ADDITIONAL NOTES ON THE GENUS AVICENNIA. IX

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AVICENNIA MARINA var. ACUTISSIMA Stapf & Moldenke

Additional bibliography: Moldenke, Phytologia 34: 85 & 93—94. 1976.

According to Jafri (1966) this plant is very common in the Karachi area of Sind, Pakistan, being dominant in the tidal swamps with only scattered shrubs of Aegiceras corniculatus interspersed. Santapau (1967) records it from Saurashtra, India, while Rao and his associates (1966) found it on Piram island. Rao & Mukherjee (1967) report that in Saurashtra it forms a community with Salicornia brachiata in thickets and dominates parts of the shore, at Bhavnagar it is found "along sea facing low-lying shores in thickets closely followed landward by Salicornia brachiata". Shah & Patel (1970) assert that in Gujarat it is the "only mangrove seen" forming dense thickets on mud flats near watercourses. These latter authors erroneously cite "A. alba Bl." as a synonym -- A. alba Blume is a separate and distinct species, as I have explained earlier in this series of notes.

Stearn found A. marina var. acutissima "on mudflats in water at high tide, left bare at low tide". Rao & Shamware (1967) found that on the sinking coast of Saurashtra this variety forms the protected mangrove coastal area with 53 percent calcium carbonate in the soil. It is one of the three pioneer plants on the muddy shores there, the others being Urochondra setulosa and Salicornia brachiata.

Khan (1961), misidentifying this plant as A. officinalis L., tells us that it is "locally known as timar" and "occurs naturally in the coastal forests of West Pakistan. It is a small tree, about 15—20 ft. high. Near Karachi in easily accessible areas it has been over exploited for firewood and fodder and in such areas it presents a shrubby appearance. It is cut for the production of firewood of cheaper quality. It is brought in boats for use in Karachi market or is used by fishermen along the coastal creeks in considerable quantities for curing of prawns during the prawn catching season from October to March each year. In addition to this, the twigs are lopped off for leaf fodder and are brought regularly in small dingy boats for stall feeding.

"Very little information is available about the silvicultural characters of Avicennia. Flowering, fruiting germination and regeneration habits were studied.....Flower buds start appearing by the middle of April; flowers are yellowish pink in colour, sessile, in bracteate heads, arranged in terminal trichotomous panicles. They appear all over the coastal areas in early May. Fruits appear towards the end of July or early August and are easily available for about a month and a half. Each fruit is a one seeded cap-

sule -- about 1" to 1.25" long and compressed. About eleven seeds weigh an ounce. The seed is viviparous and some of it starts germinating while attached to the parent branch. The entire capsule is very buoyant....Very often the seed starts germinating on the mother tree and as such, the fruit along with the seed-coat is already split. Soon after, this germinated fruit falls either on the muddy ground or on the high tide water -- the radical with the tuft of fine root-hairs starts emerging out. Thus partly germinated seed or already germinated seedlings bearing the two thick cotyledons keep afloat on the tidal water in various stages of development. These are often swept away by the waves and the prevalent winds. Hence young seedlings near or under the mother tree are few and far between. The germinating seeds or young seedlings are capable of establishing themselves on suitable soil while water recedes during the low tide. The thick welldeveloped radical with tuft of hair fixes on the soil and forms side roots quickly and the cotyledons open out. Once fixed, they are sturdy enough to stand the pressure of the tidal waves during the ensuing high tide. In case the seedlings do not get fixed up on the soil before the commencement of the next high tide, they again float up and are carried away by the tidal waves elsewhere until completely destroyed or redeposited.

"The 1st pair of leaves appear in four to six days and 2nd pair of leaves in about twenty days when the two cotyledons dry out. Young seedlings normally remain completely submerged under water during high tides in their early stages of development. The seed is very viable and germination is well near 90 percent. Viability stays for a period of seven to nine days."

Jafri (1973) cites Jafri 1643, 5001, 5002, & 5003, Khan s.n. [1.5.65], Mallik s.n. [11.5.57], and Qaiser & Azmat 5489 from Sind. He records the local vernacular names, "timir" and "tivar", asserting that the plant flowers there from February to June, commenting that "It differs from A. officinalis L. and A. alba Blume, the S. E. Asian species, by its very acute or acuminate leaves, shrubby habit and slightly smaller flowers and fruits. A. officinalis L. and several allied taxa need a critical revision, specially with regard to leaf shape varieties, flower and fruit characters, with adequate material. The bark is said to have tanning properties and [the] leaves are used as fodder for camel and goats. It forms the dominant mangrove vegetation of [the] Karachi coast or the Arabian sea coast of West Pakistan, but appears to be under collected in our area due to difficult approach to it through swamp and mud." Patel (1971) avers that its habitat and common names are the same as for A. officinalis L. He misdates my Geogr. Distrib. Avicenn. (1939) as "1938" -- its actual date of publication was September 20, 1939.

Collectors describe A. marina var. acutissima as a much-branched shrub, 4--12 feet tall, with "pencil-like roots protruding from the mud for 6 inches or so", the inflorescences compact, the flowers fragrant, the corollas yellow or yellowish, and the fruit laterally compressed.

Jafri (1966) cites his no. 1643, s.n. [China creek], s.n. [Manara], and s.n. [Sand pits] from Sind, while Stewart (1972) cites Stearn 19 and H.B. 20683. Rao & Mukherjee (1967) cite Rao 2000 from Saurashtra.

It seems most probable that the "A. officinalis L." of Parsa (1949) and of Esfandiari (1967), from Iran (Kerman and Baluchistan), is A. marina var. acutissima instead.

Additional citations: PAKISTAN: Sind: Jafri 1643 (Kh); Khan s.n. [1.5.65] (Kh); Mallik s.n. [11.5.1957] (Kh); Qaiser 5489 (Kh, Kh). INDIA: Gujarat: Thanikaimoni s.n. [Gogha, 21.3.75] (Ld), s.n. [Ratara, 21.3.75] (Ld), s.n. [Mainy, 23.3.75] (Ld), s.n. [Salaya, 23.3.75] (Ld), s.n. [Navlaki, 25.3.75] (Ld), s.n. [Rann of Kutch, 25.3.75] (Ld), s.n. [Ghodbunder, 29.3.75] (Ld), s.n. [Thana, 30.3.75] (Ld). Union Territory: Thanikaimoni s.n. [Revadanta, 2.4.75] (Ld), s.n. [Cortalin, 5.4.74] (Ld). Elephanta Island: Thanikaimoni s.n. [31.3.75] (Ld). Karumbar Island: Thanikaimoni s.n. [24.3.75] (Ld).

AVICENNIA MARINA f. ANGUSTATA Moldenke, Phytologia 23: 425, nom. mud. (1972) and 34: 18. 1976.

Bibliography: Moldenke, Phytologia 23: 425 (1972) and 34: 18 & 80. 1976.

