | small, yellow, slight scent | bigger, darkest yellow-orange, strongest scent | small, darker yellow, distinct scent |
| Fruits | distinctly elongated, pointed, chili-like, pale green | heart-shaped with beak, light green to yellow, slightly hairy | biggest, heart-shaped, pointed, yellowish, surface wrinkled | small, heart-shaped, yellowish-brown, hairy |
| Bark | sooty black, rough | shiny, flaky, light green to light brown | dark, rough, cracked | light to dark, rough |
| Pneumatophores | 10-20 cm high, 0.5-0.8 cm diameter | 10-20 cm high, 0.5-0.8 cm diameter | 15-30 cm high, 1.0 cm diameter | 10-15 cm high, 1.6 cm diameter |

^a L - length, W - width

TABLE 5Comparison of characters of *Bruguiera* species in Panay Island, central Philippines

| | <i>Bruguiera cylindrica</i> | <i>Bruguiera gymnorrhiza</i> | <i>Bruguiera parviflora</i> | <i>Bruguiera sexangula</i> |
|-----------------------------------|---|---|---|--|
| Location | low to mid-intertidal, intermediate to upstream | mid to upper intertidal, upstream to back mangrove | mid-intertidal | upper intertidal to back mangrove |
| Leaves | medium, pale green interpetiolar stipules | biggest size, reddish interpetiolar stipules | smallest size, whitish interpetiolar stipules | medium size, pale green interpetiolar stipules |
| Leaf L:W ratio^a | 2.1-2.5 | 2.4-2.8 | 2.9 | 2.6-3.0 |
| Flowers | small, white petals with brown hairs; green sepals | big, orange-brown hairy petals; reddish sepals | delicate, yellowish-green; sepals not reflexed | big, orange-brown hairy petals; yellow-orange sepals |
| Fruits | short & thin, green to purple; calyx lobes reflexed | long & stout, green to purple; calyx lobes spread | long & thin, light green; calyx lobes appressed | thick & short, green to purple; calyx lobes spread |
| Bark | pale & smooth when young, dark brown & rough when mature; some have lenticels | dark brown; prominent light-colored lenticels ~2 cm in diameter | brown to dark brown, rough; lenticels not prominent | light brown; light-colored lenticels prominent |

^a L - length, W - width

Family Rhizophoraceae

Bruguiera cylindrica (L.) Blume

Local name: *pototan*, *busain* (Tagalog)



Small to medium-sized trees with rounded crown, reaching 10 m high and 20 cm DBH. *Bruguiera cylindrica* colonizes newly-established substrates behind the pioneering *Avicennia-Rhizophora* zone along estuarine riverbanks and tidal creeks. When found beside taller *Rhizophora* trees, the species appears short (hence the local name *pototan*). *B. cylindrica* is also found as single trees on compact muds of open, more inland sites. Among the *Bruguiera* species, it has the smallest leaves and flowers next to *B. parviflora* (Table 5). The stipules (at times called leaf sheaths) are pale green. The mottled bark becomes more dark and rough in older trees (see opposite page, bottom left photos). The short and thin pencil-like propagules bear a calyx cap whose lobes are reflexed. In the past, *B. cylindrica* timber was harvested for household and construction use. Present uses are limited to firewood and as source of tannin.



General

Substrate: muddy, sandy-muddy
 Tidal level: middle
 Found with: *A. officinalis*,
A. rumphiana,
C. decandra

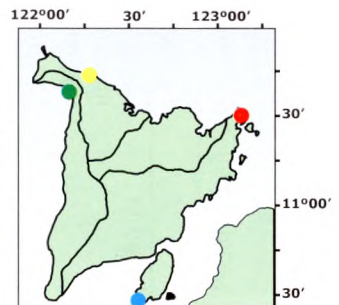
Form

Shape: tree
 Height: 2-10 m
 DBH: 10-20 cm
 Bark: slightly to very rough,
 light brown to grayish,
 few lenticels
 Aerial roots: knee roots, small
 buttresses

Sampling sites: ● Taklong Is., Guimaras
 ● Carles, Iloilo
 ● Ibabay, Aklan
 ● Pandan, Antique

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

Arrangement: simple, opposite
 Blade shape: elliptic
 Margin: entire - smooth
 Apex: acute to acuminate
 Base: acute
 Upper surface: shiny, green
 Undersurface: smooth, light green
 Size: 10 (6-17) cm long,
 4 (2-8) cm wide
 Others: light green stipules

Flowers

Inflorescence: cyme, axillary
 Petals: 8, white, with brown hairs
 Sepals: 8, light green, fused
 Stamens: 8 pairs, brown tips
 Size: 0.8-1 cm long,
 1-1.2 cm diameter

Propagules

Shape: cylindrical, short and thin
 Color: green to purple when mature
 Texture: finely rough, ridged
 Size: 10.7 (7-15) cm long,
 0.5-0.8 cm diameter
 Others: calyx slightly reflexed;
 viviparous



Family Rhizophoraceae

Bruguiera gymnorrhiza (L.) Lam.

Local names: *pototan*; *bakhaw* (Antique), *busain* (Tagalog)



Medium to large trees reaching 10 m high and 30 cm DBH, found on muddy substrate along riverbanks, sandy-muddy substrate in island mangroves, and compact mud in inner mangroves. They differ from the other *Bruguiera* species in that they have the largest leaves, flowers, propagules, and lenticels. *B. gymnorrhiza* has very heavy wood which was used in the past as timber for saltwater and foundation pilings, house posts, flooring, cabinetwork and furniture. It was also used as source of dyes for fishnets, ropes, sails and clothing and powdered bark (*baluk*) for the preparation of *tuba*, a popular drink made from coconut sap. Trees can survive partial debarking to obtain dye if limited to a small section of the trunk (see opposite page, bottom left photo). Present uses are charcoal and firewood, while the knee roots are utilized in planting rituals in Palanan, Isabela so cultivated tubers will grow big.



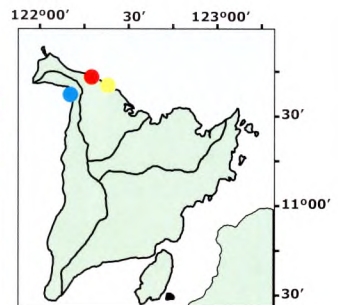
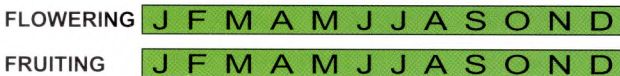
General

Substrate: muddy, sandy-muddy
 Tidal level: middle, high
 Found with: *B. cylindrica*,
C. decandra,
C. philippinensis

Form

Shape: tree
 Height: 2-10 m
 DBH: 10-30 cm
 Bark: rough, dark brown;
 prominent lenticels
 Aerial roots: knee roots, small
 buttresses

Sampling sites: ● Pandan, Antique
 ● Ibajay, Aklan
 ● Makato River, Aklan





Leaves

Arrangement: simple, opposite
 Blade shape: elliptic
 Margin: entire - smooth
 Apex: acute to acuminate
 Base: acute
 Upper surface: smooth, dark green
 Lower surface: waxy, light green
 Size: 15 (10-20) cm long,
 6 (4-8) cm wide
 Others: reddish stipules

Flowers

Inflorescence: single, axillary
 Petals: 11-14, orange, notched, hairy
 Sepals: 11-14, pink to red, fused
 Stamens: 11-14 pairs
 Size: 3-4 cm long

Propagules

Shape: cigar-like, long and stout
 Color: dark green to purple
 when mature
 Texture: finely rough, ridged
 Size: 21.7 (19-25) cm long,
 1-1.7 cm diameter
 Others: calyx cap red, lobes free;
 viviparous



Family Rhizophoraceae

Bruguiera parviflora Wight and Arn. ex Griff.

Local names: *hangalai, langarai, mangalai* (Tagalog)



Bruguiera parviflora forms solid stands of slender, tall trees reaching 15 m high. Among *Bruguiera* species, it has the darkest trunk, the most delicate flowers, and the finest leaves that appear stellate or star-shaped from a distance. The slender propagules have a distinctive calyx appressed to the fruit, unlike other *Bruguiera* spp. At first green and erect, the propagules become brown and pendulous when mature. The yellow-green leaves form a golden canopy in full sunlight. Older trees have cracked bark with reddish interior (see opposite page, bottom left photo). Like other *Bruguiera* species, past uses include saltwater and foundation pilings, house posts, flooring, cabinetwork and as a source of tannin.



General

Substrate: muddy
 Tidal level: middle
 Found with: *B. cylindrica*,
C. philippinensis
S. caseolaris

Form

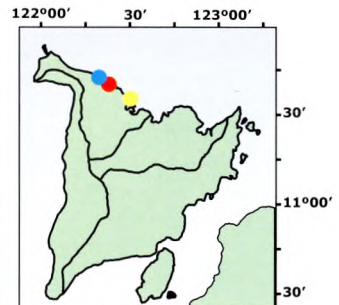
Shape: tree
 Height: 5-15 m
 DBH: 15-25 cm
 Bark: rough, dark
 Aerial roots: dark knee roots,
 low buttresses

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D



Sampling sites: ● Makato River, Aklan
 ● Altavas, Aklan
 ● New Washington, Aklan





Leaves

Arrangement: simple, opposite
 Blade shape: elliptic
 Margin: entire - smooth
 Apex: acuminate
 Base: acute
 Upper surface: smooth, light green
 Undersurface: waxy, pale green
 Size: 8 (6-10) cm long,
 3 (2-4) cm wide
 Others: whitish to light yellow stipules



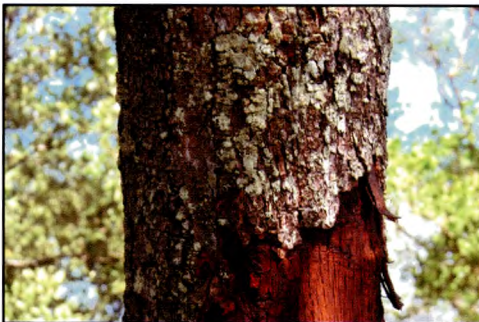
Flowers

Inflorescence: cyme, axillary
 Petals: white
 Sepals: 8, yellow-green
 Size: 0.9-1.3 cm long,
 0.4-0.6 cm diameter



Propagules

Shape: pencil-like, tapered but blunt tip
 Color: light green to brown when mature
 Texture: smooth
 Size: 14 (11-19) cm long,
 4-6 cm diameter
 Others: calyx fused, lobes appressed; viviparous



Family Rhizophoraceae

Bruguiera sexangula (Lour.) Poir.

Local names: *pototan, karakandang* (Antique)



A medium tree up to 10 m tall in the compact sandy-muddy substrate of landward mangroves; with limited distribution in Panay. *Bruguiera sexangula* groves are found in the innermost portion of the mangroves in Bugtong Bato, Ibaday, Aklan and Lipata, Culasi, Antique. The species has big flowers with yellow-orange petals and sepals, short and stout propagules, and prominent buttress and knee roots with lenticels. Bark is light brown with large corky lenticels (see opposite page, bottom left photo) and sometimes covered with lichens. Presently used for firewood and charcoal. Past uses include piles, mine timber and house posts. Roots and leaves were used to treat burns, leaves have alkaloids that are tumor inhibitors, and a lotion made from the fruit was used to treat sore eyes. Young leaves and fruits were cooked as vegetables, fruits used as betel nut substitutes, and roots made into incense wood.



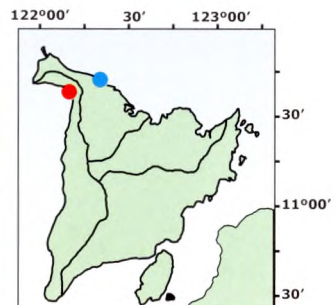
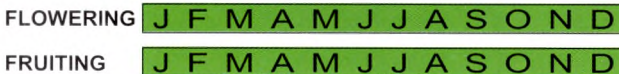
General

Substrate: hard mud, sandy-muddy
 Tidal level: high
 Found with: *H. litoralis, L. racemosa, B. gymnorhiza*

Form

Shape: tree
 Height: 5-10 m
 DBH: 10-25 cm
 Bark: rough, brown; lenticellate
 Aerial roots: knee roots, low buttresses

Sampling sites: ● Ibaday, Aklan
 ● Pandan, Antique





Leaves

| | |
|----------------|---------------------------------------|
| Arrangement: | simple, opposite |
| Blade shape: | elliptic |
| Margin: | entire - smooth |
| Apex: | acuminate |
| Base: | acute |
| Upper surface: | smooth, green |
| Undersurface: | waxy, yellow-green |
| Size: | 12 (8-15) cm long, 4 (3-6) cm wide |
| Others: | pale green to yellowish stipules |

Flowers

| | |
|----------------|-----------------------------------|
| Inflorescence: | single, axillary |
| Petals: | 10-11, orange to brown |
| Sepals: | 10-12, yellow-orange, fused |
| Stamens: | 10-11 pairs |
| Size: | 3-3.2 cm long, 1-2 cm diameter |

Propagules

| | |
|----------|---------------------------------------|
| Shape: | cigar-like, short and stout |
| Color: | green to purple when mature |
| Texture: | finely rough, ridged |
| Size: | 7.7 (4-9) cm long, 1-2 cm diameter |
| Others: | calyx lobes spreading; viviparous |



Family Bombacaceae

Camptostemon philippinensis (Vidal) Becc.

Local name: *gapas-gapas*



Also called *Camptostemon philippinense*, this species has small to medium-sized trees reaching 15 m tall and 50 cm DBH, along rivers and tidal creeks. The leaves are thick, covered with fine scales (like the buds and fruits), and crowded at the end. Surface roots emanate from the base of the trunk and spread out around mature trees – both the knobby roots and lower trunk have many lenticels and give the species a distinctive gnarled appearance. The capsule-shaped fruits have seeds covered by numerous thick white threads, hence the local name *gapas-gapas* meaning cotton (see opposite page, bottom left photo). The ground in a *C. philippinensis* grove appears white from the cottony threads of newly-fallen seeds. In Panay, the wood is used for fuel and elsewhere in the Philippines, for making household utensils and carvings.



General

Substrate: muddy
 Tidal level: low, middle
 Found with: *C. decandra*,
A. rumphiana

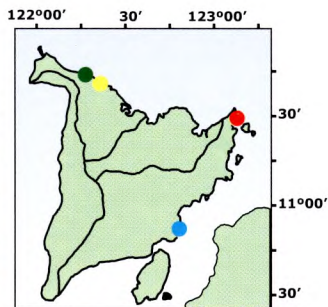
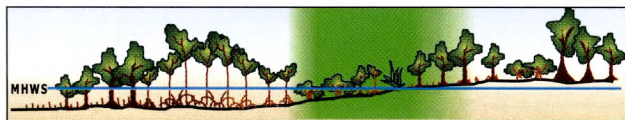
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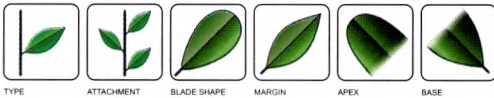
Shape: tree
 Height: 5-15 m
 DBH: 10-50 cm
 Bark: rough, brown-gray,
 irregular flakes;
 lenticellate
 Aerial roots: surface, gnarled,
 curling, with lenticels

Sampling sites: ● Barotac Nuevo, Iloilo
 ● Carles, Iloilo
 ● Makato River, Aklan
 ● Ibajay, Aklan

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





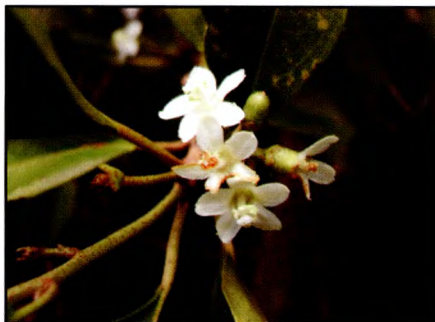
Leaves

Arrangement: simple, alternate, spiral
 Blade shape: obovate
 Margin: entire - smooth
 Apex: round to emarginate
 Base: acute
 Upper surface: leathery, dark green
 Undersurface: smooth, light green; with scales
 Size: 8 (5-9) cm long,
 5 (3-7) cm wide
 Others: fine salt crystals on leaves



Flowers

Inflorescence: cyme, terminal
 Petals: 5, white to reddish brown
 Sepals: 5, green
 Size: 1-1.3 cm diameter
 Others: 3-4 flowers per cluster



Fruits

Shape: rounded, dehiscent
 Color: green to brown
 Texture: cottony inside
 Size: 1-2 cm long,
 7 cm diameter
 Others: attractive to big red ants



Family Rhizophoraceae

Ceriops decandra (Griff.) Ding Hou

Local names: *baras-baras*, *lapis-lapis*, *malatangal* (Tagalog)



Shrubs reaching 3 m tall that grow on the compact mud or sandy-mud of inner mangroves. This pioneer species occurs as monospecific stands that provide the leading edge of mangrove invasion of grasslands, up to the high tide limit (see opposite page, bottom left photo), but may also form the understory portion of a mixed mangrove community. *Ceriops decandra* differs from *C. tagal* by its shorter height, multiple stems, and shorter fruits (with red cotyledonary collar) that point in all directions. Roots have small flaky buttresses that give the trunk a swollen appearance. Commonly used as firewood, and as Christmas trees in Luzon. The bark of mature trees is harvested for the *baluk* powder used in making local *tuba*, although the preferred species is *C. tagal*.