This form differs from the typical form of the species in its much narrower leaves which are 5—9 cm. long and only 1—2.2 cm. wide. The type is Chai S.29949 from on consolidated mud near bank in front of Buntal Village, Buntal River, 1st Division, Sarawak, collected on June 18, 1971, and deposited in my personal herbarium at present in Plainfield, New Jersey.

Chai describes this plant as a shrub, treelet, or tree, 4—18 feet tall, with a 4-inch trunk girth, pneumatophores present (on individuals in consolidated mud) or absent (individuals on pure sand bars), the bark surface gray, lenticellate, "with much narrower and longer leaves than the typical form of the species also present", the flowers fragrant, the corollas yellow or orange-yellow, and the fruits glaucous-green with a blunt (flat) apex. He reports "a few trees among the sp[ecies]" on soft muddy riverbanks, in consolidated mud near the banks, on sand bars, and at the mouth of the Buntal River in front of Kampong Buntal village, flowering in May and June, also fruiting in June.

Citations: GREATER SUNDA ISLANDS: Sarawak: Chai S.29938 (Ft), S.29947 (Ld), S.29949 (Z—type).

AVICENNIA MARINA var. ANOMALA Moldenke

Additional bibliography: Moldenke, Phytologia 7: 226—227. 1960; Moldenke, Fifth Summ. 1: 349 (1971) and 2: 839. 1971.

AVICENNIA MARINA var. RESINIFERA (Forst. f.) Bakh.

Additional & emended synonymy: Avicennia resinosa Forst. apud Decne., Nouv. Ann. Mus. Hist. Nat. Paris 3: 402, in syn. 1834.

Avicennia tomentosa R. Br. ex Decne., Nouv. Ann. Mus. Hist. Nat. Paris 3: 402, in syn. 1834 [not A. tomentosa Blanco, 1845, nor Blume, 1918, nor Jacq., 1760, nor L., 1826, nor L. & Jacq., 1783, nor G. F. W. Mey., 1818, nor Nutt., 1947, nor Nutt. & Br., 1832, nor Roxb., 1835, nor Schau., 1940, nor Sw., 1864, nor Vahl, 1921, nor Weigelt, 1851, nor Willd., 1822]. ?Avicennia officinalis δ spathulata f. glandulosa Kuntze, Rev. Gen. Pl. 2: 502. 1891. Avicennia marina var. resinifera (Forst.) Bakh., Null. Jard. Bot. Buitenz., ser. 3, 3: 210. 1921. Avicennia marina var. australasica (Walp.) Moldenke ex Beadle, Evans, Carolin, & Tindale, Fl. Sydney Reg., ed. 2, 509. 1972.

Additional & emended bibliography: Forst. f., Pl. Escul. Ins. Ocean. Austr. 72. 1786; Forst. f., Fl. Ins. Austr. Prod. 45. 1786; Raeusch., Nom. Bot., ed. 3, 182. 1797; Pers., Sp. Pl. 3: 359. 1819; Decne., Nouv. Ann. Mus. Hist. Nat. Paris 3: 402. 1834; Dieffenb., Trav. N. Zeal. 1: 431. 1843; W. Griff., Notul. Pl. Asiat. 4: 186—188. 1854; Twining, Ill. Nat. Ord. Pl. 2: 104. 1855; Drury, Useful Pl. India 57 & 490. 1858; Nutt., N. Am. Sylva 2: 144. 1865; R. Schomb., Fl. S. Austr. 52. 1875; C. B. Clarke in Hook. f., Fl. Brit. India 4: 604. 1885; Kuntze, Rev. Gen. Pl. 2: 502. 1891; R. T. Baker, Journ. Proc. Roy. Soc. N. S. Wales 49: 257—281. 1916; H. Hallier, Meded. Rijks Herb. Leid. 37: 88. 1918; Ostenfeld, Dansk Bot. Ark., ser. 2, 8: 28. 1918; Cockayne in Engl. & Drude, Veget. Erde 14: 51, 52, 56, 62, 65, & 66, pl. 4, fig. 5. 1921; Wangerin in Just, Bot. Jahresber. 51 (1): 553 (1923), 46 (1): 859 (1926), 49 (1): 521 (1928), and 50 (1): 339. 1930; Fedde & Schust. in Just, Bot. Jahresber. 53 (1): 1069. 1932; Fedde in Just, Bot. Jahresber. 49 (2): 388 (1932) and 51 (2): 259. 1933; Bakh., Journ. Arnold Arb. 16: 70. 1935; Parsa, Fl. Iran 4 (1): 536. 1949; W. C. Davies, N. Zeal. Pl. Stud., ed. 1, 126—127, pl. 48. 1956; S. P. Meyers, Mycologia 49: 489. 1957; Rageau, Pl. Méd. Nouv.-Caléd. 61, 78, 79, 81, 84, 86, 92, 104, & 113. 1957; Chapm. & Ronaldson, D. S. I. R. Bull. 125. 1958; Gilham, Austral. Journ. Bot. 8: 314. 1960; Van Royen, Nova Guinea, ser. 2, 10: 235. 1960; Allan, Fl. N. Zeal. 1: 961 & 1041. 1961; W. C. Davies, N. Zeal. Pl. Stud., ed. 2, 126—127, pl. 48. 1961; Moore & Adams, Pl. N. Zeal. Coast [104] & 105, fig. 162. 1963; R. Good, Geogr. Flow. Pl. 241. 1964; Laing & Blackwell, Pl. N. Zeal., ed. 7, 373—383, fig. 140—143. 1964; Anon., Ind. Bibliog. Bot. Trop. 4: 85. 1967; Clarke & Hannon, Journ. Ecol. Brit. 55: 753—758, pl. 13, photo 1-4. 1967; Cockayne, N. Zeal. Pl. & Story, ed. 4, 54—55, fig. 18. 1967; Cockayne & Turner, Trees N. Zeal. 33, 177, & 179, fig. 11. 1967; Kohlmeyer, Icon. Fung. Mar. 1: Anh. 5, pl. 48a & 64a. 1967; J. M. Ward, Veget. Act. Geobot. 14: 247, 249—252, 268, 273, 276, 279, 280, & 294, pl. 2, fig. 4e, 5, 14, 17, 19, 20, & 25 (2). 1967; Maxwell, Tane 14: 6, 13, & 20. 1968; Moldenke, Phytologia 15: 476 & 478. 1968; Moldenke, Résumé Suppl. 16: 15. 1968; Uphof, Dict. Econ. Pl., ed. 2, 60. 1968; H. Walt., Veget. Erde 2: 260 & 262. 1968; Anon., Biol. Abstr. 50 (9): B.A. S.I.C. S.16. 1969; Clarke & Hannon, Journ. Ecol. Brit. 57: 220.