General

- Substrate: sandy, muddy
- Tidal level: middle, high
- Found with: *A. officinalis*,
A. rumphiana,
N. fruticans

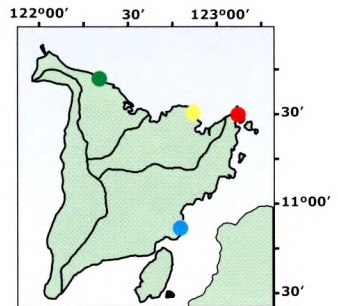
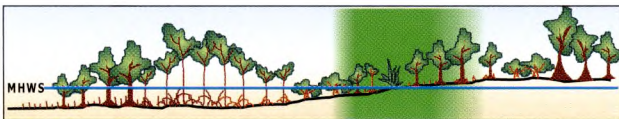
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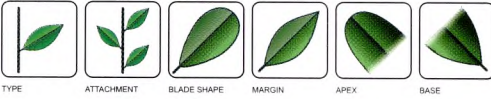
- Shape: shrub
- Height: 2-3 m
- Bark: rough, gray to brown,
few lenticels
- Aerial roots: small, buttress-like

- Sampling sites:
- Barotac Nuevo, Iloilo
 - Carles, Iloilo
 - Pan-ay, Capiz
 - Ibajay, Aklan

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

Arrangement: simple, opposite
 Blade shape: mostly obovate
 Margin: entire - smooth
 Apex: round to emarginate
 Base: acute
 Upper surface: smooth, green
 Undersurface: smooth, light green
 Size: 7 (4-10) cm long,
 4 (3-8) cm wide

Flowers

Inflorescence: cyme, axillary
 Petals: 5, white, with hairs
 Sepals: 5, light green, fused
 Size: 0.3-0.5 cm diameter
 Others: 6-8 flowers per cluster,
 on short thick stalks

Propagules

Shape: cylindrical, pencil-shaped
 Color: green to brown when mature
 Texture: smooth, slender, slightly ribbed
 Size: 13.5 (10-18) cm long,
 0.5-0.9 cm diameter
 Others: reddish brown cotyledonary
 collar (see inset)



Family Rhizophoraceae

Ceriops tagal (Perr.) C.B. Rob.

Local names: *tungog, tangal, tagasa* (Tagalog)



Small trees reaching 6 m tall, on firm sandy to muddy substrates of inner mangroves. Compared to *C. decandra*, trees are taller with a single straight trunk, and longer fruits point downwards. Leaves turn yellowish green in sunlight. Roots have small flaky buttresses; knee roots appear in older trees. Among the Rhizophoraceae, the dried *C. tagal* bark gives the best quality *baluk* powder used in making *tuba*, *bahalina* (a special *tuba* variety in Leyte and Samar), and *basi* (rice wine), and in dyeing fish nets and clothing. Wood is used for fuel, charcoal, poles for *baklad* (fish corrals) and house posts. In the past, big trees provided hard, fine-textured wood for furniture and house construction. The bark was used to treat hemorrhages and ulcers; older folks chewed on dried bark. Only isolated trees of *C. tagal* are found in Panay, aside from a small 20-year old plantation in Naisud, Ibajay, Aklan (see opposite, bottom left photo).



General

Substrate: sandy, muddy
 Tidal level: middle, high
 Found with: *A. corniculatum*,
A. rumphiana,
R. apiculata, *S. alba*

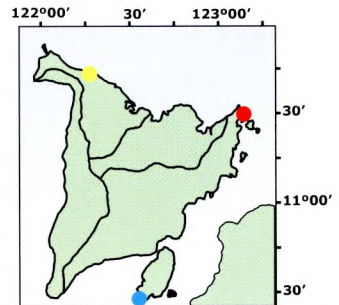
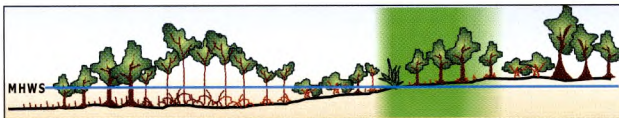
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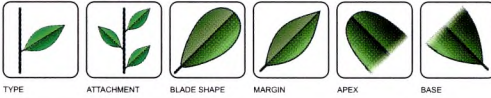
Shape: tree, shrub
 Height: 2-6 m
 DBH: 5-10 cm
 Bark: rough, light brown to gray; flaky
 Aerial roots: knee roots, low buttresses

Sampling sites: ● Taklong Is., Guimaras
 ● Carles, Iloilo
 ● Ibajay, Aklan

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

- Arrangement: simple, opposite
 Blade shape: mostly obovate
 Margin: entire - smooth, curl downwards
 Apex: round
 Base: acute
 Upper surface: smooth, green to yellow green
 Undersurface: smooth, yellow green
 Size: 8 (5-12) cm long, 4 (2-6) cm wide
 Others: leaves directed upward, brittle

Flowers

- Inflorescence: cyme, axillary
 Petals: 4-6, white, with brown hairs
 Sepals: 4-6, light green, fused
 Stamens: 4-6, brown tip
 Size: 0.6-0.9 cm long, 0.6-0.9 cm diameter

Propagules

- Shape: cylindrical, pencil-shaped
 Color: dark green to brown when mature
 Texture: ridged, with a few warts
 Size: 20.5 (16-30) cm long, 0.6-1 cm diameter
 Others: pendulous, calyx spread, yellow cotyledonary collar (inset)



Family Euphorbiaceae

Excoecaria agallocha L.

Local names: *lipata*, *alipata* (Visayan), *buta-buta* (Cebuano)



Small to medium trees with surface roots on sandy-muddy substrate along tidal creeks or on hard mud in the inner mangroves and along dikes of ponds. The leaves are highly variable in size, shape and color. They fall off in the dry season just before the flowers appear, but sometimes flowering trees show leaves. The only dioecious mangrove species, female and male plants can be distinguished during the reproductive period. Male flowers in full bloom, which are longer than those of females, present a spectacular but short-lived sight of numerous golden catkins hanging from bare branches. The twigs are used as pest repellent, burnt ashes for salt extraction, and leaves to treat epilepsy. Its milky sap, which flows from any cut surface on the leaf, twig or trunk can cause skin irritation and alleged blindness, hence the local name *buta-buta*. The sap is used to treat toothache and ulcers, and as fish poison.



General

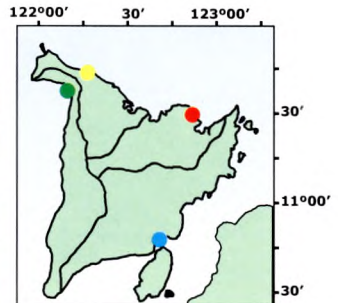
Substrate: sandy-muddy, hard mud
 Tidal level: middle, high
 Found with: *A. officinalis*,
A. rumphiana,
N. fruticans,
Rhizophora spp.

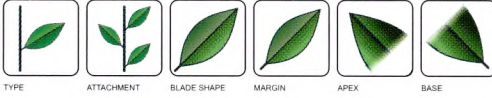
Form

Shape: tree
 Height: 5-15 m
 DBH: 10-60 cm
 Bark: slightly rough, grayish brown; often mottled due to lichens

Aerial roots: surface

Sampling sites: ● Zarraga, Iloilo
 ● Pan-ay, Capiz
 ● Ibajay, Aklan
 ● Pandan, Antique





Leaves

Arrangement: simple, alternate, spiral
 Blade shape: elliptical
 Margin: entire - smooth
 Apex: acute
 Base: acute
 Upper surface: smooth, green
 Undersurface: smooth, light green
 Size: 5 (3-8) cm long,
 3 (2-4) cm wide
 Others: white milky sap,
 deciduous

Flowers

Inflorescence: catkin, axillary
 Petals: yellow (male & female)
 Stamens: yellow (male & female)
 Size (catkin): male 1.9-3.0 cm long,
 female 0.3-0.7 cm long

Fruits

Shape: rounded with 3 lobes
 Color: green, brown when mature
 Texture: smooth
 Size: 0.4-0.6 cm diameter
 Others: short style splits into 3 curling
 strands



Family Sterculiaceae

Heritiera littoralis Dryand. ex W. Ait.

Local names: *dungon*, *dungon-late*



Medium-sized trees up to 20 m high found in back mangroves, often on dry land along forest margins. The big, dark green leaves have a characteristic silvery-white undersurface, and the hard, shiny fruits are boat-shaped with a ridge. Prominent buttress roots have flattened extensions, called plank roots, that criss-cross the substrate. These buttresses reach ~3 m high in the magnificent *Heritiera littoralis* stand in Iriomote, Okinawa, southern Japan (S. Baba, personal communication). The species is widely distributed in the Philippines – evidence of its previous abundance are two neighboring *barangays* both named *Dungon* in Jaro, Iloilo City. Past uses of the hard, heavy wood include piles, bridges and wharves. The pre-Hispanic *balanghais* boats excavated from Agusan del Norte were made of *dungon*. Roots used as fish poison, seed extracts to treat diarrhea and dysentery.



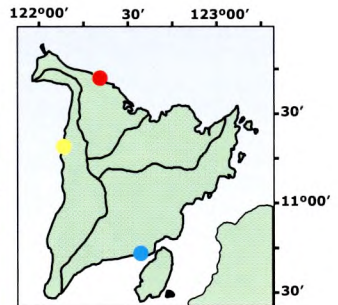
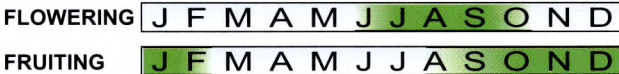
General

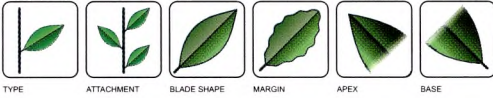
Substrate: firm mud
 Tidal level: high
 Found with: *N. fruticans*

Form

Shape: tree
 Height: 5-20 m
 DBH: 20-50 cm
 Bark: rough, dark brown;
 flaky
 Aerial roots: prominent buttresses,
 plank or ribbon roots

Sampling sites: ● Oton, Iloilo
 ● Ibajay, Aklan
 ● Culasi, Antique





Leaves

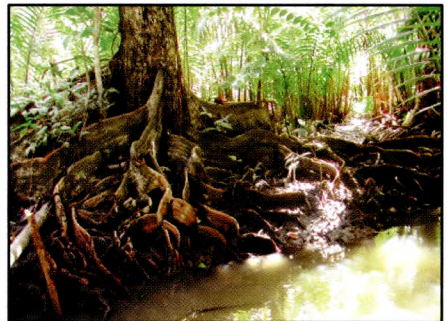
Arrangement: simple, alternate, spiral
 Blade shape: elliptical to oblong
 Margin: entire - undulate
 Apex: acute
 Base: acute to round
 Upper surface: leathery, dark green
 Undersurface: tiny scales, silvery
 Size: 17 (11-27) cm long,
 8 (5-14) cm wide
 Others: some with insect galls (see photo below)

Flowers

Inflorescence: panicle, axillary
 Petals: none
 Sepals: 4, hairy, pink-red inside, yellow green outside,
 Size: 0.3-0.5 cm diameter
 Others: unisexual

Fruits

Shape: boat-shaped
 Color: green to brown
 Texture: shiny, hard
 Size: 5-9 cm long,
 4-6 cm diameter
 Others: central ridge or keel



Family Rhizophoraceae

Kandelia candel (L.) Druce

Local names: *tangal*



Kandelia candel has been found in only two sites in the Philippines – Castillo, Baler (~ 10 specimens) and Cozo, Casiguran Bay – both in Aurora Province on the eastern side of Luzon. It was first identified in May 1996 (Zisman et al., 1998). Except for this report, *K. candel* is not mentioned in any of the published lists of Philippine mangrove species. The Aurora plants are small, slender trees up to 5 m tall on muddy substrate along tidal creeks and rivers where they are associated with *N. fruticans* and *S. alba*. In other Southeast Asian countries, the trees are reported to be taller, with bigger buttresses, prop roots and pneumatophores.



General

Substrate: soft mud
Tidal level: low
Found with: *A. corniculatum*,
A. marina,
B. gymnorrhiza,
N. fruticans, *S. alba*

Form

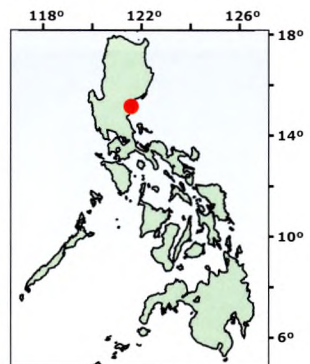
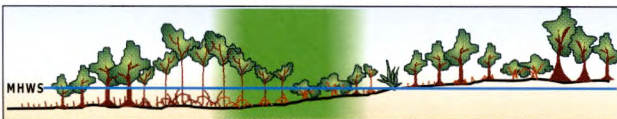
Shape: tree
Height: 3-5 m
DBH: 5-15 cm
Bark: smooth, brown;
with lenticels
Aerial roots: low buttresses

Sampling

sites: ● Baler, Aurora province

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

Arrangement: simple, opposite
 Blade shape: oblong to elliptic
 Margin: entire - smooth
 Apex: obtuse to round
 Base: acute
 Upper surface: smooth, yellow green to green
 Undersurface: smooth, green
 Size: 10-16 cm long,
 3-5 cm wide
 Others: stipule reddish to yellow,
 prominent midrib

Flowers

Inflorescence: cyme, axillary
 Petals: 4-5, white, thin
 Sepals: 4-5, reflexed
 Stamen: numerous, white
 Size: 1.5-2 cm long,
 Others: 2 flowers per cluster

Propagules

Shape: cylindrical, slender,
 tapering with pointed tip
 Color: yellow green to green
 Texture: smooth
 Size: 20-30 cm long,
 ~1 cm diameter
 Others: long (3-4 cm) peduncle;
 sepals persistent on calyx
 cap; viviparous



ANNE ROBERTS



SEV ANGARA (inset)



Family Combretaceae

Lumnitzera littorea (Jack) Voigt.

Local name: *tabao, libato* (Tagalog)



Medium to tall trees reaching 12 m high in stands along tidal creeks and on muddy to sandy-muddy substrates of back mangroves. In Palawan, a natural stand provides shade to a multispecies mangrove nursery (see opposite page, bottom left photo). *Lumnitzera littorea* is easily differentiated from *L. racemosa* by its bigger size, darker green leaves, and bright red flowers whose buds look like small lipsticks. The beautiful decorative flowers make *L. littorea* suitable for planting in beach resorts. Old *L. littorea* trees in a small pristine mangrove patch in Jawili, Tangalan, Aklan have branches bent close to the ground and a dark trunk that is crooked. Branches can be used for fuel and for smoking fish. A decoction of the leaves is used to treat thrush in infants. In the past, the hard, strong wood was used for heavy construction – bridges, wharves, ships, cart axles, flooring and furniture.



General

Substrate: muddy, sandy
Tidal level: middle, high
Found with: *A. rumphiana*,
B. cylindrica,
O. octodonta,
S. hydrophyllacea

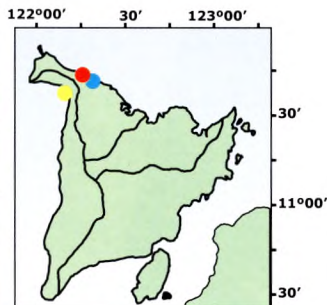
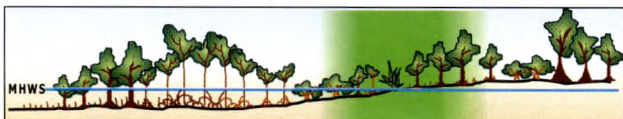
Form

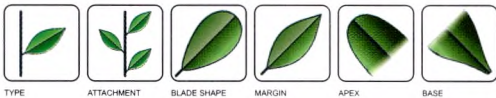
Shape: tree
Height: 3-12 m
DBH: 10-60 cm
Bark: fibrous, rough, deeply
fissured; dark brown
Aerial roots: extensive surface

Sampling sites: ● Tangalan, Aklan
● Ibajay, Aklan
● Pandan, Antique

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

Arrangement: simple, alternate, spiral
 Blade shape: obovate
 Margin: entire - smooth
 Apex: round to emarginate
 Base: sessile
 Upper surface: smooth, green
 Undersurface: smooth, green
 Size: 6 (4-9) cm long,
 2 (1-4) cm wide
 Others: succulent, brittle

Flowers

Inflorescence: spike, axillary
 Petals: 5, bright red
 Sepals: 5, green, fused
 Stamens: 10, red filaments, yellow pollen
 Size: 1-3 cm long,
 0.1-0.3 cm diameter
 Others: stamens longer than petals

Fruits

Shape: vase-shaped
 Color: dark green, reddish base
 Texture: smooth
 Size: 1-2 cm long,
 0.3-0.7 cm diameter
 Others: succulent



Family Combretaceae

Lumnitzera racemosa Willd.

Local names: *tabao, culasi, bolali* (Negros Occidental)



A pioneering species of small trees up to 6 m high often found in the muddy back mangrove where it forms thick stands and on sandy beaches near the high water line. It has multiple stems, surface roots and succulent leaves with many conspicuous insect bites; older trees have a single trunk and looping roots. *Lumnitzera racemosa* is so widely distributed that many Philippine towns and villages are named after it (Table 8). Interestingly, the two sister species are rarely found together, except in Naisud, Ibabay, Aklan. Aside from firewood, the dried twigs are used as fish-aggregating devices and the leaves as forage for livestock. The trunks of bigger trees are used as house posts. Villagers in Tabao, Sagay, Negros Occid. use both cut stems, and planted *L. racemosa* interspersed with *B. cylindrica*, to form a living fence around their dwellings (see opposite, bottom left photos). It is also planted along dikes of fishponds.



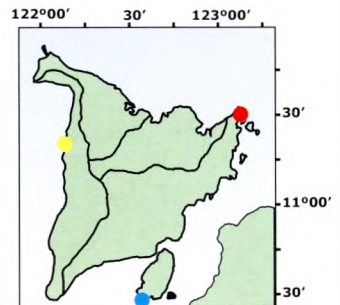
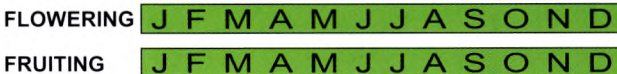
General

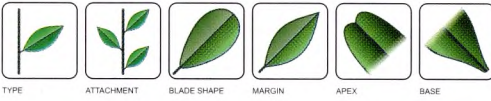
Substrate: sandy, muddy
Tidal level: middle, high
Found with: *A. marina*, *C. decandra*,
Rhizophora spp.,
S. hydrophyllacea

Form

Shape: tree, shrub
Height: 3-6 m
DBH: 3-10 cm
Bark: rough, fibrous, brown;
deeply fissured
Aerial roots: surface, looping
in older trees

Sampling sites: ● Taklong Is., Guimaras
● Carles, Iloilo
● Culasi, Antique





Leaves

Arrangement: simple, alternate, spiral
 Blade shape: obovate
 Margin: entire - smooth
 Apex: emarginate to round
 Base: sessile
 Upper surface: smooth, light green
 Undersurface: smooth, light green
 Size: 6 (4-9) cm long,
 2 (2-4) cm wide
 Others: succulent

Flowers

Inflorescence: spike, axillary
 Petals: 5, white
 Sepals: 5, green, fused
 Stamen: 10, pale yellow
 Size: 1-1.6 cm long,
 0.6-1 cm diameter

Fruits

Shape: pitcher-like
 Color: green
 Texture: smooth, waxy
 Size: 1.1-1.8 cm long,
 0.5-0.7 cm diameter
 Others: one side slightly bulging,
 the other side flat



Family Palmae

Nypa fruticans (Thunb.) Wurmb.

Local names: *nipa*, *sapsap*, *sasa* (Tagalog)



The only palm among true mangrove species, *Nypa fruticans* forms extensive belts along muddy edges of brackish to almost freshwater creeks and rivers. Individual plants are also found in mixed mangrove communities. It has creeping stems called rhizomes from which tall (up to 8 m high) compound leaves arise. Commercially important, its products include the local drink *tuba*, vinegar and alcohol from the sap of the inflorescence (see opposite, bottom left photo); roofing material, native hats (*salakot*), raincoats, baskets, bags, mats, and wrappers from leaflets; and brooms from midribs. The fruit endosperm is eaten fresh or cooked, and the trunk pith is prepared as salad. The Sanskrit name *Nypatithau* was that of a generous man who gave everything of himself. Coincidentally, *Nypa* was first applied in Indonesia to this palm species, which gives of its every useful part so to speak (M. Vannucci, personal communication).



General

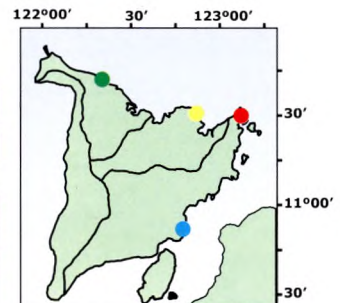
Substrate: soft to hard mud
Tidal level: middle, high
Found with: various species

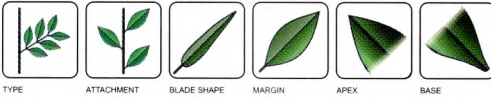
Form

Shape: palm
Height: 2-8 m
Roots: creeping rhizomes

Sampling sites: ● Barotac Nuevo, Iloilo
● Carles, Iloilo
● Panay, Capiz
● Ibajay, Aklan

FLOWERING J F M A M J J A S O N D
FRUITING J F M A M J J A S O N D





Leaves

Arrangement: compound, odd pinnate
 Blade shape: lanceolate leaflet
 Margin: entire - smooth
 Apex: acute
 Base: sessile leaflet
 Upper surface: smooth, green
 Undersurface: powdery, light green
 Size (leaflet): 40-120 cm long,
 4-9 cm wide
 Others: 80-120 leaflets per leaf
 10-20 leaves per cluster

Flowers

Inflorescence: catkin, axillary
 Petals: yellow to orange
 Sepals: orange
 Stamens: yellow
 Others: dimorphic

Fruits

Shape: ball-shaped cluster of fruits
 Color: light to dark brown
 Texture: individual fruit smooth, shiny
 Size: 20-40 cm diameter (cluster)
 Others: meat (endosperm) edible



Family Myrtaceae

Osbornia octodonta F. Muell.

Local names: *bunot-bunot, tawalis, dukduk* (Negros)



Shrubs to small trees reaching 6 m tall with surface roots, often with multiple irregular stems. They can tolerate high salinity and are found in stands on the high tide line on exposed rocky and sandy shores or the sheltered elevated flats of the foreshore. *Osbornia octodonta* is sometimes associated with other high shore species like *P. acidula* and *A. floridum*, and shares a superficial resemblance with the latter. It has small, brittle leaves which emit an aroma when crushed, small white flowers, capsule-shaped fruits, deeply fissured bark and cable roots often exposed on rocky shores. Aside from fuelwood, the dried twigs (see opposite page, bottom left photo) are made into baskets and used as fish-aggregating devices by local fishers.



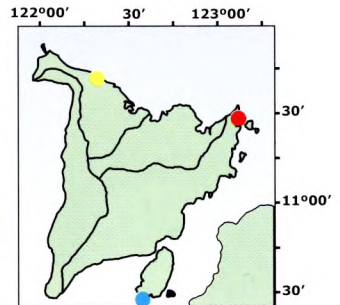
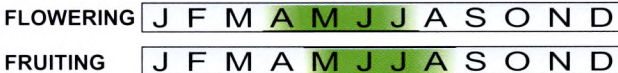
General

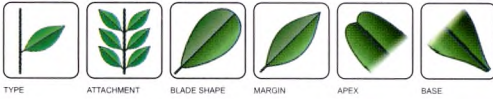
Substrate: sandy, rocky
 Tidal level: middle, high
 Found with: *P. acidula*, *A. floridum*,
L. littorea

Form

Shape: tree, shrub
 Height: 3-6 m
 DBH: 5-15 cm
 Bark: thick, spongy, rough
 with long fissures;
 brown to gray
 Aerial roots: surface

Sampling sites: ● Taklong Is., Guimaras
 ● Carles, Iloilo
 ● Tangalan, Aklan





Leaves

Arrangement: simple, opposite, decussate
 Blade shape: obovate
 Margin: entire - smooth
 Apex: emarginate
 Base: sessile
 Upper surface: smooth, pale green
 Undersurface: smooth, pale green
 Size: 4 (3-6) cm long,
 2 (1-3) cm wide
 Others: thin, brittle



Flowers

Inflorescence: cyme, axillary
 Petals: apetalous
 Sepals: yellow green, fused
 Stamens: numerous, white; yellow pollen
 Size: 0.5-1 cm long,
 0.2-0.5 cm diameter
 Others: usually 3 flowers per cluster



Fruits

Shape: capsule
 Color: pale green
 Texture: hairy (dense)
 Size: 0.7-1 cm long,
 0.3-0.5 cm diameter
 Others: calyx completely encases fruit



Family Lythraceae

Pemphis acidula J.R. Forst. and G. Forst.

Local names: *bantigi*



Shrubs 3-5 m tall, along the high tide line of coralline-rocky and sandy foreshores, often in association with *O. octodonta* and *A. floridum*. It has irregularly shaped branches, small leaves, and small white flowers. Distribution in Panay is limited to small stands in Carles, Iloilo; Taklong Island, Guimaras; and Anini-y, Antique. The twigs are used for fuel and also as fish-aggregating devices, like *O. octodonta*. Wood of *Pemphis acidula* is very hard and strong, hence it is used in house and fence construction. Because of its small size and sturdy nature, the species is a favorite material of *bonsai* enthusiasts (see opposite, bottom left photo). Some ten years ago, the Department of Environment and Natural Resources confiscated specimens collected from Nogas Is., Antique which were to be smuggled to Taiwan and sold at Philippine Pesos (Php) 2,000 per plant.



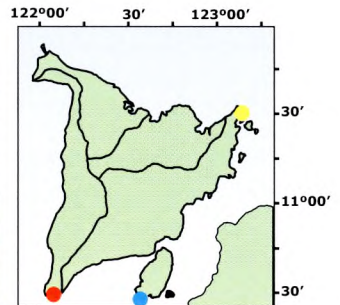
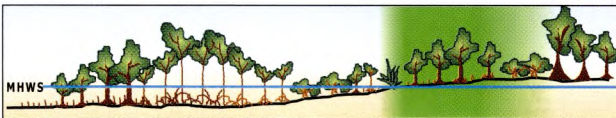
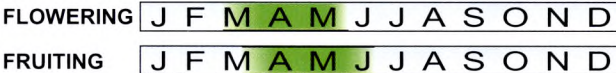
General

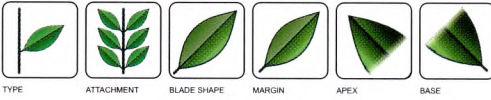
Substrate: sandy, coralline
 Tidal level: high
 Found with: *O. octodonta*,
A. floridum

Form

Shape: shrub, tree
 Height: 3-5 m
 DBH: 5-12 cm
 Bark: rough, grayish brown;
 with large lenticels
 Aerial roots: not prominent

Sampling sites: ● Taklong Is., Guimaras
 ● Anini-y, Antique
 ● Carles, Iloilo





Leaves

Arrangement: simple, opposite, decussate
 Blade shape: elliptical
 Margin: entire - smooth
 Apex: acute to obtuse
 Base: acute
 Upper surface: velvety, pale green
 Undersurface: velvety, whitish green
 Size: 2-3 cm long,
 1 cm wide
 Others: covered with minute hairs

Flowers

Inflorescence: single, axillary
 Petals: 6, white
 Sepals: 12, fused
 Stamens: 12
 Size: 0.7-1 cm long,
 0.9-1.8 cm diameter

Fruits

Shape: capsule
 Color: brown
 Texture: smooth
 Size: 0.4-0.9 cm long,
 0.3-0.6 cm diameter
 Others: fruit encased in a bell-like structure



Family Rhizophoraceae

Rhizophora apiculata Blume

Local names: *bakhaw*, *bakhaw laki*, *bulubaladaw* (Antique)



Medium to tall trees reaching 20 m on loose mud of tidal rivers and creeks, and sandy mud of the seaward zone behind the outer *S. alba*-*A. marina* band where *Rhizophora apiculata* forms monospecific stands. Its wide distribution in Panay and elsewhere in the Philippines is due to its pioneering nature and popularity for replanting. It is the preferred species for plantations because of availability of propagules and fast growth. The inflorescence usually bears 2 sessile flowers on a very short peduncle. The buds are compact and used by children as bullets for toy guns. The fruits are long, smooth and viviparous. The leaves are dark green and flat, and may be fed to pigs (see opposite page, bottom left photo); the interpetiolar stipules are dark pink to red. Other differentiating features are found in Table 6.



General

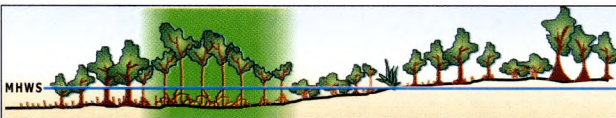
Substrate: muddy
 Tidal level: low, middle
 Found with: *A. marina*, *S. alba*,
R. stylosa, *R. mucronata*

Form

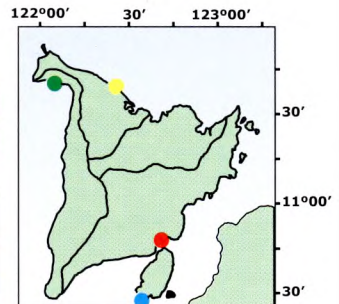
Shape: tree
 Height: 4-20 m
 DBH: 10-40 cm
 Bark: rough, grayish to brown
 Aerial roots: prop roots

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D



Sampling sites: ● Taklong Is., Guimaras
 ● Zarraga, Iloilo
 ● Kalibo, Aklan
 ● Libertad, Antique





Leaves

Arrangement: simple, opposite
 Blade shape: elliptic
 Margin: entire - smooth
 Apex: apiculate
 Base: acute
 Upper surface: smooth, dark green
 Undersurface: smooth, green
 Size: 13 (9-19) cm long,
 5 (4-7) cm wide
 Others: stipules dark red



Flowers

Inflorescence: cyme, axillary
 Petals: 4, white
 Sepals: 4, yellow to red outside
 Stamen: 12, brown
 Size: 1.2-1.4 cm long
 Others: 2 flowers per cluster,
 no style



Propagules

Shape: cylindrical, straight
 Color: dark green
 Texture: smooth
 Size: 24 (22-26) cm long,
 0.9-1 cm diameter
 Others: viviparous; short (~1 cm)
 peduncle so the upper part
 tends to be curved; yellowish
 cotyledonary collar



Family Rhizophoraceae

Rhizophora x lamarckii Montr.