1969; Maxwell, Biol. Abstr. 50: 4766. 1969; A. L. Moldenke, Phytologia 18: 113. 1969; V. J. Chapm., Trop. Ecol. 11: 12 & 16. 1970; Clarke & Hannon, Journ. Ecol. Brit. 59: 535—550 & 552—553. 1971; Moldenke, Fifth Summ. 1: 320, 329, 331, 334, 340, 341, 344, 349, 350, & 392—394 (1971) and 2: 839. 1971; Beadle, Evans, Carolin, & Tindale, Fl. Sydney Reg., ed. 2, 508—509. 1972; N. F. Good, Biol. Abstr. 53: 1298. 1972; Farnsworth, Pharmacog. Titles 7 (10): ii. 1972; Fong, Trojánkova, Trojánek, & Farnsworth, Lloydia 39: 147. 1972; Hedrick, Sturtevant's Edible Pl. 79. 1972; Kuchler, N. Zeal. Geogr. 28: 113—129. 1972; Anon., Biol. Abstr. 56 (6): B.A.S.I.C. S.22. 1973; N. F. Good, Biol. Abstr. 56: 4260. 1973; V. J. Chapm., Biol. Abstr. 56: 2506. 1973; Hartley, Dunstone, Fitzgerald, Johns, & Lamberton, Lloydia 36: 233 & 293. 1973; Kratochvil, Hannon, & Clarke, Proc. Linn. Soc. N. S. Wales 97: [262]—[274]. 1973; Farnsworth, Pharmacog. Titles 9 (3): iii. 1974; Gibbs, Chemotax. Flow. Pl. 3: 1752—1754. 1974; Kratochvil, Hannon, & Clarke, Biol. Abstr. 57: 761. 1974; Salmon, N. Zeal. Fls. & Pl., ed. 2, imp. 3, 23 & 227. 1974; [Farnsworth], Pharmacog. Titles 7, Cum. Gen. Ind. [15]. 1975; Moldenke, Phytologia 32: 443 & 455 (1975), 33: 240, 241, 260, & 261 (1976), and 34: 72, 75, 76, 82, 84, 85, 93, & 94. 1976.

Additional illustrations: Cockayne in Engl. & Drude, Veget. Erde 14: pl. 4, fig. 5 [as A. officinalis]. 1921; Davies, N. Zeal. Pl. Stud., ed. 1, pl. 48 (1956) and ed. 2, pl. 48. 1961; Moore & Adams, Pl. N. Zeal. Coast [104], fig. 162. 1963; Laing & Blackwell, Pl. N. Zeal., ed. 7, 374, 375, 378, & 382, fig. 140—143. 1964; Clarke & Hannon, Journ. Ecol. Brit. 55: 753—758, pl. 13, photo 1-4. 1967; Cockayne, N. Zeal. Pl. & Story, ed. 4, 54, fig. 18. 1967; Cockayne & Turner, Trees N. Zeal. fig. 11. 1967; J. M. Ward, Veget. Act. Geobot. 14: 249—252, 273, 276, 279, 280, & 294, pl. 2, fig. 4e, 5, 14, 17, 19, 20, & 25 (2). 1967; Salmon, N. Zeal. Fls. & Pl., ed. 2, imp. 3, 23 (in color). 1974.

Recent collectors describe this plant as an upright shrub, 2 m. tall, or a medium-sized tree, 5—10 m. tall, the bark gray, light-gray, or grayish, varying from smooth or fairly smooth to slightly rough, the outer bark light-brown and flakey, the wood cream-color, the leaves dark- or glossy-green above, light gray-green or silver-green beneath, aromatic, the buds green, the flowers scented, with a pleasant although rather sharp aromatic scent, abundant from February to April, the calyx green, and the fruit yellow or light yellow-green, the cotyledons deep-green. They have found it growing in mangrove and saltwater swamps, coastal marshes, mud-flats along tidal rivers, sheltered coastal mangrove swamps, and along roadsides in saltwater swamps, at altitudes of sealevel to 15 m., flowering in April, May, August, and October, and fruiting in February and April. MacDaniels 2010 is said to have been collected "on a dry hillside", but this seems hardly believable.

The corollas are said to have been "yellow" on MacDaniels 2504, "yellow-orange" on Conn & al. LAE.66147, "yellow-brown" on McKee 3153, and "dull yellowish-reddish-white" on Fosberg 30297. E. H. Walker 5352 represents a "prostrate form, mature trees 2—3 ft.

tall on typical tidal mudflats". Clarke & Hannon (1967) report that such dwarf forms are common as inliers in the Sydney district, Vernacular names reported are "bu-bula", "manawa", "mangrove", and "grey mangrove".

The accepted trinomial for this taxon was previously accredited by me to "(Forst.) Bakh.", but actually it is based on the A. resinifera of the younger Forster -- Johann Georg Adam Forster (1754—1794), son of Johann Reinhold Forster (1729—1798).

Fosberg reports A. marina var. resinifera "common at edge of saltwater in low sparse forest of Metrosideros excelsa on scoria substrate" in New Zealand's North Island. Chapman (1970) proposes the ecologic association, Avicennietum resiniferae. Gilham (1960) refers to the plant as a woody perennial making up 10 percent of the dune vegetation in Victorian seabird colonies but asserts that it is not inhabited by the birds. The Gill s.n. [8 April 1970] collection, cited below, is said to be from an "area close to the most southerly edge of both mangrove and of Avicennia distribution" in the world. MacDaniels found it "frequent" in New Caledonia. Dieffenbach (1843) calls it A. tomentosa, classifies it in the Myoporineae, and asserts that it "is the Mangrove of New Zealand, covering the shallow inlets in the northern part of North Island".

It is perhaps worth noting here that the A. tomentosa of Blanco, referred to in the synonymy of this variety, is actually a synonym of A. marina var. rumphiana (H. Hallier) Bakh., the A. tomentosa of Blume is A. alba Blume, that credited to Jack, to Jacquin, to Linnaeus & Jacquin, to G. F. W. Meyer, to Nuttall, to Nuttall & Brown, to Sieber (in part), to Swartz, and to Weigelt is A. germinans (L.) L., that credited to Linnaeus, to Vahl, and to Wallich is typical A. marina (Forsk.) Vierh., that credited to Roxburgh and to Willdenow is a synonym of A. officinalis L., and that credited to Schauer is A. schaueriana Stapf & Leechman.

Decaisne (1834) describes A. marina var. resinifera as "ramis ramulisque teretibus laevibus nigricantibus; foliis subellipticis vel obovato-subtruncatis obtusis basi in petiolum attenuatis, supra laevibus nigricantibus, subtus glauco-tomentosis, junioribus tomentoso-flavidis; pedunculis angulatis tomentosis; corolla segmentis acutis; stylo brevissimo, stigmatibus subulatis." Beadle and his associates (1972) describe it as "Small trees. Leaves opposite, ovate-lanceolate to lanceolate, glabrous and shining on the upper surface, whitish below, 5—8 cm. long. Flowers in small, dense cymes on angular peduncles in upper axils or in terminal panicles. Calyx divided to the base into 5 segments. Corolla orange; tube shorter than the sepals; lobes ovate, longer than the tube. Stamens 4, inserted in the throat. Fruit a compressed capsule about 3 cm. diam. Seed solitary, without integuments; the embryo, with two large cotyledons folded longitudinally, germinates before the fruit drops. Saltwater swamps and estuaries."

Bird (1973) affirms that "Mangrove colonization has led to a

reshaping of the upper part of the intertidal profile [in the Cairns Bay area of North Queensland]. Avicennia marina [var. resinifera] has particularly promoted accretion of sediment and it is suggested that mangroves with pneumatophores are more effective in trapping sediment than mangroves with prop-roots, such as Rhizophora. The succession from mangrove to swamp forest is interrupted in slightly drier areas by the development of salt marsh." Kuchler (1973) describes the ecology of A. marina var. resinifera from the north of New Zealand to its southern limit in the middle of North Island. He states that there are relatively few strata in its ecologic association and "the floristic composition is always simple". There are six communities associated with it and "the seral status of the mangrove vegetation is emphasized. They can be reclaimed and converted to good pastures. They are not otherwise of economic importance in New Zealand." Uphof (1966), however, says that the baked or steamed fruits are eaten as food by the aborigines of North Queensland, the bark is used for tanning, producing a harsh, pale-brown, firm leather, and the wood is used for boat-building and for piles.

Twining (1855) tells us that the resin exuding from this plant was formerly eaten by the New Zealand natives. Moore & Adams (1963), on the other hand, insist that the epithet, "resinifera", "is based on an error of the first collectors, Banks and Solander, who found lumps of kauri gum floating amongst mangrove roots and believed that this resin had been produced by the mangrove trees". These modern authors give the southern limit of the tree in New Zealand as "about Opotiki and Kawhia. In North Auckland the grey trunks may be as thick as a man's body, carrying the olive-green leathery leaves thirty feet above the tide; at Tauranga the closely growing woody bushes are little taller than a well-grown crop of potatoes." They say, further: "Our mangroves grow only in muddy estuaries. About the trunks, roots of a specialized kind impede the flow of water, and the fine silt that is deposited accumulates as black, smelly, gluey mud up to four feet or more deep. Mangrove roots, like all others, need to breathe, and in the water-logged and poorly aerated mud this is achieved with the aid of special breathing roots called pneumatophores. They arise from the upper sides of horizontal roots, and push straight up until their pointed tops stand a few inches to a foot above the mud. At high tide they are surrounded by water, at low tide by air. They have spongy cortex and the thin bark is full of lenticels through which air enters. Yellowish flowers give rise to flattened fruits nearly an inch long. The velvety fruit-coat....splits soon after the fruit falls, exposing the fleshy cotyledons...that are already green and well-developed. The whole sturdy embryo is soon freed and floats with the tide until the stout hypocotyl.... has grown out and is ready to attach itself by a ring of rootlets. Mangrove plantlets, with their folded cotyledons reminiscent of the compartments of an old-fashioned purse, are familiar objects amongst light drift-wood on many Auckland beaches. Mangrove flats have their own assemblage of smaller plants and animals, lichens

on the trunks, seaweeds, barnacles, and sometimes oysters on the breathing roots, and crabs in mud holes, the whole making a natural community."

Laing & Blackwell (1964) also trace the history of the misapplied epithet, "resinifera": "Forster originally named the plant A. resinifera, from the belief that a gum chewed by the natives came from this source. This gum was perhaps kauri-gum. Lindley, in his 'Vegetable Kingdom', when speaking of the Mangrove, improves upon Forster's statement thus: 'It exudes a kind of green aromatic resin, which furnishes a miserable food for the barbarous natives of New Zealand.' (The source of the error may be traced to Croziot's 'Voyage to Tasmania'; v. Long-Roth's Translation p. 36)." Kauri-gum, it should be noted, come from a New Zealand conifer, Agathis australis, and not from an Avicennia.

Ward (1967) avers that "Chapman, in Chapman & Ronaldson (1958) believes that A. resinifera is part of the ecocline represented by A. marina (Forst.) Vierh." She also says that pneumatophores of dead A. marina var. resinifera trees remain in place and "resist erosion causing old lagoon mud to project as a ledge 6—10 inches high."

Cockayne (1967) refers to the Avicennia colonies as "one of the natural wonders of New Zealand". He continues: "Now, quite undeservedly, the mangrove has got a bad reputation. A mangrove swamp is supposed to represent all that is most hideous on earth -- alligators in crowds, a fearsome odour, crabs waiting to pick such of the victim's bones as are left by the alligators, malaria, and deadly 'microbes' in vast abundance. Even in the tropics this picture has been shown to be absurd, but in New Zealand the mangrove belt is quite a pleasing feature of the northern rivers. The mangrove is also a beneficial plant, as it materially assists in turning muddy useless shores into good dry land." He also definitely asserts that "While still on the tree....the seed has germinated." [I emphasize this and the many similar statements quoted by me previously because of the recent claim be certain writers that Avicennia differs from the other mangrove genera in NOT producing viviparous seeds].

Davies (1961) reports that in New Zealand this plant occurs on tidal flats and estuaries "from the far north to the Bay of Plenty on the east coast, and Kawhia on the west.....Though the mangrove, with its insignificant flowers, sombre foliage, and muddy crab-infested surroundings at low water, is not usually regarded as an attractive member of our flora, it teems with interest for the plant-student and few can fail to be impressed by the beauty of the scene presented at high tide by the vista of partially submerged trees lining our northern tidal waterways."

Laing & Blackwell (1964) are in error when they ascribe to var. resinifera a range "Throughout Melanesia and Malaysia to India, and sporadically as far north as Mount Sinai in the Red Sea." They continue: "Mangroves have been generally regarded as the pariahs of the forest, and A. resinifera has not escaped the

usual condemnation. Thus, the following impassioned but somewhat inaccurate description as it occurs in one of the earliest New Zealand novels: 'Oh! those mangroves. I never saw one that looked as if it possessed a decent conscience. Growing always in shallow stagnant water, filthy black mud, or rank grass, gnarled, twisted, stunted, and half bare of foliage, they seem like crowds of withered, trodden down old criminals, condemned to the punishment of everlasting life.....Anyone who has seen a mangrove swamp will know what I mean.'

"Doubtless, however, much of the evil reputation of the mangrove forest is due to the fact that, to its presence, has long been erroneously attributed the prevalence of malaria in tropical river estuaries. Miasmic vapours were supposed to arise from the pestilential mangrove swamps, and spread their contagion around. Science had not then burdened the misguided mosquito with sins of transmission, as well as commission. Fortunately, New Zealand does not possess the malaria carrying mosquito (Anopheles), and so her mangrove forests, in spite of their foul appearance, are no more dangerous to human life than any other part of the country. Indeed, at high tide, a mangrove swamp is often a pleasant place to punt in, for then the somewhat sickly odour of the mud, is replaced by the fresh smell of the sea.