Local name: *bakhaw*



A sterile hybrid of *Rhizophora apiculata* x *R. stylosa*, this species can be found on the sandy-muddy substrate along the seaward fringe of protected islands. The trees are usually isolated but close to the parent plants. The characters are the same as *R. apiculata* – reddish interpetiolar stipules but slightly longer peduncles with two flowers each which never develop into fruits. The buds look like those of *R. apiculata* and the style is shorter than in *R. stylosa*. A single specimen has been found in the Taklong Island National Marine Reserve, Nueva Valencia, Guimaras (10°24'22.46" N, 122°30'46.26" E). This hybrid has also been reported by Yao (1999) from various sites in central Visayas – Okiot, Dewey Is., Bais and Tinguib, Ayongon both in Negros Oriental; Pagangan Is., Calape and Handayan Is., Getafe both in Bohol; and Taug, Carcar, Cebu. Uses of the various *Rhizophora* species are similar (see opposite page).



General

Substrate: sandy-muddy
 Tidal level: low
 Found with: *A. marina*, *S. alba*,
R. stylosa, *R. apiculata*,
R. mucronata

Form

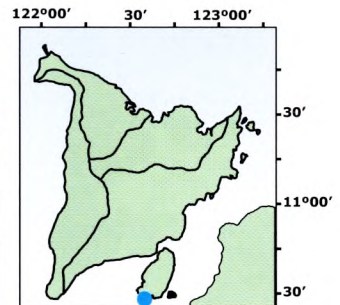
Shape: tree
 Height: 12 m
 DBH: 15 cm
 Bark: rough, grayish to brown
 Aerial roots: prop roots

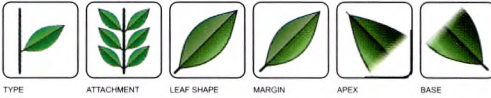
Sampling

site: ● Taklong Is., Guimaras

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

| | |
|----------------|-------------------------------|
| Arrangement: | simple, opposite |
| Blade shape: | elliptic |
| Margin: | entire - smooth |
| Apex: | apiculate |
| Base: | acute |
| Upper surface: | waxy, dark green |
| Undersurface: | smooth, yellow green |
| Size: | 13-15 cm long, 5-6 cm wide |
| Others: | stipules reddish |

Flowers

| | |
|----------------|--|
| Inflorescence: | cyme, axillary |
| Petals: | 4, white, hairy |
| Calyx: | 4, yellowish |
| Size: | 1.1-1.4 cm long |
| Others: | 2 flowers per cluster, longer (2-3 cm) peduncle, sterile |



USES OF RHIZOPHORA SPECIES

As in the past, *Rhizophora* species are popular at present for firewood and charcoal because of their high heating value and little smoke. At the turn of the century, thousands of hectares around Manila Bay were planted with *Rhizophora* to provide household fuel. They are also used for posts, frames and flooring of coastal houses, furniture, *banca* (small boat) outrigger, and fishing poles of *baklad* (fish corrals). The original *taku* (cue stick) used by Efren "Bata" Reyes, the country's first world-class billiard player, was made of *bakhaw* wood, most probably *R. apiculata*. Tender *bakhaw* leaves are fed to pigs, goats and other livestock. The *baluk* from *Rhizophora* can also be used in preparing tuba, if the preferred *C. tagal* is not available. Fishers wash jellyfish with *bakhaw* bark solution before eating, or apply the bark directly to affected skin, to neutralize the sting. A bark decoction is used to heal scabies and other skin infections. Coastal folks seek decaying branches of *bakhaw* and other mangroves for *tamiluk*, or shipworms (right) which are a highly-prized delicacy. Past uses of *bakhaw* include timber for railroad ties, mine posts, wharves, beams and joists. *Bakhaw* wood is especially suited for use as foundation piles because it is resistant to salt water.



SABINE SCHOPPE
DARIO NOVELLINO (inset)

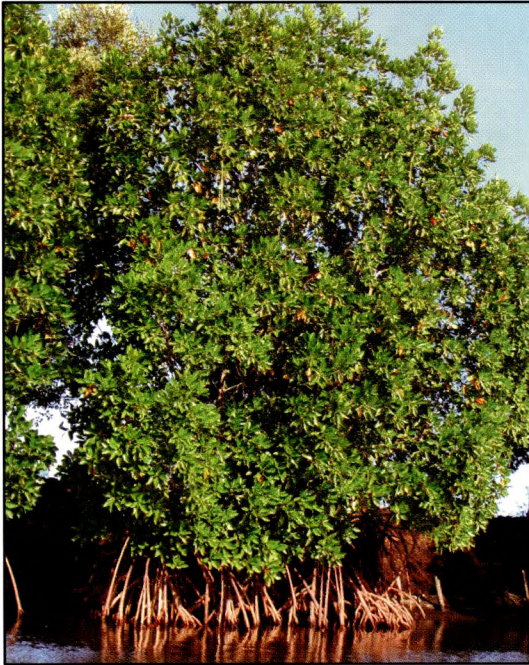
Family Rhizophoraceae

Rhizophora mucronata Lam.

Local names: *bakhaw*, *bakhaw babae*



Medium to big trees reaching 15 m in Panay (but 30 m in Aurora and other provinces). Its wide distribution overlaps with other *Rhizophora* species although *R. mucronata* is more strongly associated with the soft muds of estuarine rivers and tidal creeks. In the seaward fringe, it is typically found behind *R. apiculata*, the “front-line” species. *R. mucronata* has broader leaves with yellow to light green stipules, pendulous flowers, and long warty propagules. It is favored for fuelwood and charcoal because of its high heating value, like other *Rhizophora* species. In the past, it was cultivated with *R. apiculata* in fuelwood plantations around Manila and sold on the street (see opposite, bottom left photo). The dried hypocotyls were smoked as cigars. In the 1950s-70s, wood chips from these two species were exported from the Philippines, Malaysia and other Southeast Asian countries to Japanese rayon fiber factories.



General

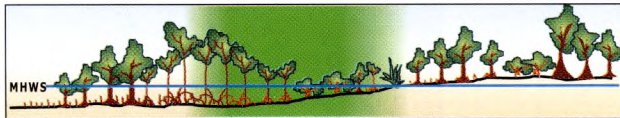
Substrate: sandy, muddy
Tidal level: low
Found with: *A. marina*, *R. apiculata*,
R. stylosa, *S. alba*

Form

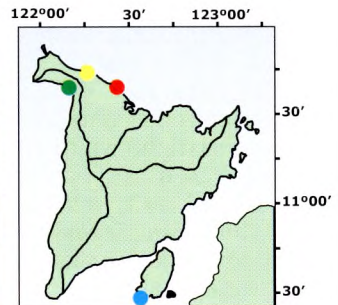
Shape: tree
Height: 4-15 m
DBH: 8-20 cm
Bark: rough, grayish to brown
Aerial roots: prop roots

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D



Sampling sites: ● Taklong Is., Guimaras
● Kalibo, Aklan
● Ibajay, Aklan
● Pandan, Antique





Leaves

Arrangement: simple, opposite
 Blade shape: elliptic
 Margin: entire - smooth
 Apex: mucronate
 Base: acute
 Upper surface: smooth, dark green
 Undersurface: smooth, yellow green
 Size: 14 (11-19) cm long,
 7 (6-10) cm wide
 Others: black dots, light green stipules

Flowers

Inflorescence: cyme, axillary
 Petals: 4, white, hairy
 Sepals: 4, light yellow
 Stamens: 8, brown
 Size: 1.2-2 cm long,
 1-1.5 cm diameter
 Others: 3-5 cm long peduncle,
 2-6 flowers per cluster,
 1 mm style

Propagules

Shape: cylindrical
 Color: dark green
 Texture: warty
 Size: 57 (34-70) cm long,
 1-2 cm diameter
 Others: viviparous; yellow collar



FROM BROWN & FISCHER (1920)



Family Rhizophoraceae

Rhizophora stylosa Griff.

Local names: *bakhaw, bakhaw bato, bangkao*



Small to medium trees up to 10 m high. Widely distributed, *Rhizophora stylosa* overlaps with the habitat of *R. apiculata* but prefers sandy and rocky intertidal shores. Leaves have sides which typically curl or roll downward, differentiating it from other *Rhizophora* species; the leaves on terminal branches slant or point upward. Like other mangroves, the roots are often overgrown by epiphytic algae (see opposite page, bottom right photo). Uses for fuelwood and dyes are similar to other *Rhizophora* species. It is also favored for planting – the provincial government of Antique provided funds for the almost yearly procurement from 1995 to 2001 of more than 70,000 *R. stylosa* propagules from Semirara Island for planting in Lipata, Culasi by the people's organization OMMMALI (see Table 13).



General

Substrate: sandy, muddy
 Tidal level: low, middle
 Found with: *A. marina, R. apiculata, R. mucronata, S. alba*

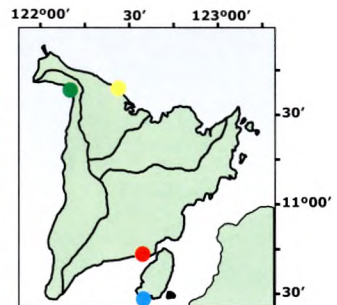
Form

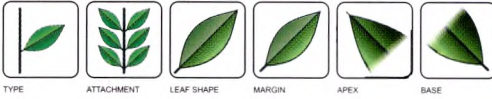
Shape: tree
 Height: 3-10 m
 DBH: 6-15 cm
 Bark: rough, grayish to brown
 Aerial roots: prop roots

Sampling sites: ● Taklong Is., Guimaras
 ● Oton, Iloilo
 ● Kalibo, Aklan
 ● Pandan, Antique

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

Arrangement: simple, opposite
 Blade shape: elliptic
 Margin: entire - smooth
 Apex: apiculate
 Base: acute
 Upper surface: waxy, light green
 Undersurface: smooth, yellow green
 Size: 11 (8-14) cm long,
 5 (3-7) cm wide
 Others: leaves point upward, sides
 curling; stipules light green



Flowers

Inflorescence: cyme, axillary
 Petals: 4, white, hairy
 Sepals: 4, light yellow
 Stamen: 8, brown
 Size: 1.1-1.5 cm long,
 1.4-2 cm diameter
 Others: ~7 flowers per cluster,
 long peduncle, 6 mm style



Propagules

Shape: cylindrical, straight
 Color: light green to green
 Texture: warty
 Size: 34 (26-42) cm long,
 1-2 cm diameter
 Others: viviparous; greenish collar



TABLE 6Comparison of characters of *Rhizophora* species in Panay Island, central Philippines

| | <i>Rhizophora apiculata</i> | <i>Rhizophora lamarckii</i> | <i>Rhizophora mucronata</i> | <i>Rhizophora stylosa</i> |
|-----------------------------------|--|--|--|---|
| Location | low to mid-intertidal, marine | low intertidal, marine | low to mid-intertidal, marine to estuarine | low to mid-intertidal, marine to estuarine |
| Leaves | narrow, dark red interpetiolar stipules | narrow, reddish interpetiolar stipules | broadest, light green interpetiolar stipules | smallest, leaves point upward, light green interpetiolar stipules |
| Leaf L:W ratio^a | 2.5 | 2.5 | 2.0 | 2.2 |
| Flowers | 2 sessile flowers on short (1-2 cm) peduncle | 2 flowers on longer (3-4 cm) peduncle | pendulous, stalk with 6-8 flowers; short style | pendulous stalk with 8-16 flowers; long style |
| Propagules | up to 30 cm long, dark green, smooth | not observed, plants sterile | largest - up to 80 cm long, green to dark green, warty | up to 45 cm long, light green to green, warty |

^a L - length, W - width

TABLE 7Comparison of characters of *Sonneratia* species in Panay Island, central Philippines

| | <i>Sonneratia alba</i> | <i>Sonneratia caseolaris</i> | <i>Sonneratia ovata</i> |
|-----------------------------------|---|--|---|
| Location | seaward: low to mid-intertidal, high salinity, associated with <i>A. marina</i> | low to mid-intertidal, along upstream rivers, low salinity, found with <i>N. fruticans</i> | high intertidal, back mangrove, almost freshwater, found with <i>N. fruticans</i> |
| Leaves | big rounded shape, thick, light green petiole | smaller, elliptical, thin, reddish petiole, end branches drooping | big, rounded, thin, light reddish petiole |
| Leaf L:W ratio^a | 1.1-1.5 | 1.9 | 1.3-1.4 |
| Flowers | white filaments and petals | filaments with red base and white tips, red petals | white filaments and petals |
| Fruits | smooth; calyx lobes reflexed or spread out | shiny; top-shaped with long style; calyx reflexed; fruit edible | large, smooth; calyx lobes appressed on fruit which is soft, edible |
| Seeds | large, U- to V-shaped, pointed | shape similar to, but ~¼ the size of <i>S. alba</i> | smaller, shaped like irregular granules |
| Pneumatophores | corky, 15-30 cm high | woody in older ones, tapering and pointed, up to 1 m long | corky, 15-30 cm long |

^a L - length, W - width

Family Sonneratiaceae

Sonneratia alba J. Smith

Local name: *pagatpat*



Pioneering species of medium to large trees that co-occur with *A. marina* in fringing mangroves, but are dominant in more coralline-sandy substrates. Leaves are obovate to rounded, but those of seedlings and lowermost branches ~1 m aboveground are more elongated (see opposite, bottom left photo). The short-lived white flowers open at dusk and drop at dawn – standing in a *Sonneratia alba* grove as numerous white filaments fall from the canopy with the early morning breeze is a magical experience. This species hosts colonies of fireflies – a northern Agusan settlement was called Masawa (now Masao), meaning bright, from the insects' sparkling lights that greeted seafarers on moonless nights. Likewise, the Spanish name of Siquijor Is. was Isla del Fuego, referring to the *pagatpat*-lined shore seemingly on fire. Past uses include housing construction materials, furnishing, and musical instruments. Due to salt content, woodwork required copper nails and screws.



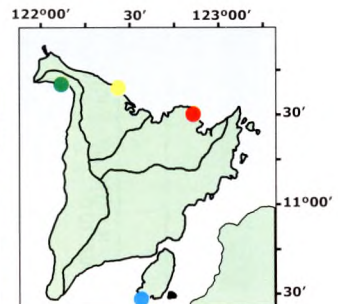
General

Substrate: coralline-sandy, muddy
 Tidal level: low
 Found with: *A. marina*,
Rhizophora spp.