"Nor is the New Zealand mangrove so ugly, as those of more tropical regions. The gruesome conception of the mangrove forest existing in the minds of most people, is doubtless derived from the well-known word picture of Kingsley's Westward Ho. The passage begins: 'The night mist began to steam and wreath upon the foul beer-coloured stream,' etc. Then follows a description of the hoarse night raven, the loathly alligators lounging in the slime, the sad-coloured mangrove hens wailing sadly, and the great purple crabs crawling over the snake-like roots. Of these hideous accessories, only the mangrove-hen (the weka), and the crabs, are to be found in New Zealand.....

"The twisted and gnarled stems and roots give the tree an unwarranted appearance of age, so that even the youngest mangrove looks old. Barnacles and oysters fix themselves upon the roots which are uncovered by the withdrawal of the tide; eels wiggle in and out of their holes, and the mass of fibrous rootlets which forms a mat beneath the mud, provide dwelling places for innumerable mud-coloured crabs. These are sought after, not only by the somber-hued wekas, but also by the beautiful kingfishers. A dark-coloured fish, with curious flexible dental plates, may frequently be seen swimming over the flats at low tide."

These authors also state that "The fibrous matting [of roots] between the pegs [=pneumatophores] is rarely laid bare, save after a heavy flood, and spreads widely, forming a huge disk that prevents the mangrove from being upset. The tree is further propped up by a number of stilt roots. These, however, are not so large or so long as in the typical mangrove (Rhizophora mangle) of the tropics. The trees thus buttressed, stayed, and fixed by their varied roots, stand firm in the highest tide and the strong-

est flood, and gather about them material for a rich soil, which gradually becomes suitable for cultivation. Then they step farther out into the water and begin their work again. So far as can be roughly estimated, the mud-flats are thus raised by the action of the mangroves, on an average, a little over an inch each year. This rate of speed is probably only that of the present time, as it must have been much slower in past years before the bush was so extensively cut. Since the clearing of the land, slips have been much more frequent, and hence the rate of deposition is now faster than before."

Clarke, Lesley, & Hannon (1971), in their investigation of species interaction via phytotoxic exudates, shading, and associated growth, found that the growth of Arthrocnemum australasicum was definitely reduced and its mortality increased in association with Avicennia marina var. resinifera (as it was also with Juncus maritimus). No evidence of inhibition of Arthrocnemum by leachates or macerates of mangrove bark, leaves, or soil was found, but the higher light requirements of all of the species of Arthrocnemum zone, compared with Avicennia or Juncus, would prevent their migration into the adjacent zones where these other species are dominant. No reciprocal diminution in growth or survival of Avicennia or Juncus occurred when in association with Arthrocnemum.

McNae (1966) points out that Avicennia marina var. resinifera occurs farther south and in cooler temperatures in Australia than typical A. marina does in Africa. Sauer (1965) notes that the variety grows under a great climatic range around the periphery of the Australian continent, its sparse geographic pattern in the Sydney area probably reflecting unfavorable edaphic and exposure conditions there, where Kratochvil and his associates (1973) report that "in a few isolated areas.....mature Avicennia individuals of only 1 m height occur in situations where at high tide the shoot system is completely submerged. Long, finger-like projections hand downward from the stems and are exposed to the air at low tide.....Avicennia penetrates a long way inland....some plants occurring in positions that are rarely (if ever) flooded by the tide. Some individuals are very large (7.6 m tall; 46 cm D.B.H.). Some show unusual features, such as pneumatophore-like structures of 5—9 cm length projecting downwards from the trunks of the trees at distances of 2 to 6 m above ground level. Many... are unhealthy and large numbers of the 'dwarf' form occur. Contrary to Hamilton's (1919) interpretation, these 'dwarf' forms are thought to develop in areas of increased salinity."

Kohlmeyer (1967) records the fungi, Halosphaeria quadricornuta and Metasphaeria australiensis as attacking this mangrove. Maxwell (1968) adds a species of Phytophthora as attacking it in New Zealand, "perhaps derived from nearby Cupressus macrocarpa trees." It causes the death of the mangroves after symptoms of chlorotic and partially blackened leaves, severe defoliation, and dead and

moribund root tissue. Meyers (1957) also lists Metasphaeria australiensis.

Gibbs (1974) found cyanogenesis absent from the shoots of A. marina var. resinifera, the Ehrlich test negative in the leaves, and the HCl/methanol test negative.

It is also worth noting here that Baker (1916), Ostenfeld (1918) and Cockayne (1921) erroneously adopt the name, A. officinalis L., as the name for the present taxon. Laing & Blackwell (1964) give "A. officinalis" as a synonym of the present taxon, but the true A. officinalis of Linnaeus, type species of the genus, is a very different, distinct, and valid taxon (which see). Similarly, Uphof (1968) lists "A. tomentosa Jacq." as a synonym, but Jacquin's binomial actually refers to the very different New World A. germinans (L.) L.

The Griffith (1846) work cited in the bibliography is sometimes mis-dated "1851" in bibliographies.

Pételot (1954) reports on the use of this plant in the treatment of leprosy: "A la Nouvelle-Calédonie, où la lèpre s'étendait d'une façon inquiétante et où la médicine déclarait son impuissance, MM. Birard, Pharmacien en Chef de l'Hôpital de Nouméa, et F. Fruitet, Pharmacien, ont expérimenté également le traitement au Palétuvier.

"Par son abondance, par la facilité avec laquelle on peut l'administrer, par son innocuité physiologique, par la tolérance que les malades présentent pour lui et par les resultats que l'on en obtient, l'Avicennia est le meilleur remède que possède la médecine pour combattre la lèpre: a la première période 100 percent de guérison, a la deuxième période, période d'état si les viscères sont atteinte d'une façon légère, 60 percent des ces guérissent complètement dans un laps de temps variant entre 2, 3, 4 et 6 ans; les 40 percent restant, présentent une amélioration appréciable."

Rageau (1957) says: "Il a des propriétés astringentes, amères et fébrifuges grâce á son écorce tannifère: l'écorce est encore diurétique à faible dose mais émétique et causant des céphalées intenses à haute dose; elle passe pour anti-lépreuse. L'exsudation des feuilles chauffées servirait contre les piqûres de poissons venimeux."

Van Royen (1960) cites his no. 4924, while Hartley & al. (1973) cite their no. 10293, Fedde & Schuster (1932) cite Branderhorst 227 and Versteeg 1893 from New Guinea, Robinson 1862 from the Moluccas, and Elmer 11900 and Curran 17337 from the Philippines. Bakhuizen (1935) cites Kajewski 2344 from Malaita island.

The R. A. Perry 2547, distributed as A. marina var. resinifera and so filed in some herbaria, actually is A. eucalyptifolia Zipp., while A. M. Gill s.n. [7 April 1970], in part, is A. officinalis L.

Additional citations: NEW GUINEA: Papua: Conn & al. LAE.66147 (Mu). NEW CALEDONIAN ISLANDS: New Caledonia: Baas Becking 6185

(N); MacDaniels 2010 (Ba), 2504 (Ba); McKee 2114 (W—2187229), 3153 (W—2210100). AUSTRALIA: New South Wales: Gill s.n. [7 April 1970], in part (Ft—3131); L. A. S. Johnson 24412 (W—2185581). South Australia: Dangerfield s.n. [25.XI.1963] (Mu). Victoria: Gill s.n. [8 April 1970] (Ac, Ft—9721, Ft, Ft, Ft, Ft). NEW ZEALAND: North: K. E. Adams s.n. [Feb. 1950; Herb. Bot. Div. D.S.I.R. 68986] (Z); J. H. Davis s.n. [May 1950] (W—2037461); F. R. Fosberg 30297 (W—2696435); U. Schweinfurth 1066 (Mu); P. B. Tomlinson s.n. [3 January 1969] (Ft—4414); E. H. Walker 5352 (W—1994518); K. Wood s.n. [22-6-52] (Ba). Rangitota: Trevarthen s.n. [18.2.1950] (Se—174623). GREAT BARRIER REEF: Bay Islands: Doore & Earle 276 (N, Tu—175730).

AVICENNIA MARINA var. RUMPHIANA (H. Hallier) Bakh.

Additional bibliography: Wangerin in Just, Bot. Jahresber. 51 (1): 553 (1923) and 49 (1): 521. 1928; Fedde & Schust. in Just, Bot. Jahresber. 53 (1): 1069. 1932; Fedde in Just, Bot. Jahresber. 49 (2): 388 (1932) and 51 (2): 259. 1933; Bascope, Bernardi, Jorgensen, Hueck, & Lamprecht, Inst. Forest. Latinoam. Invest. Capac. Descrip. Arb. Forest. 5, ed. 1, 13. 1959; Burkill, Dict. Econ. Prod. Malay Penins. 1: 277. 1966; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 10: p. prec. 225. 1968; Moldenke, Phytologia 15: 477. 1968; Bascope, Bernardi, Jorgensen, Hueck, & Lamprecht, Inst. Forest. Latinoam. Invest. Capac. Descrip. Arb. Forest. 5, ed. 2, 13. 1970; Molden e, Fifth Summ. 1: 304, 314, 320, 329, 331, 334, 338, 339, & 392—394 (1971) and 2: 570 & 839. 1971; Moldenke, Phytologia 32: 443 (1975), 33: 239 (1976), and 34: 72, 75, 76, 84, 85, 91, 93, & 94. 1976.

Additional illustrations: Meijer, Bot. Bull. Herb. Forest Dept. Sabah 10: p. prec. 225 [as A. alba]. 1968.

Hallier (1918), in his original description of this taxon, describes it as "Ramuli novelli, petioli, laminae pagina inferior, inflorescentiae, fructus ochraceo-tomentosi. Ramuli adultiores cinerascentes, parcius tomentelli, teretes. Folia breviter petiolata, coriacea, obovata vel obovato-lanceolata, obtusa vel acutiuscula, basi acuta, nonnumquam inaequilatera, supra viridia vel fuscentia, glabra, nitidula. Florum capitula terminalia et in foliorum supremorum axillis lateralia, paniculam parvam foliosam formantia. Pedunculi quadranguli. Bracteae subtus ochraceo-tomentosae. Flores pro genere mediocres. Sepala extus glabra, olivacea vel atrofusca, margine ciliata. Fructus amygdaliformes, ovati, a latere compressi, acuti, apice nonnumquam curvati. Foliorum petiolus 0,5—2 cm longus, lamina 4,5—11,5 cm longa, 17,5 mm x 5 cm lata. Paniculae usque 6 cm longae. Capitula ca. 7 mm diametro. Fructus (an maturi?) usque ultra 2 cm longi, 1,5 cm lati." He cites Zippelius 59b from New Guinea, Forsten s.n. from Little Seran, De Vriese & Teijsmann s.n. from Buru, Forsten s.n. from Halmahera, Elmer 10451a & 12006 from Mindanao, Curran 19385 from Negros, and Ahern 116, Hallier 3522, Perrottet 819, and Vi-

dal 497 from Luzon.

Recent collectors describe this plant as a shrub, 12 feet tall, branching from the base, or a tree, 40 feet tall, the trunk 3—10 inches in girth, the bark surface pale chocolate-brown and lenticellate, the inflorescences appearing black in bud, the corollas light orange-yellow (Chai PC.3), the pistil brown, and the fruit brown-tomentose. They have encountered it in sandy mangrove areas and on "inland well consolidated soil", flowering from April to August, and fruiting in April, May, and August. Fosberg found it to be "occasional at edge of mangrove swamps at sealevel" in Sarawak.

Burkill (1966) places an "Avicennia marina var. rumphiana..... of many authors" as a synonym of A. lanata Ridl.

Fedde & Schuster (1932) cite Beguin 933 from Ternate, Teijsmann 7795 from New Guinea, Robinson 301 from the Moluccas, Ahern 1160 & 148, Curran 3536 & 19385, Elmer 10451a & 12006, Merrill 583, Miranda 18272, and Ramos 4954 from the Philippines, and Watson & Burkill 3795 from Malacca.

Material of this variety has been misidentified and distributed in some herbaria as A. intermedia Griff. and as typical A. marina (Forsk.) Vierh. The "Avicennia alba" of Meijer's illustration (1968) is probably A. marina var. rumphiana instead. On the other hand, the J. V. Santos 4748 & 5148, distributed as A. marina var. rumphiana, are typical A. marina (Forsk.) Vierh.

Additional citations: MALAYA: Selangor: Chai 4 (Kl—14967), PC. 3 (Kl—14976). State undetermined: Medway s.n. (Kl—13294). MALAYAN ISLANDS: Langkawi: Turnau 745 (Kl—2745). PHILIPPINE ISLANDS: Luzon: Gill 2 (Ac, Ft—9712, Ft), 5 (Ft—9713, Ft, Z), s. n. [16 March 1970] (Ft—9727). GREATER SUNDA ISLANDS: Sarawak: F. R. Fosberg 43820 (N, W—2638786).

AVICENNIA MIOCENICA Berry

Additional bibliography: Moldenke, Phytologia 7: 266. 1960; Moldenke, Fifth Summ. 1: 375 (1971) and 2: 839. 1971; Moldenke, Phytologia 32: 365. 1975.

AVICENNIA NITIDAFORMIS Berry

Additional bibliography: Knowlton, U. S. Geol. Surv. Bull. 696: 109. 1919; Lamotte, Geol. Soc. Am. Mem. 51: [Cat. Cenoz. Pl. N. Am.] 80. 1952; Moldenke, Phytologia 7: 266—267. 1960; Moldenke, Fifth Summ. 1: 375 (1971) and 2: 839. 1971; Moldenke, Phytologia 32: 365. 1975.

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1962, nor Miq., 1918, nor Watt, 1958].