Form

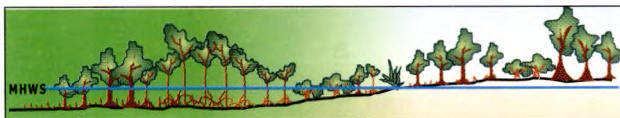
Shape: tree
 Height: 5-20 m
 DBH: 20-120 cm
 Bark: rough, brown; fissured
 and flaky
 Aerial roots: conical, corky
 pneumatophores

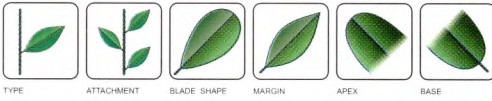
Sampling sites: ● Taklong Is., Guimaras
 ● Pan-ay, Capiz
 ● Kalibo, Aklan
 ● Pandan, Antique



FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

Arrangement: simple, opposite
 Blade shape: obovate to rounded
 Margin: entire - smooth
 Apex: round
 Base: round
 Upper surface: smooth, dark green
 Undersurface: smooth, light green
 Size: 8 (6-12) cm long,
 7 (3-11) cm wide
 Others: leathery, succulent, brittle



Flowers

Inflorescence: cyme, terminal
 Petals: 4-6, white, thin
 Sepals: 4-7 fused, green
 Stamens: 300+ white filaments,
 3-5 cm long
 Size: 5-7 cm long,
 6-9 cm diameter
 Others: long 5-6 cm style, light green



Fruits

Shape: rounded
 Color: dark green
 Texture: smooth
 Size: 3-4 cm high,
 3-5 cm diameter
 Others: contain many V- and U-shaped seeds (see inset)



Family Sonneratiaceae

Sonneratia caseolaris (L.) Engl.

Local names: *pedada*, *kalong-kalong*



Prominent trees on the muddy substrate of low salinity upstream riverbanks; closely associated with *N. fruticans*. *Sonneratia caseolaris* can be distinguished from *S. alba* (with which it forms hybrids) by bigger pneumatophores that reach 1 m long when mature, bright red flowers, and elongated leaves with reddish petioles. Like *S. alba*, fireflies are also found on *S. caseolaris*. Heavy fruits cause the drooping branches to bend some more (see opposite, bottom left photo). Pneumatophores are used as floats for fishing nets and as corks (hence the vernacular term *duol*). Branches are used as firewood, the leaves as forage for goats and cows, and the bark yields tannin. The slightly acidic fruit is eaten raw or added to soups for souring, or made into vinegar. In the past, the sap was applied to the skin as cosmetic; other uses, e.g., firewood and forage, are similar to *S. alba*.



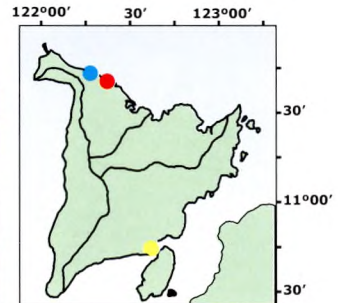
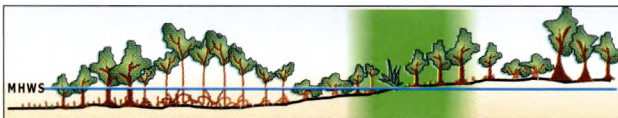
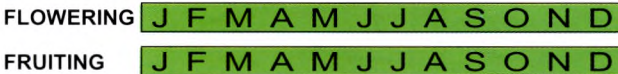
General

Substrate: muddy
Tidal level: high
Found with: *N. fruticans*

Form

Shape: tree
Height: 6-20 m
DBH: 15-50 cm
Bark: rough, light to dark brown; cracked (old); lenticellate (young)
Aerial roots: pneumatophores long, slender and pointed like a spear

Sampling sites: ● Ibajay, Aklan
● Makato River, Aklan
● Jaro, Iloilo





Leaves

Arrangement: simple, opposite
 Blade shape: elliptic
 Margin: entire - smooth
 Apex: acute
 Base: acute
 Upper surface: smooth, light green
 Undersurface: smooth, light green
 Size: 8 (6-12) cm long,
 4 (3-7) cm wide
 Others: thin, petiole base reddish,
 leaf twigs drooping



Flowers

Inflorescence: cyme, terminal
 Petals: 4-6, red, thin
 Sepals: 4-7 lobed, green
 Stamens: numerous (300+) filaments
 Size: 6-9 cm long,
 5-9 cm diameter
 Others: filaments with red base
 and white tips



Fruits

Shape: rounded
 Color: light green
 Texture: smooth, shiny
 Size: 2.8-4 cm high,
 4-8 cm diameter
 Others: sour-sweet smell when ripe,
 many seeds smaller than
S. alba (see inset)



Family Sonneratiaceae

Sonneratia ovata Backer

Local name: *pedada*

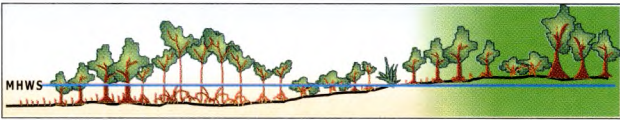


Shorter trees that grow on firm mud in almost freshwater habitats located considerable distances from the shore; closely associated with *N. fruticans*. Areas may have access to seawater through seepage during months of higher tide. The white flowers of *Sonneratia ovata* are similar to those of *S. alba*, but the filaments fall from the tree earlier in the morning before sunrise. Leaves are bigger and more rounded, and fruits are much larger than those of *S. alba* and *S. caseolaris*. Because their delicious sweet-sour taste is much appreciated by children and local folk, fruits are plucked from trees as soon as they mature, as in Pan-ay, Capiz (see opposite page, bottom left photo). Other differentiating characters are listed in Table 7.

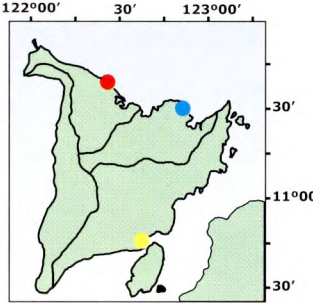


- General**
 Substrate: muddy
 Tidal level: high
 Found with: *N. fruticans*
- Form**
 Shape: tree
 Height: 5-10 m
 DBH: 15-30 cm
 Bark: rough, brown
 Aerial roots: conical pneumatophores

FLOWERING J F M A M J J A S O N D
 FRUITING J F M A M J J A S O N D



- Sampling sites:
 ● Pan-ay, Capiz
 ● Kalibo, Aklan
 ● Iloilo River, Iloilo





Leaves

Arrangement: simple, opposite
 Blade shape: round to ovate
 Margin: entire - smooth
 Apex: round
 Base: round
 Upper surface: smooth, dark green
 Undersurface: smooth, green
 Size: 9 (6-11) cm long,
 6 (5-9) cm wide
 Others: petiole base reddish



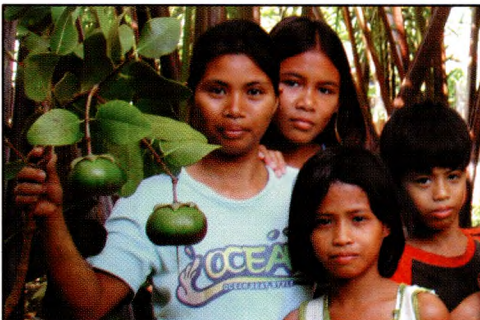
Flowers

Inflorescence: cyme, terminal
 Petals: white, thin
 Sepals: 5-6 lobed, thick, rough
 Stamens: numerous filaments,
 white (300+)
 Size: 6-8 cm long



Fruits

Shape: rounded
 Color: dark green
 Texture: smooth
 Size: 3-9 cm high,
 5-6 cm diameter
 Others: fleshy; sour-sweet smell
 when ripe; seeds are
 irregular granules larger
 than *S. caseolaris* (inset)



Family Rubiaceae

Scyphiphora hydrophyllacea Gaertn.

Local names: *bolaling, sagasa, hanbulali* (Negros), *nilad* (Tag.)



Shrubs with multiple stems to trees up to 10 m tall, on firm mud near tidal creeks or sandy mud near river mouths; tolerate high salinity. The small pinkish-white flowers occur in dense clusters; fruits are deeply grooved and turn brown when ripe. Leaves have a distinct glossy or varnished appearance. Young stems and petioles are reddish and succulent like the leaves, which have been successfully tested as forage for goats and other livestock. Like other mangroves, the branches provide homes for birds (see opposite page, bottom left photo). *Scyphiphora hydrophyllacea* grows in monospecific stands – it was so abundant along Manila Bay and the Pasig River in pre-Hispanic times that the natives called the place “Maynilad” referring to the presence of *nilad*, its local name.



General

- Substrate: sandy, muddy
- Tidal level: middle, high
- Found with: *C. decandra, C. tagal, L. littorea, O. octodonta*

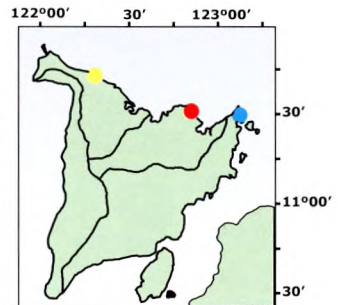
Form

- Shape: shrub, tree
- Height: 2-10 m
- DBH: 5-20 cm
- Bark: smooth, light brown
- Aerial roots: surface

- Sampling sites:
- Carles, Iloilo
 - Pan-ay, Capiz
 - Tangalan, Aklan

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

Arrangement: simple, opposite, decussate
 Blade shape: obovate
 Margin: entire - smooth
 Apex: round
 Base: acute
 Upper surface: waxy, dark green
 Undersurface: waxy, light green
 Size: 7 (5-10) cm long,
 4 (3-6) cm wide
 Others: succulent, pointing upward,
 reddish petiole and stems



Flowers

Inflorescence: cyme, axillary
 Petals: 4, whitish pink
 Sepals: 4, fused
 Stamen: 4, brown
 Size: 0.6-1.5 cm long,
 0.6-0.8 cm diameter
 Others: 15-20 flowers per cluster



Fruits

Shape: barrel-like, with longitudinal ridges
 Color: light green to brown
 when mature
 Texture: smooth
 Size: 0.7-0.9 cm long,
 0.3-0.7 cm diameter



Family Meliaceae

Xylocarpus granatum Koen.

Local names: *tabigi*, *tambigi*



Medium trees up to 17 m tall, found along estuarine rivers and tidal creeks, whose low buttresses extend as distinctive, snakelike plank roots. *Xylocarpus granatum* is also found in higher intertidal, inner mangroves as part of a mixed community that includes, among others *X. moluccensis*, *C. decandra*, and *B. cylindrica*. It has compound leaves which are shed in some trees, and big brown globose fruits with 10-12 irregularly shaped seeds. The smooth, light brown to greenish outer bark flakes off (see opposite, bottom left photo); the inner bark is red and a source of dye for tanning. Oil from seeds is used for lamps and for grooming hair, the fruits and seeds are used to treat diarrhea, and a bark decoction for cholera. Described as the best and most beautiful cabinet wood, its fine, glossy texture is suitable for furniture. It was also used for poles, railroad ties, posts and beams.



General

Substrate: hard mud
 Tidal level: middle
 Found with: *B. cylindrica*,
N. fruticans,
X. moluccensis

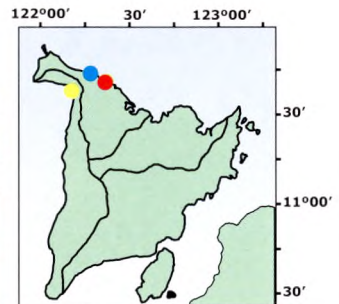
Form

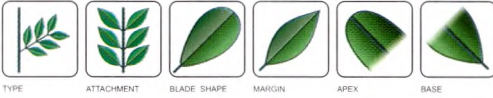
Shape: tree
 Height: 3-17 m
 DBH: 10-70 cm
 Bark: smooth, light brown;
 thin flakes
 Aerial roots: low buttresses, plank
 or ribbon

Sampling sites: ● Ibajay, Aklan
 ● Makato River, Aklan
 ● Pandan, Antique

FLOWERING J F M A M J J A S O N D

FRUITING J F M A M J J A S O N D





Leaves

- Arrangement: paripinnate compound, opposite
- Blade shape: obovate
- Margin: entire - smooth
- Apex: round to emarginate
- Base: acute
- Upper surface: smooth, dark green
- Undersurface: smooth, light green
- Size: 12 (7-19) cm long,
6 (4-9) cm wide
- Others: 2-3 pairs of leaflets;
sometimes deciduous



Flowers

- Inflorescence: panicle, axillary (a few terminal)
- Petals: 4, white
- Calyx: 4, lobed, yellowish green
- Stamen: tubular
- Size: 1.1-1.2 cm long,
1.1-1.4 cm diameter
- Others: unisexual



Fruits

- Shape: like cannon ball or bowling ball
- Color: green to brown
- Texture: smooth to slightly rough
- Size: 8-13 cm high,
8-14 cm diameter
- Others: 10-12 irregularly-shaped seeds



Family Meliaceae

Xylocarpus moluccensis (Lam.) M. Roem.

Local names: *piagao, lagutlot*



Smaller trees on the firm substrate of back mangroves rarely appearing along the edges of rivers or creeks; they are also identified as *X. mekongensis*. Their low-salinity habitats overlap with those of *X. granatum*, but *X. moluccensis* has smaller pointed leaves; dark, rough and fissured bark; peg- or cone-shaped pneumatophores; and smaller, dark green fruits. The species is deciduous – the leaves turn golden brown to red then drop (see opposite, bottom left photo); the new leaves appear together with the short-lived flowers. Seeds were used for insect bites, diarrhea and as astringent, the fruits for diarrhea, and the bark as astringent. Past uses of the wood were as poles, railroad ties, posts, beams and for interior finish, musical instruments and high grade furniture. The royal throne of the king of Malaysia is made of *X. moluccensis* wood because of its fine grain and deep dark color.



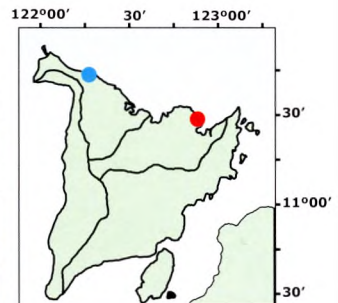
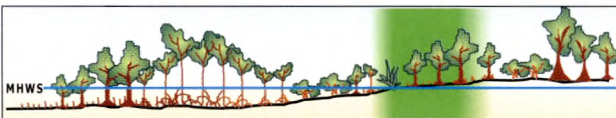
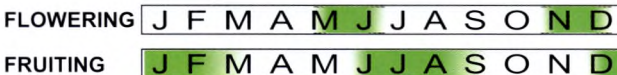
General

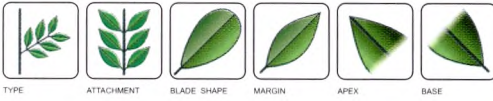
Substrate: hard mud
Tidal level: middle
Found with: *B. cylindrica*,
N. fruticans,
R. apiculata,
X. granatum

Form

Shape: tree
Height: 3-10 m
DBH: 10-50 cm
Bark: rough, dark brown;
fissured
Aerial roots: cone or peg roots
arising from cable roots

Sampling sites: ● Ibajay, Aklan
● Pan-ay, Capiz





Leaves

- Arrangement: paripinnate compound, opposite
- Blade shape: elliptical
- Margin: entire - smooth
- Apex: acute
- Base: acute
- Upper surface: smooth, green
- Undersurface: smooth, light green
- Size: 8 (5-12) cm long, 4 (2.5) cm wide
- Others: usually with 3-4 pairs of leaflets; deciduous

Flowers

- Inflorescence: panicle, mainly axillary
- Petals: 4, white
- Calyx: 4, lobed, pale yellow-green
- Stamen: fused, white
- Size: 0.6-0.7 cm long, 0.9-1.0 cm diameter
- Others: unisexual

Fruits

- Shape: like small cannon ball
- Color: light green
- Texture: smooth to slightly rough
- Size: 8-9 cm high, 9-10 cm diameter



IMPORTANCE OF MANGROVES



Fringing mangroves and beach forests such as in Nogas Is., Aniniy, Antique (top) form a buffer zone that protects coastal areas from destructive typhoons; loss of such greenbelt has eroded 40 meters from the coastline of Naisud, Ibabay in Aklan (bottom).