Additional & emended synonymy: Avicennia tomentosa Willd. in L., Sp. Pl., ed. 4, 3 (1): 395. 1800 [not A. tomentosa Blanco, 1845, nor Blume, 1918, nor R. Br., 1851, nor Jacq., 1760, nor "Jacq. sensu Schau.", 1939, nor L., 1821, nor L. & Jacq., 1783, nor G. F. W. Mey., 1818, nor Nutt., 1947, nor Nutt. & Br., 1832, nor Schau., 1940, nor Sieber, 1844, nor "sensu Marc.", 1971, nor "sensu Mayc.", 1965, nor Sw., 1864, nor Vahl, 1921, nor Wall., 1851, nor Weigelt, 1851]. Avicennia obovata W. Griff., Notul. Pl. Asiat. 4: 189—190. 1854. Avicennia tomentosa Lam. apud H. Hallier, Meded. Rijks Herb. Leid. 27: 90, in syn. 1918. Anacardium orientale Jouston ex Pételot, Archiv. Recherch. Agron. & Past. Viet-Nam 18: 255, in syn. 1953. Avicenia officinalis L. apud Masamune, Sci. Rep. Kanazawa Univ. 4: 50, sphalm. 1955. Avicennia officianlis Puri, Indian Forest Ecol. 2: 225, sphalm. 1960. Avicennia officialis Por ex "A. V.", Biol. Abstr. 57: 5223, sphalm. 1974.

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Additional & emended illustrations: Beddome, Fl. Sylv. Anal. Gen. pl. 22, fig. 2. 1872; Schimp., Indo-mal. Strandfl. pl. 6. 1891; Talbot, Forest Fl. Bombay 2: 362, fig. 456. 1911; Bakh., Bull. Jard. Bot. Buitenz., ser. 3, 3: pl. 20 & 21. 1921; Ernould, Mém. Acad. Roy. Belg. Cl. Scienc., ser. 2, 6: 5, 25, & 27, fig. 15—17. 1921; Annal. Mus. Colon. Marseille, ser. 4, 4: pl. 64. 1926; Mém. Acad. Malgache 5: pl. 20, fig. 56. 1927; Metcalfe & Chalk, Anat. Dicot. fig. 248 A & I. 1950; Arulchelvam, Ceylon Forest., ser. 2, 8: 74. 1968; Mallik & Chaudhuri, Bull. Bot. Soc. Bengal 22: pl. 1, fig. 11. 1968; Caratine, Blasco, & Thanikaimoni, Pollen & Spores 15: 287 & [289]. 1973; Mukherjee, Journ. Palynol. 9: 180, fig. 1—11. 1973; Mukherjee & Chanda, Geophytol. 3: pl. 1, fig. 1. 1973.

Recent collectors describe this species as a tree, 4—13 m. tall, the trunk 12—54 inches in girth, the bole 5 m. tall, with a diameter of 15 cm. at breast height, with pneumatophores and sometimes also with stilt-roots (prop-roots), shoots often to 15 feet tall from old stumps, the bark surface smooth, pinkish-gray or gray to brownish-gray, very thin, brittle, not fissured or narrowly cracked horizontally, the inner bark white, spongy, 2 mm. thick, the wood white, with the cylinders of soft tissue very conspicuous, the leaves dark-gray or dull-green above, rounded at the tip, green or gray-green to pale gray-brown beneath, the sepals dark-green, the petals 4 or 5, the stamens 4, yellow, brown-tipped, the anthers yellowish, turning black, the style greenish-brown, and the fruit a short capsule, green or pale-brown, covered with brown or shiny-brown to dark yellowish-brown tomentum.

The corollas are said to have been "yellow" on Chai S.30643 and Fosberg 36953, "bright-yellow" on Chai & al. S.26712, "dark-yellow" on Stone 5930, "cream, yellow inside" on Streitmann & Lelean NGF.18468, "pale-orange" on Darbyshire 784, and "orange" on Jayasuriya 1356.

The species has been found by collectors in mangrove swamps, disturbed mangrove areas, brackish swamps and mangrove deltas, and in sandy mud or water at the margins of mangrove swamps, on lagoon margins, at the edge of canals, on well consolidated soil near riverbanks, and on inland well consolidated soil by lagoons, in region of up to 60 inches rainfall, from sealevel to 3 m. altitude. They have collected it in anthesis in March, April, June, July, September, and October, and in fruit in March, July, August, and December.

The Streitmann & Lelean NGF.18468 collection was taken from a

"damaged tree with solid bole and numerous suckers"; Jayasuriya 2824g was also taken from a deformed tree. Womersley encountered the species in a mangrove forest dominated by Rhizophora apiculata, Bruguiera gymnorrhiza, B. parviflora, and Xylocarpus granatum, with an understory of Nypa fruticans.

A large number of common and vernacular names occur in the literature, but many of these probably really apply to A. alba Blume, A. marina (Forsk.) Vierh., A. marina var. acutissima Stapf & Moldenke, A. marina var. resinifera (Forst. f.) Bakh., or A. marina var. rumphiana (H. Hallier) Bakh., all of which taxa have frequently been confused with and misidentified as A. officinalis L. in the field and in the herbarium. Among those apparently genuinely applied to A. officinalis are "afi-afi", "api-api", "api-api brajoe", "api-api daun lebar" (=api-api with broad leaves), "api-api katjang", "api-api ludat", "api-api puteh" (white api-api), "api-api sudu", "apie-apie", "baen", "bâen", "bakal", "bani", "bina", "cher", "cheria", "cheriya", "delena", "ipati", "kajoeting",

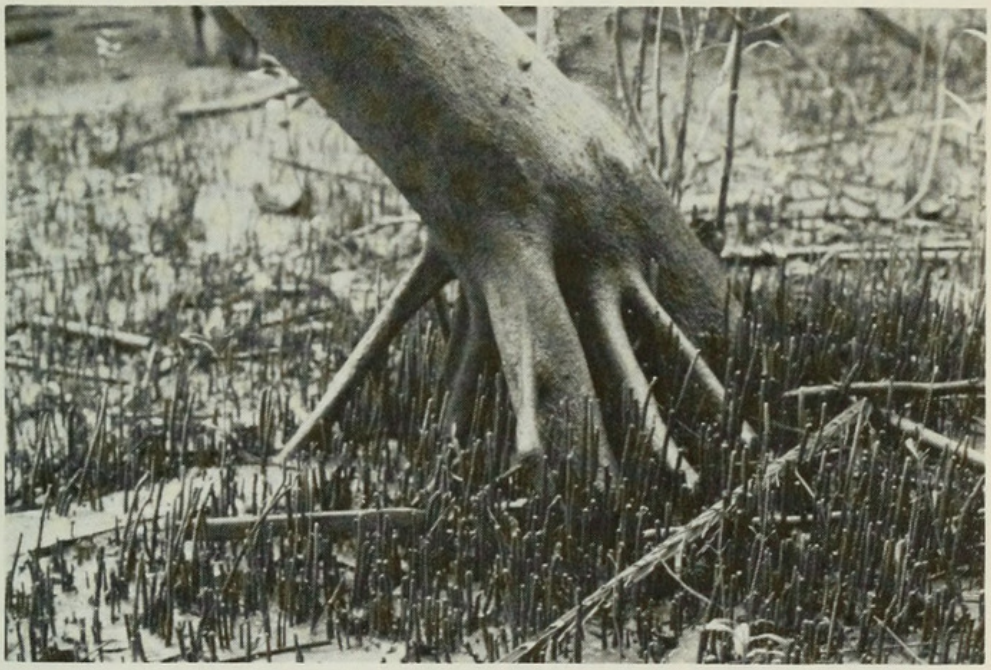

Fig. 1. Avicennia officinalis, showing pneumatophores and prop-roots. Sg. Santoboug, January 21, 1976 (photo courtesy of P. Chai)