Over the centuries, mangrove ecosystems have provided a variety of goods and services to coastal communities and the larger society. They form a protective buffer zone, stabilize sediments, reduce shoreline and riverbank erosion, regulate flooding, and recycle nutrients. Particularly important is coastal protection because 20-30 destructive typhoons visit the country yearly. For example, the fringing mangrove-beach forest near the mouth of Naisud River in Ibabay, Aklan has been cleared to build settlements and coconut plantations. This has made the shoreline vulnerable to storms and monsoon winds, pushing it back by 40 meters in the last 30 years. Coastal dwellers have survived the strong waves of typhoons and *tsunamis* by clinging to nearby *Avicennia* and *nipa*

plants. Similarly, Tangalan, Aklan oldtimers tell stories of hiding among mangroves to escape the enemy during World War II.

To these roles may be added the information function which refers to religious, cultural and historical aspects. The country's premier city of Manila, or Maynila, owes its name to the species *Scyphiphora hydrophyllacea*, locally called *nilad*, which grew abundantly along Manila Bay and the Pasig River in pre-Hispanic times. Numerous towns and villages all over the islands are named after mangroves and their associates (Table 8). This indicates the wide distribution and diversity of these plants in times past.

TABLE 8

Some cities, towns, villages and other places in the Philippines
named after mangrove species and their associates

| Genus/species (local name) | Place |
|---|---|
| <i>Rhizophora</i> spp. (bakhaw) | bakhawan (general term) |
| <i>Ceriops tagal</i> (tungog) | katunggan (general term) |
| <i>Avicennia marina</i> , <i>A. alba</i> (piapi) | Piapi Beach, Dumaguete City |
| <i>Barringtonia</i> spp. (bulubituon) | Bitoon, Jaro, Iloilo City |
| <i>Calophyllum inophyllum</i> (dangcal) | Dangcalan, Tangalan, Aklan |
| <i>Excoecaria agallocha</i> (lipata) | Lipata, Culasi, Antique Lipata, Bacacay, Albay Lipata, Surigao City |
| <i>Heritiera littoralis</i> (dungon) | Dungon, Jaro, Iloilo City |
| <i>Hibiscus tiliaceus</i> & <i>Thespesia populnea</i> (balabago) | Balabago, Jaro, Iloilo City |
| <i>Lumnitzera racemosa</i> (culasi, tabao) | Culasi, Antique Culasi, Ajuy, Iloilo Tabao, Buenavista, Guimaras Taba-ao, Sagay, Negros Occidental Matabao, Buenavista, Agusan del Norte Matabao, Siquijor |
| <i>Nypa fruticans</i> (nipa, sapsap, sasa) | Casapsapan, Aurora Canipaan River, Palawan |
| <i>Rhizophora</i> spp. (bakhaw) | Bakhaw, Jaro, Iloilo City Bakhaw, San Joaquin, Iloilo Bacjauan (old name for Concepcion), Iloilo |
| <i>Scyphiphora hydrophyllacea</i> (nilad) | Maynilad (now Manila) |
| <i>Sonneratia</i> spp. (pagatpat/pedada) | Pagatpatan, Jasaan, Misamis Oriental Pedada Bay, Ajuy, Iloilo |

Fish resources provide the greatest (65%) and cheapest form of dietary protein in the Philippines, an archipelago of 7,150 islands bordered by a long ~36,300 km coastline where more than half of the country's 1,500 municipalities and 42,000 villages are located. Fisheries products from mangroves which include fish, prawns, shrimps and crabs harvested by fishermen are important for food security and income. When the tide goes out, children and women glean for



The highly prized mangrove clam *imbao* (inset) provides substantial income to gleaners, mostly women, in Mambuquiiao, Capiz (left); other mangrove products are wood for furniture (center) and shrimps (right).

mollusks and other sedentary invertebrates in intertidal mudflats. Harvested deep below the surface, the mangrove clam *Anodontia edentula*, locally known as *imbao*, is relished for its delicious meat and reputed aphrodisiac properties. Another mollusk delicacy is the shipworm (*tamiluk*) belonging to Family Teredinidae, which bores into decaying wood of *Rhizophora* and *Avicennia* trees.

Forest products include firewood, tanbark and timber used for dwellings, construction, fences, furniture, boats and fishing poles. Minor products are fibers, ropes, corks, floats, mats and paper. Before the Spanish came in 1521, Filipinos actively traded in Southeast Asia, crossing the South China Sea in boats called *balanghais* which measured up to 15 meters long and 3 meters wide, and carried 60-90 persons. Nine of these boats, some dating back to 320 A.D. based on the

carbon-14 method, were excavated in Agusan del Norte, a major barter and gold panning area in northern Mindanao. The *balanghais* were constructed by joining planks, rather than using single trees, of *dungon* (*Heritiera littoralis*); the same mangrove wood was used for house posts and coffins.

In the early 1900s, thousands of hectares around Manila Bay were planted with *Rhizophora* spp. (*bakhaw*) for firewood, and *nipa* palm for roof shingles and alcohol production. *Bakhaw* was cultivated to replace the natural stands depleted by firewood collection near populated centers. Sited in the soft mud near rivers, the preferred



FROM MABUHAY MAGAZINE (1988)

Built by seafaring pre-Hispanic Filipinos, the 15-m long *balanghais* used planks of mangrove *dungon* (*Heritiera littoralis*) wood – as excavated from a swamp in Agusan del Norte, Mindanao.

Plantation species was *R. apiculata* because of its straight stems and more readily available seeds. *R. mucronata* has faster growth rates but crooked trunks. One hectare of 7-yr old trees could give a profit of 32% on PhP831 gross sales minus PhP515 costs for planting, harvest and selling. Products included firewood or *rajitas* (four different grades according to size), poles (from plant tops) for growing pepper, and charcoal (from joints and other rough pieces).

The palm *Nypa fruticans* is very versatile. The leaflets are made into fans or thatch used for roofing and walls of rural houses. The endosperm is served fresh or cooked as sweetmeats, and the sap is made into tuba, a local drink which may be fermented further into vinegar, wine or alcohol. Plants are harvested either for leaves or sap. Leaves can be harvested at three years (one ha yields 14,000 to 16,000 leaves per year) but sap collection requires 4-yr old palms (each yielding

TABLE 9
Medicinal uses of Philippine mangroves

| Species | Uses |
|-----------------------------------|---|
| <i>Acanthus</i> spp. | dried flowers boiled and water drunk to relieve cough |
| <i>Avicennia alba</i> | bark as astringent; resinous secretion for birth control; ointment from seeds for smallpox ulceration |
| <i>Avicennia marina</i> | smoke of dried branches as mosquito repellent |
| <i>Avicennia officinalis</i> | fruits as astringent; seeds and roots as poultice to treat ulcers |
| <i>Bruguiera sexangula</i> | roots and leaves for burns; leaves have tumor-inhibiting alkaloids; fruits chewed as substitute for betel nut; lotion made from fruits to treat sore eyes |
| <i>Ceriops tagal</i> | bark infusion for obstetric and haemorrhagic conditions, e.g. ulcers; dried bark chewed by old folks |
| <i>Excoecaria agallocha</i> | leaves for epilepsy; sap for ulcers and toothache; twigs as pest repellent |
| <i>Heritiera littoralis</i> | seed extract for diarrhea and dysentery |
| <i>Lumnitzera littorea</i> | leaf decoction for thrush in infants |
| <i>Rhizophora</i> spp. | pounded bark placed on skin to relieve jellyfish sting; bark decoction used to wash jellyfish before eating, and for scabies and skin infection |
| <i>Scyphiphora hydrophyllacea</i> | decoction of leaves used in folk medicine |
| <i>Sonneratia caseolaris</i> | sap as skin cosmetic |
| <i>Xylocarpus granatum</i> | seed oil used for lamps and grooming hair; fruits and seeds for diarrhea; bark decoction for cholera |
| <i>Xylocarpus moluccensis</i> | seeds for insect bites and diarrhea; seeds and bark as astringent |



Mangroves – from turn-of-the-century *Rhizophora* plantations (top) to *Avicennia marina* branches from natural stands at present (bottom) – provide domestic firewood to low-income households.

an average of 43 liters per season). Before the fruit is cut off, the stalk is kicked or bent to loosen crystal-like deposits that block the flow of sap. Sap flowing from the cut stalk is collected daily and fermented into *tuba* or vinegar. In the 1800s, huge vats containing the collected sap were transported by boat to alcohol distilleries. Each hectare of *nipa* could produce 6,500-10,200 liters of alcohol yearly and over 85% of the proof alcohol production at this time came from *nipa* plants.

The importance of mangrove barks to early Filipinos can be seen from the amount on which forest charges were paid: 3,165,687 kg of tanbark in 1917 and 148,764 kg of dye bark in 1918. Many mangrove species yield tannins and dyes but the superior quality of *C. tagal* tanbark, and its wide distribution in the past, give mangroves their local generic name *katunggan* (from *tungog* or *C. tagal*) in the Visayas and Mindanao. The other common name of mangroves is *bakhawan*, referring to *Rhizophora* species. The Bohol-based *tungog* collecting industry consisted of 100 sailboats, the biggest of which could load 6,000 kg of dried tanbark collected from Zamboanga, Surigao, Polilio Is. and other parts of the archipelago. A soluble dye powder called *tungog* or *baluk*, extracted from the dried bark, is used as retardant in preparing *tuba* from fermented coconut or *nipa* sap. In the absence of *C. tagal*, the bark of *Rhizophora* spp. is used, but drinks prepared this way often cause diarrhea. This powder was widely used for tanning leather and dyeing fish nets made of cotton before the arrival of nylon nets.



Thatch or shingles from *nipa* palm leaflets are sold as inexpensive roofing for rural houses, but demand has transformed mixed mangrove communities to mono-culture *nipa* plantations.



Ceriops tagal (a) is a back mangrove species whose bark (b) is boiled and dried to produce a reddish-brown powder called *baluk* or *tungog* (c) which is used to dye fish nets and clothes, and also as retardant in processing coconut sap (d) into *tuba* (c).

Continuous exploitation in the 1930s to 1950s wiped out most of the *C. tagal* stands, except in Palawan. But even these are harvested illegally for tanbark smuggled to Zamboanga and Malaysia for soft drinks and *batik* making. In the village of Naisud in Ibajay, Aklan, a small plantation of *C. tagal* has been maintained for over 20 years now by planting of propagules and cutting of alternate sections once the trees are 5-6 m tall.

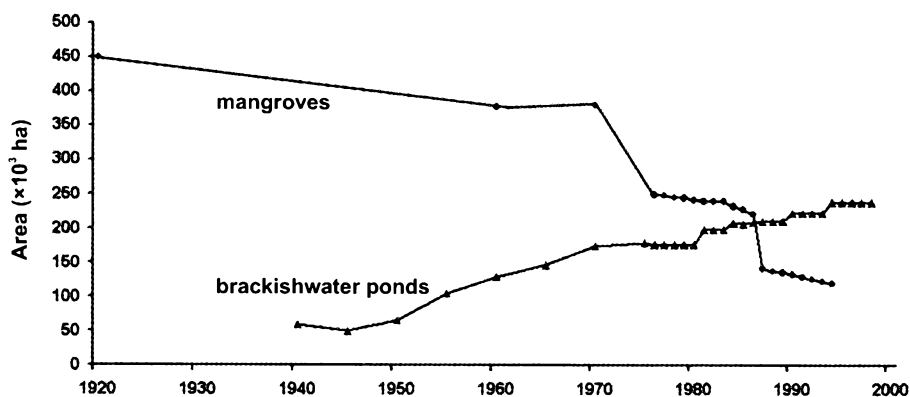
Mangrove plants also yield honey and vegetables. The fruits of *Sonneratia caseolaris* and *S. ovata* are eaten by coastal folk, as are leaves and stems of the mangrove herb *Sesuvium portulacastrum*. The young leaves of *A. marina* and *R. apiculata* are given as forage to cows and pigs. Salt-laden leaves of *A. officinalis/A. rumphiana* and *Aegiceras*, and *S. caseolaris* fruits are thrown into a pot of soup for seasoning. Mangrove extracts have been found to contain glues, steroids, alkaloids, flavonoids, saponins and polyunsaturated fatty acids. The leaves, branches, fruits, seeds, bark and roots of *Avicennia*, *Bruguiera*, *Xylocarpus*, and other mangroves have been used as medicine, astringent, insect repellent and cosmetic (Table 9). The Arab pharmacopoeia was so rich that the naturalist Linnaeus named the most widely distributed mangrove genus *Avicennia*, after the famous Arab doctor Abu-bin-Sinna (M. Vannucci, personal communication).

MANGROVE DECLINE AND LEGISLATION

Mangroves cover some 18 million hectares worldwide, of which 38% are found in Asia. The Philippines had at least half a million hectares in the early 1900s, but the National Forest Resource Inventory estimated only 139,100 ha remaining in 1988. It should be noted that all post-1987 mangrove statistics published by the DENR are based on a model rather than actual surveys.

Among the major marine ecosystems in the Philippines, it is mangroves that have suffered the earliest and greatest degradation because of their relative accessibility to humans. Over-exploitation by coastal communities for domestic fuelwood and by companies for commercial charcoal and timber are causes of mangrove decline. So is conversion to agriculture, salt ponds, urban development and industry, harbor and channel construction and mining. Even replacement by monoculture *nipa* plantations has reduced the area of natural mangroves. However, the greatest mangrove loss has been due to the large-scale development of milkfish culture ponds at 4,000-5,000 ha/yr in the 1950s and 1960s with government incentives in the form of loans. About 50% of the 279,000 ha of mangroves lost from 1951 to 1988 were converted into aquaculture ponds. Conversely, 95% of brackishwater ponds in the same period were derived from mangroves.

Another widespread mechanism by which mangroves have been lost from the public domain is when local residents or even outsiders stake their claim to an area by paying land taxes. These claims are handed down to family members or "sold" to other persons; an interested party with sufficient funds can have the



The intertwined histories of Philippine mangroves and brackishwater (milkfish) ponds show aquaculture to be a major factor in mangrove decline (after Primavera, 2000a).

TABLE 10**Philippine laws on mangrove jurisdiction, zoning and fishpond conversion**

| | |
|--------------------------|---|
| BFD Cir. 95 (1952) | Zoning of swamplands for various uses |
| Fisheries A.O. 60 (1960) | Definition and regulation of Fishpond Lease Agreement (FLA) |
| PD. 43 (1972) | Transfer to BFAR of public lands for fishpond development |
| PD. 704 (1975) | Fisheries Code: policy of accelerated, integrated fishpond development; set conditions for mangrove conversion to ponds; public lands for fishponds can only be leased, not owned |
| PD. 705 (1975) | Revised Forestry Code: Defined public lands for fishponds, to be placed under BFAR |
| MNR S.O. 309 (1976) | Creation of National Mangrove Committee (NMC) to formulate national mangrove plan, review pond and timber license applications |
| MNR S.O. 309 (1978) | Reorganization of NMC in line with new emphasis on ecological importance of mangroves, including rehabilitation of degraded areas |
| BFAR A.O. 125 (1979) | Conversion of fishpond permits and 10-year Fishpond Lease Agreement (FLA) to 25 years (to accelerate pond development) |
| DA A.O. 15 (1981) | Guidelines on cancelled, expired FLAs |
| MNR A.O. 3 (1982) | Revision of guidelines in classification and zoning of forest lands |
| E.O. 192 (1987) | DENR Reorganization Act: Mangroves and swamplands in public forests placed under DENR |
| R.A. 6657 (1988) | Exemption of fishpond areas from Comprehensive Agrarian Reform Law for 10 years |
| DENR A.O. 7 (1989) | Suspension of mine applications, issuance of mine prospecting permits in government reservations including mangrove areas |
| R.A. 7160 (1991) | Local Govt. Code: Devolved management/implementation of community forestry projects, communal forests <500 ha, enforcement of community-based laws to local government |
| BFAR A.O. 125-1 (1991) | Increase in fishpond lease fee from US\$2 to US\$40/ha per year effective 1992 |
| BFAR A.O. 125-2 (1991) | Full implementation of A.O. 125-1 delayed |
| R.A. 7881 (1995) | Fishpond exemption from agrarian reform extended |
| DENR A.O. 17 (1998) | Defined fishpond conversion as major cause of mangrove deforestation; prohibited further zonification and release for pond development of already zonified forests |
| BFAR FAO 197 (2000) | FLA annual rental set at PhP500/ha starting year 2000, increased by PhP100 yearly until it reaches PhP1,000/ha in 2004 |

Abbreviations: A.O. = Administrative Order, BFAR = Bureau of Fisheries and Aquatic Resources, BFD = Bureau of Forest Development, DA = Department of Agriculture, DENR = Department of Environment and Natural Resources, E.O. = Executive Order, FAO = Fisheries Administrative Order, MNR = Ministry of Natural Resources, PD. = Presidential Decree, PhP = Philippine peso, R.A. = Republic Act, S.O. = Special Order



area declared A&D (alienable and disposable) for eventual issuance of title. To raise much-needed revenue, local governments accept these tax payments in clear violation of laws that protect mangroves.

The earliest legislation pertaining to mangroves established criteria for zoning forests into different uses and the corresponding administrative agency (Table 10). Hence forests remained with the Forestry Bureau of the Ministry of Natural Resources or MNR (later renamed the Department of Environment and Natural Resources) while sites considered for fishpond construction came under the jurisdiction of the Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture (DA). At the same time, guidelines were being put in place for mangrove development into fishponds as the government embarked on a policy of aquaculture promotion (Table 10). Numerous laws protecting mangroves and requiring the retention or replanting of a mangrove greenbelt or buffer zone along waterways were promulgated during the pro-conservation decades of the 1970s-80s (Table 11). As hundreds to thousands of

FROM TRANSPARENCY BY VIC MANCEBO

Despite blanket protection of mangroves by various laws, illegal conversion to ponds and other uses continues to this day in Zarraga, Iloilo (top) and Ibajay, Aklan (center); aerial view (bottom) shows non-compliance with the required 20-100 m greenbelt or buffer zone.

hectares of ponds have been unutilized or abandoned, the government has mandated their rehabilitation or reversion back to mangrove forest (Table 12). Legal property instruments such as renewable 25-year Community Forest Management Agreements and Mangrove Stewardship Agreements (Table 12) allow selective harvest of mangrove products for livelihood, thereby encouraging

TABLE 11

Philippine laws on mangrove protection

| | |
|-------------------------|---|
| PD. 705 (1975) | Revised Forestry Code: retention (and exclusion from pond development) of 20 m-wide mangrove strip along shorelines facing oceans, lakes, etc. |
| PD. 953 (1976) | Fishpond/mangrove leaseholders required to retain or replant 20-m mangrove strip along rivers, creeks |
| PD. 1067 | 3 to 20 m of riverbanks, seashore for public use: recreation, navigation, floatage, fishing and salvage; building of structures not allowed |
| PD. 1586 (1978) | Environmental Impact Statement (EIS) system covering resource extractive industries (such as fishponds) |
| BFD A.O. 2 (1979) | Minimum 25% of total mangrove forest in any given area declared completely protected as Mangrove Wilderness Areas |
| PP 2151 & 2152 (1981) | Declaration of 4,326 ha of mangroves as wilderness areas and 74,767 ha (including entire Palawan province) as forest reserves |
| PP 2146 (1982) | Prohibition on mangrove cutting throughout country |
| BFD Cir. 13 (1986) | Processing of applications prohibited for mangrove lands which are part of forest lands |
| MNR A.O. 42 (1986) | Expansion of mangrove belt in storm surge, typhoon areas: 50-100 m along shorelines, 20-50 m along riverbanks |
| DENR A.O. 76 (1987) | Establishment of buffer zone: 50 m fronting seas, oceans and 20 m along riverbanks; leases of ponds under FLA required to plant 50-m mangrove strip |
| L.O.I. 917 | Mangrove forests declared essential to foreshore protection, maintenance of estuarine and marine life |
| DENR Mem. Cir. 5 (1990) | Guidelines on mangrove cutting inside approved FLA areas |
| DENR Mem. Cir. 7 (1991) | Mangrove cutting in FLA area prohibited if $\leq 10\%$ canopy cover and/or capable of natural regeneration |
| R.A. 7161 (1991) | Ban on cutting of all mangrove species |
| DENR A.O. 34 (1991) | Guidelines for Environmental Clearance Certificate (applicable to fishponds) |
| DENR A.O. 21 (1992) | Implementing guidelines for EIS |
| DENR A.O. 13 (1992) | Same as MNR A.O. 42 (see above) |
| DENR A.O. 16 (1993) | Guidelines for establishment of buffer zones in protected areas |

Abbreviations: L.O.I. = Letter of Instruction, PP = Presidential Proclamation; see Table 10 for others

TABLE 12

Philippine laws on mangrove use, tenure, and rehabilitation

| | |
|--------------------------|---|
| DENR A.O. 77 (1988) | Implementing guidelines of Integrated Social Forestry Program (incentives for co-management of forest resources through provision of legal tenure) |
| DENR Mem. Cir. 15 (1989) | Implementation of reforestation for mangrove rehabilitation and diversity prioritized |
| DENR A.O. 123 (1990) | Award of 25-yr Community Forestry Management Agreement for small scale utilization of mangroves, establishment of <i>Rhizophora</i> and <i>Nypa</i> plantations, aquasilviculture activities |
| DENR A.O. 15 (1990) | Policies on communal forests, plantations, tenure through Mangrove Stewardship Contracts; revert abandoned ponds to forest; ban cutting of trees in FLA areas; prohibit further conversion of thickly vegetated areas |
| DENR A.O. 3/9 (1991) | Policies and guidelines for Mangrove Stewardship Agreement |
| DA-DENR M.O. 3 (1991) | Guidelines for FLA cancellation; mangrove areas released to BFAR but not utilized or abandoned 5 years from release to be reverted to forest land under DENR administration |
| DENR A.O. 6 (1992) | Reversion to forest land category of portions of Bohol mangroves declared Alienable and Disposable for ponds |
| E.O. 263 | Community-Based Forest Management (CBFM) adopted as national strategy for sustainable development of forests |
| DENR A.O. 23 (1993) | Combined 3-yr Mangrove Reforestation Contract and 25-yr Forest Land Management Agreement into new 25-yr FLMA for families (1-10 ha) and communities (10-1,000 ha) |
| DENR A.O. 30 (1994) | Community-Based Mangrove Forest Management; NGO assistance |
| R.A. 8550 (1998) | Reforestation of riverbanks, seashore, etc. fronting fishponds; reversion of abandoned, underdeveloped or under-utilised ponds to mangroves |

Abbreviations: M.O. = Memorandum Order; see Tables 10 and 11 for others

community participation and local responsibility, and ensuring sustainability of mangrove rehabilitation. This grant of tenure has been critical in the success of community-based mangrove replanting programs by legitimizing the *de facto* management of coastal resources by local communities. Therefore legislation that conserves, protects, and rehabilitates Philippine mangroves has not been wanting – it is their implementation that is absent or generally weak.

MANGROVE CONSERVATION

Three “success stories” of mangrove conservation in the provinces of Negros Occidental and Quezon are noteworthy, given the poor enforcement of mangrove laws. In Sagay City, Negros Occidental a local court declared null and void the title to 627 ha of primary mangrove forests held by the relative of an associate of then Pres. Marcos because the area was classified as timberland. Reaffirmed by a higher court and the Supreme Court in 1988, the decision could not be enforced by the DENR even with military back-up because armed guards patrolled the area, by then developed into ponds. Despite many reversals over three decades of litigation, the perseverance of a private citizen (who grew up among these mangroves) and the 2000 ruling of the Office of the President to enforce the decision of the courts saved the Bulanon, Sagay City mangroves. Thousands of fruit bats now roost on *Sonneratia alba* trees in this forest. The mangroves of Bais, Negros Occidental illustrate the political will of local officials in conserving the environment. When Mayor Francisco (Boy) Villanueva took office in 1992, he initiated a ban on the use of mangroves as fuelwood. Those who cut and sold mangrove wood and used dynamite for fishing were apprehended. With the subsequent return of many dolphin and whale species to Tañon Strait separating Negros from Cebu, ecotourism activities have been developed that include snorkelling among seagrass beds and coral reefs, and visiting the mangroves.

In the village of Binulasan, Infanta in Quezon Province during the year 2000, the secondary mangrove growth in a 15-ha abandoned



ROMEO BUENDIA

Spanning 35 years, the legal tug-of-war over these 600-ha Bulanon, Sagay, Negros Occid. mangroves (roosting place of hundreds of bats) is a classic in environmental jurisprudence.



Successful protection of the 200-ha Talabong Mangrove Forest Reserve in Bais Bay, Negros Occid. demonstrates political will in local governance.



Treehouses such as this one, built jointly by the local government of Bugtong Bato, Ibajay, Aklan and SEAFDEC/AQD, offer a refreshing view of the mangrove forest canopy.



Mangrove wetlands are NOT wastelands for throwing garbage!!!

pond was cleared despite the pending status of the fishpond lease application of a former Metro Manila mayor. Village and town officials asked the applicant to stop the clearing and petitioned the national DA and DENR offices to deny the pending application, prosecute violations of mangrove laws, and rehabilitate the area to mangroves. Despite a cease-and-desist order from the DENR, pond development proceeded. Fishers were alarmed at the threat to mangroves whose yields of fish and shellfish helped mitigate their “seasonal poverty” during the typhoon-prone *amihan* or northeast monsoon. Supported by local church and government officials, police and navy personnel, NGOs and POs, thousands of villagers stopped construction work and demolished dikes. Because of widespread print, radio and television coverage, the BFAR rescinded its earlier conditional permit and rejected the application. Despite later appeals all the way to the Office of the President, such rejection was sustained. Local groups have applied for a Community-Based Forest Management Agreement and started to plant mangrove seedlings in the site. Aside from communities, schools have come up with creative conservation strategies -- Mr. and Ms. Aklan State University in New Washington, Aklan are selected on the basis of mangrove propagules, rather than votes, collected.

MANGROVE-FRIENDLY AQUACULTURE

Philippine mangroves may be classified as: Protected Forest for the preservation of pristine forests for biodiversity and scientific studies; Rehabilitation Forest for degraded areas including abandoned culture ponds; and Production Forest for the conservation, responsible development and management of remaining mangrove areas. Production Forest can be useful for sustained forestry and fisheries yields, the latter option including mangrove-friendly aquaculture or aquasilviculture that integrates the rearing of aquatic organisms and maintenance of healthy mangrove trees.

Mangroves and aquaculture can be compatible because some technologies do not require mangrove clear-cutting. Examples are the farming of seaweeds, bivalves like mussels, oysters, and crab/fish cages in waterways, and the culture of crabs and fish in land-based ponds and pens. These technologies are amenable to small-scale, family-based operations. Local communities in Iloilo and Capiz grow the alga *Gracilariopsis heteroclada* on longlines in mangrove waterways and mudflats.

Fattening (duration of 2 weeks or less) and grow-out of mud crabs *Scylla olivacea*, *S. tranquebarica*, and *S. serrata* in pens and cages can be profitable. Operators of 15-25 cu m cages for fattening in Altavas, Aklan earned net profits of ~PhP3,500 per cage per week in early 2000. Nevertheless, the use of low-value fish (also

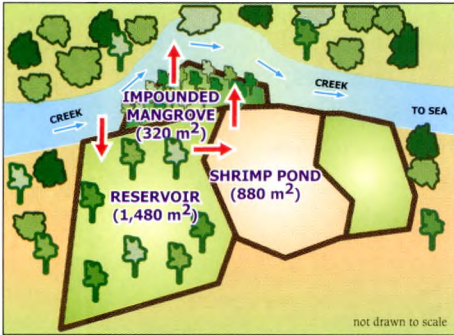


ANNE HURTADO

Commercially important seaweeds of the *Gracilaria* group cultured in mangrove waterways are a source of agar used in the food and pharmaceutical industries.



SEAFDEC/AQD research on mudcrab (inset) culture inside mangrove pens aims to replace dietary fish biomass with low-cost pellets.



ROMEO BUENDIA

To integrate mangroves with aquaculture (top), creek water conditioned in a reservoir then used in a shrimp pond is passed through mangroves to absorb excess nutrients prior to release; shrimp harvest (bottom).

called trash fish) to feed crabs deprives low income groups of an important source of protein. The SEAFDEC/AQD is therefore testing low-cost formulated pellets and waste products such as slaughterhouse discards and *copra* (dried coconut) meal byproducts to replace raw fish, in trials on mud crab culture in mangrove pens. The pens are carefully constructed to avoid cutting roots and changing tidal water flow, both of which can damage or even kill the mangrove trees. Another research study addresses the problems of intensive aquaculture by passing shrimp pond effluents through natural or planted mangroves. Excess nutrients are absorbed by the mangrove flora, as seen in their increased biomass, and the drain water is cleaned up prior to release back to the waterways.

Miracle holes, locally called *amatong* or *atub*, also provide villagers fish for home consumption or for sale. More of fisheries than aquaculture, these intertidal excavations are filled with rocks and big branches that serve as homes for *danggit*, *lapulapu* and *alimango* (siganids, groupers and crabs) which are harvested at 1-3 month intervals.



Fish and crabs seek shelter among rocks and branches inside miracle holes (*atub*) adjoining mangroves and are regularly harvested by Malhiao villagers in Badian, Cebu.

MANGROVE REHABILITATION

Rehabilitation of abandoned ponds and other damaged sites should be done naturally by restoring tidal flow to allow entry of propagules. If natural recruitment in an area fails due to factors such as lack of mother trees, then active planting should be considered. Replanting projects should follow biophysical criteria, e.g., suitable species, sites and seasons, to avoid high mortality rates. *Rhizophora* should not be planted in what are clearly native *A. marina*-*S. alba* zones; neither should mangroves be planted in existing seagrass beds, no matter how degraded the latter are. The thriving mixed *A. marina*-*S. alba* stand planted in 1989 in Latasan, Pan-ay, Capiz (Table 13) demonstrates the use of naturally abundant species. In 1984 when Typhoon Undang struck Latasan, 186 villagers died; others survived by clinging to the few remaining *A. marina* trees. Local people therefore welcomed the mangrove project proposed by then Mayor (now Governor) Vicente Bermejo for funding by the Asian Development Bank and the Overseas Economic Cooperation Fund (OECF) of Japan. Twenty hectares of degraded coastline were planted with *A. marina* and *S. alba* by the community. The success of this mangrove project can be attributed to the close coordination among the local government unit, national agencies with DENR as implementing body, and NGOs. The local people protected the young plants through their growing years.

The same formula for success applies to the New Buswang, Kalibo plantation in Aklan which won the national *Galing Pook* Award in 1996 and the 2003 Award for Excellence in Forest Management in the Asia-Pacific Region from the U.N. Food and Agriculture Organization. The Buswang Mangrove Reforestation Project was initiated in 1989 by then Kalibo Mayor Allen Quimpo with technical assistance from provincial and national DENR offices, and OECF funding. Planted by the people's group KASAMA (Table 13), the thriving mangroves have stabilized



Avicennia marina seedlings (left) reflect the dominance of this species in fringing mangroves; well-meaning but ecologically unsound mangrove projects, as in Nogas Is., Aniniy, Antique (right), plant *Rhizophora* seedlings on seagrass beds and/or natural *S. alba*-*A. marina* habitats.



Pioneers of KASAMA (top), the community organization responsible for the success of the New Buswang, Kalibo, Aklan mangrove plantation, proudly stand beside their multi-awarded forest. Footwalks (bottom) provide access to the Buswang, and other mangrove forests – often muddy at low tide, and under water during high tide.

the shoreline and created a buffer zone against typhoons, provided a habitat for wildlife, and improved family incomes. It has also attracted many visitors such as schoolchildren, local teen-agers and foreign guests; the latter come to Aklan mainly to join the yearly *Ati-atihan* Festival in Kalibo and to enjoy the world-famous beaches of Boracay.

Critical factors behind the successful planting project are local political will and excellent coordination among government and non-government agencies. Buswang is also the site of European Union-funded research on mud crab *Scylla* fisheries and an earlier study on mud crab culture in mangrove pens, both conducted by SEAFDEC/AQD. Another key to the Buswang success has been the grant by DENR of tenurial rights over the mangroves (considered open-access public lands under Philippine law) through a 1994 Forest Land Management Agreement and later a

Community-Based Forest Management Agreement (Table 12). Table 13 lists the various mangrove planting projects undertaken in Panay. Whether reserves, rehabilitation or mangrove-friendly aquaculture, mangrove conservation should be considered within the wider scheme of integrated coastal zone management that coordinates the needs of various sectors such as: fisheries, aquaculture, forestry and industry. Management of mangroves should be community-based, recognizing the role of local residents as users and day-to-day managers of coastal resources, and guided by ecological information. Community involvement in the planning and implementation of coastal resource management (CRM) projects and sharing in their benefits will contribute to the success of CRM. In addition, co-management of CRM with local government units is also important, especially in the context of the Local Government Code, as illustrated by the Kalibo, Aklan and Pan-ay, Capiz case studies.

TABLE 13

Mangrove plantations and other mangrove rehabilitation projects in Panay Island, central Philippines

| Location | Area (ha) | Year Planted | Species Planted | Fund Source/Implementors |
|---|-------------------------------|--------------------|--|--|
| <u>Aklan</u> | | | | |
| New Buswang, Kalibo | 50 + 13 7 | 1989, 1993 1994 | <i>R. apiculata</i> , <i>R. mucronata</i> <i>R. apiculata</i> , <i>R. mucronata</i> | OECF (Japan) thru DENR: NGO USWAG & KASAMA Countryside Development Fund |
| Jawili, Tangalan | 13 | 1995 | <i>R. apiculata</i> , <i>R. mucronata</i> | Jawili Farmers & Fishermen Association |
| Capispisan Farm, New Washington | margins of 32 ha-pond | 1998 | <i>R. apiculata</i> , <i>R. mucronata</i> | LGUs, Aklan State University - School of Fisheries & Marine Science |
| <u>Antique</u> | | | | |
| Semirara Island | 54 established, 15 natural | 1995 | <i>R. apiculata</i> , <i>R. mucronata</i> | DENR-CEP Program |
| Nogas Island | 8 | 1995 | <i>R. apiculata</i> , <i>R. mucronata</i> | DENR-CEP; covers seagrass beds |
| Lipata, Culasi | >10 | 1995-99 | <i>R. stylosa</i> | Netherlands Gov't: ANIAD (LGU), OMMMALI |
| Centro Weste, Libertad | ~3 | 1997-99 | <i>R. apiculata</i> , <i>R. mucronata</i> | DENR, Municipal Agriculture Office |
| <u>Capiz</u> | | | | |
| Latasan Is., Pan-ay | 20 | 1989 | <i>A. marina</i> , <i>S. alba</i> | OECF-Asian Development Bank: local community |
| Sapian Bay | 6 | 2001 | <i>R. apiculata</i> , <i>R. mucronata</i> | DENR-CEP |
| <u>Guimaras</u> | | | | |
| Nueva Valencia | 149 | 1994 | <i>R. apiculata</i> , <i>R. mucronata</i> | DENR-CEP |
| <u>Iloilo</u> | | | | |
| Carles | 530 | 2001 | <i>R. apiculata</i> , <i>R. mucronata</i> | DENR Forestry Sector Program: MACABATA-ARM Federated People's Org.; partly covers seagrass beds |
| Barotac Nuevo (Talogangan, Palaciawan) | 3 ha +54,000 propagules | 1997-2002 | <i>A. marina</i> , <i>R. apiculata</i> , <i>R. mucronata</i> | BBRMCI, SK, BFARMC, LGUs, local students and faculty |

Sources: M. Reino and S. Geollegue, DENR Region VI, Iloilo; M. Larroza, BBRMCI; C. Magsipoc, OMMMALI

Abbreviations: ANIAD - Antique Integrated Area Development; BBRMCI - Banate Bay Resource Management Council, Inc.; BFARMC - Barangay Fisheries & Aquatic Resources Management Council; CEP - Coastal Environment Protection; DENR - Department of Environment and Natural Resources; KASAMA - Kalibo Save the Mangrove Association; LGU - local government unit; MACABATA-ARM - Manlot, Cabilao, Bancal, Tarong-Association for the Rehabilitation of Mangroves, Inc.; NGO - non-governmental organization; OECF - Overseas Economic Cooperation Fund, OMMMALI - *Organisasyon sang mga Mangunguma, Mamumugon kag Mangingisda sa* Lipata, Culasi, Antique; PO - People's Organization; SK - Sangguniang Kabataan; USWAG - United Services Welfare Assistance Group

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GLOSSARY

- acuminate** – tapering to the apex, the sides more or less concave or incurved before reaching tip
- acute** – sharply pointed, the sides not incurved but straight or nearly so (forming $<90^\circ$ angle)
- adventitious** – outside the normal or usual place, e.g., roots on a stem
- alternate** – one leaf (or other structure) per node
- apetalous** – without petals
- apiculate** – ending as an abrupt tip which is not stiff
- appressed** – pressed to, or lying flat against, a part of the plant
- axil** – the angle on the upper side of a plant between a leaf and the stem
- axillary** – arising from the axil, as in an axillary bud
- beak** – pointed end, applies to fruits
- blade** – the expanded, flattened part of a leaf
- buttress** – flattened projection or outgrowth from lower trunk which joins lateral roots to stem
- calyx** – the outer or lowermost envelope of a flower, consisting of separate (free) or fused sepals
- canopy** – the uppermost layer of branches and leaves of a single tree or forest
- capsule** – dry fruit which bursts when ripe
- catkin** – inflorescence with many small, sessile flowers on a spike-like axis, usually pendulous
- compound leaf** – divided into 2 or more leaflets
- cone roots** – aerial roots shaped like a cone, shorter and more woody than pneumatophores
- cotyledon** – seed-leaf or embryonic leaf
- cotyledonary collar** – extended tube formed by fusion of cotyledons (at their junction with hypocotyl), remains on plant after seedling drops; in rhizophoraceae
- cryptoviviparous** – germinating seed attached to the parent plant which is covered by the intact fruit wall (i.e., cryptic or hidden)
- cuticle** – waxy or fatty layer on the external or outer surface of leaves, fruits, etc.
- cylindrical** – long and tubular
- cyme** – compound inflorescence with flat or convex shape whose inner flowers open first
- DBH** (diameter at breast height) – width of trunk of a standing tree measured at ~ 1.3 meters above the ground
- deciduous** – shed leaves at the end of the growing (dry) season; applies to trees
- decoction** – herbal preparation made by boiling a plant part in water
- decussate** – pairs of opposite leaves at right angles to preceding pair
- dehiscent** – opening spontaneously when ripe to release pollen or seeds
- desiccation** – drying up
- dimorphic** – either male or female, applies to flowers
- dioecious** – male and female flowers borne on separate plants, i.e., dioecious species have separate sexes
- elliptic** – oval-shaped, usually with pointed apex and base
- emarginate** – with a shallow notch at the apex
- endosperm** – nutritive material stored inside the seed, often surrounding the embryo
- entire** – continuous or undivided margin
- epidermis** – outer layer of cells or tissues
- erect** – vertical or upright
- facultative** – optional, not obligatory
- filament** – stalk of the stamen before the anther
- fissured bark** – bark that splits or cracks
- flaky bark** – bark that falls off in flakes or thin sheets
- forage** – food for domestic animals
- glabrous** – smooth, without hairs
- globose** – almost globular or spherical
- glossy** – smooth and shining
- gnarled** – twisted, knobby, contorted
- grove** – group of trees
- habit** – the general appearance of a plant
- halophytes** – plants adapted to highly saline habitats
- hypocotyl** – part of the embryo or seedling below the cotyledon(s)
- inflorescence** – arrangement of flowers or flower cluster
- keel** – projecting ridge on a surface, like the keel of a boat
- knee roots** – aboveground roots shaped like a knee
- knobbed, knobby** – full of knots, twisted

- lanceolate** – lance-shaped; much longer than wide with broad base tapering to the apex
- leaflet** – part or segment of a compound leaf
- leathery** – tough, leather-like texture
- lenticel** – corky cells on woody stems or aerial roots, used for gas exchange
- lenticellate** – with lenticels
- lobe** – division of a leaf
- midrib** – large central vein of a leaf
- monoecious** – male and female flowers separate but borne on the same plant; applied to species
- mottled** – with a variegated coloring
- mucronate** – leaf apex usually broad, terminated by a short stiff point called mucro
- node** – point where leaves or branches arise from a stem
- notched** – with a v-shaped gap or cut in an edge
- oblong** – elongated, two to four times longer than broad
- obovate** – inversely egg-shaped, with the broader end upward
- obtuse** – blunt at the end (forming $>90^\circ$ angle)
- opposite** – two leaves per node on opposite sides of the stem; as opposed to alternate
- ovate** – shaped like an egg, broader at the base
- panicle** – inflorescence whose primary branches are racemose, and flowers are pedicellate
- paripinnate** or **even-pinnate** – equal numbers on each side of the axis; applies to leaves
- peat** – wet, spongy, acidic substrate mainly of accumulated organic matter
- pedicel** – stalk of individual flower in a cluster
- peduncle** – stalk of single flower, or of flower cluster (inflorescence)
- peg roots** – pneumatophores shaped like pegs
- pendulous** – hanging or drooping
- persistent** – remaining attached for along time
- petiole** – leaf stalk
- plank roots** – vertically flattened, lateral extensions of buttress root
- pneumatophores** – spongy or corky aerial roots arising from cable roots; variable in shape, e.g., peg, conical, pencil, knee
- prop roots** – aerial roots that form on the stem above ground; also called stilt roots
- propagule** – seed or seedling capable of producing a new plant, applied to Rhizophoraceae, e.g., *Rhizophora*, *Bruguiera*
- pubescent** – covered with short, soft fine hairs
- raceme** – unbranched inflorescence with pedicelled or stalked flowers arranged along the sides of a common peduncle
- racemose** – raceme-like
- reflexed** – bent or turned backward, or folded back on itself
- rhizome** – root-stock or rootlike stem on or below the ground
- ridge** – angular and with lengthwise lines
- rugose** – wrinkled
- scales** – small dry flakes covering the surface of leaves, fruits, etc.
- sepal** – outermost part of a flower, collectively called the calyx
- serrate** – with regular pointed teeth, like a saw
- sessile** – without a stalk, i.e., directly attached
- shrub** – low (<5 meters high) woody plant with several major branches, no distinct trunk
- simple** – single, undivided piece; applied to leaves
- smooth** – leaf texture not rough
- spike** – elongated, unbranched inflorescence like a raceme, but flowers are sessile
- stalk** – petiole, peduncle or stem
- stamen** – male organ of a flower, consisting of pollen-bearing anther on a filament
- stellate** – star-shaped
- sterile** – infertile, nonreproductive
- stilt roots** – prop roots
- stipules** – paired leafy appendages of a leaf, at the base of the petiole
- stomata** – openings of the leaf connected to internal air spaces
- style** – usually elongated part of the pistil connecting ovary and stigma
- succulent** – juicy or fleshy, as in succulent leaves
- terminal** – borne at the end or apex
- tree** – higher woody plant, usually with one major trunk
- umbel** – umbrella-like inflorescence with pedicels arising from common base
- undulate** – wavy
- unisexual flower** – either female or male only
- viviparous** – seeds that germinate while still attached to the parent plant

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ABOUT THE AUTHORS

Jurgenne Honculada Primavera (1st from right, below) finished Zoology at the University of the Philippines (U.P.) in Diliman in 1966 when she first encountered mangroves during field trips. After graduation, she taught at the Mindanao State University in her home island, then in 1975 joined the Iloilo-based SEAFDEC Aquaculture Department where she is now Senior Scientist. Her studies on brackishwater aquaculture emphasized the connection between pond development and mangrove loss. Hence her research shift to mangrove-friendly aquaculture and the mangrove-penaeid shrimp linkage, the latter for a Ph.D. thesis in Marine Science at U.P. Diliman. She has produced more than 60 scientific articles, review papers, manuals, book chapters, technical reports, etc. as senior author, and another 20 papers as co-author. Her long career includes numerous conferences, symposia and workshops on aquaculture, fisheries, mangroves and the environment, and consultancy work. Upon retirement, she hopes to have more time to bake bread, babysit her grandchild and tend a backyard nursery, which includes *Heritiera littoralis* and *Bruguiera* seedlings.

Resurreccion Bito-on Sadaba (3rd from right) finished B.S. Natural Science at the U.P. Visayas where his exposure to the mangroves of Taklong Island National Marine Reserve in Guimaras, and realization of their value encouraged him to make an assessment of these mangroves for his M.S. in Environmental Studies at the U.P. Los Baños. Although most of his published works are on the ecology of mangrove fungi in the Philippines and Hong Kong (based on his Ph.D. dissertation at The University of Hong Kong in 1996), he has not forgotten the bigger elements of the ecosystem – the mangrove flora. Thus, his current research on the mangroves along Iloilo River and planned inventory of Panay Island mangroves. As Assistant Professor of the College of Arts and Sciences of U.P. Visayas in Miag-ao, Iloilo, he supervises the mangrove research of undergraduate and graduate students, and regularly takes them on weekend trips all over the island, locating and studying any remaining mangroves.

Ma. Junemie Hazel Leonida Lebata (2nd from right) was first introduced to mangroves as Dr. Sadaba's Field Biology student at the U.P. Visayas where she finished Biology. While working on a coral taxonomy project in Guimaras for the U.P.V., she regularly observed the Taklong mangroves, but did not know their names. Her mangrove association continued when she joined SEAFDEC/AQD (where she is now Associate Scientist) in 1993 to assist Dr. Primavera's research on shrimp populations in the Guimaras mangroves. Her M.S. in Fisheries Biology at the U.P. Visayas focused on the endosymbiotic capabilities of the mangrove clam *Anodonta edentula*. She has published papers on this lucinid clam and other mangrove-associated fauna. As member of the EC-SEAFDEC Project on the Management and Culture of Mud Crabs, she now studies *Scylla* populations in the pristine mangroves of Ibajay, Aklan for possible stock enhancement trials.

Jon Palmos Altamirano (4th from right) is pursuing his M.S. in Ocean Science at the U.P. Visayas where he also completed his B.S. in Fisheries in 1999. Soon after graduation, he joined the SEAFDEC/AQD as Technical Assistant where his skills in computer operations have served him well – he takes charge of digital mangrove mapping and species survey, and assists in mangrove-related studies and training courses (e.g., mangrove community structure). He has attended national and international seminars and workshops in mangrove biodiversity, fisheries and marine science. A Philippine participant of the Government of Japan-funded Asian Youth Fellowship Program 2004, he hopes to specialize in mangrove hydrology/geology and GIS applications for further graduate studies in Environmental Sciences.



The world of mangroves is complex and offers many challenges for the casual visitor. An understanding of ... the nature of its parts is essential before a clear idea of its essence can emerge. Mangroves have acquired a mystical, somewhat eerie reputation because of their unusual habitat between the land and the sea, the outlandish forms that they adopt and their unapproachable terrain. As one becomes familiar with various forest types and their animal inhabitants, a deep sense of their beauty will develop. It is easy to be romantic about these strange ecosystems but ... it is necessary to be better informed.

Colin Field (1995)



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