"kujuh apie-apie", "kanna", "kari", "ki blanak", "ludat", "mada", "mada-chettu", "madda", "mǎm", "mǎm den", "manggi-mangiggi poetih", "mangrove", "nalla-mada", "palétuvier blanc", "palétuvier gaïac", "pèpé-pèpé", "purunde-mara", "sa-mae-tha-le", "tavar", "tavariya", "tavariyan", "tavra", "tavri", "tereh-tereh", "thame", "timar", "timmar", "tioes léwo", "tivar", "tivara", "tiwar", "udat",

"upatha", "upputi", "wata koemban", "white mangrove", and "white mangrove tree". "Hirugidamasi" and "hirugi-damashi" are recorded by Sonohara and his associates (1952) and by Masamune (1955), but surely apply to A. marina instead, as does their recording of A. officinalis from Iriomote, Ishigaki, Komi, Miyako, and Obama. Masamune also avers that A. officinalis has a natural distribution of "Taiwan; Fukien (?) to tropical Asia", but the species actually is not known from either Formosa or China. The vernacular names listed by Glover (1947) also apply, not to A. officinalis, but to A. marina.

The wood of A. officinalis is said to be known as "bakol" in the trade.

Tan & Keng (1969) report that in the vasculature of the [usually] 4-lobed corolla of 3 of the 4 species investigated three species have 4 traces each supplying one corolla-lobe, but in A. officinalis an additional trace runs into the posterior corolla-lobe. This suggests that the present 4-lobed corolla of the genus is probably derived from a 5-lobed ancient form and this is further borne out by the fact that 5-lobed corollas are occasionally found in A. officinalis. These authors also point out that even

Fig. 2. Avicennia officinalis, showing pneumatophores and prop-roots. Sg. Santoboug, January 21, 1976 (photograph courtesy of P. Chai)

though A. intermedia W. Griff. was originally proposed as a natural hybrid between A. officinalis L. and A. alba Blume, "seed-

lings of this species are uniform, and do not reveal any hybrid nature. Although the pollen-grains exhibit intermediate characters between A. alba and A. officinalis, they are mostly well-filled, rather than empty, thus suggesting that it is a distinct species [now known as A. marina (Forsk.) Vierh.]."

Fig. 3. Avicennia officinalis, showing prop-roots (photograph courtesy of P. Chai)

Mallik & Chaudhuri (1968) describe the pollen of A. officinalis as "3-colporate grains, prolate, 32 mu — 39 mu x 22 mu — 34 mu, exine 2.5 mu thick, reticulate, nexine thick at colpi margin, colpi 30 mu in length, 5 mu broad, crassimarginate, ora lalongate, mesocolpium diameter 19 mu."

Mukherjee & Chanda (1973) describe the wood of A. officinalis as having "distinct growth rings, which are diffuse porous and non-storied. Simple perforated vessels are generally multiple, 2—3

in radial sequence, diameter 20 mu — 100 mu and 150 mu x 40 mu in size. Fibres 300 mu — 350 mu x 20 mu — 25 mu in size, aseptate. Axial parenchyma with paratracheal vesicentric and apotracheal boundary parenchyma of 2—4 cells, thick layers having crystals. Multiseriate, /heterogenous rays are 260 mu — 480 mu x 32 mu in size."

These same authors describe the pollen grains as being the same

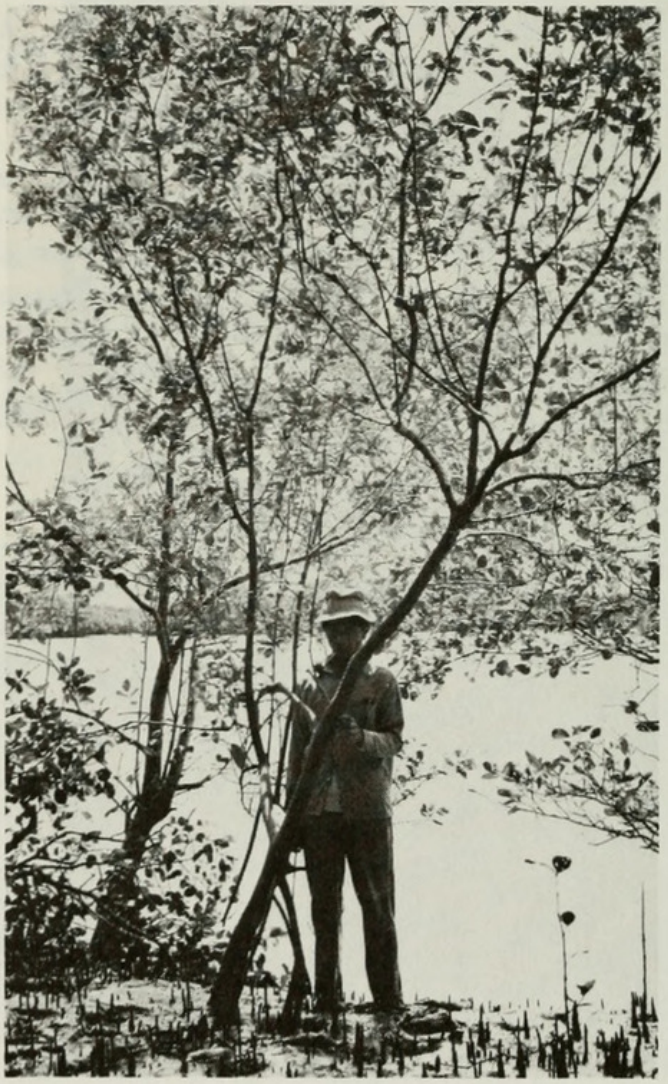

Fig. 4. Avicennia officinalis, showing prop-roots (photograph courtesy of P. Chai)

in all the species studied (viz., A. eucalyptifolia, A. marina, A. officinalis, and what they call "A. tomentosa Roxb.", by which they probably mean, in this case, A. alba): "tricolporate; colpi about 25 mu x 5 mu (range 22 mu — 35 mu x 4 mu — 5.5 mu) with thin margin. Ora lolongate, confined within the limits of colpi, about 9 mu x 5 mu (range 5 mu — 12 mu x 3 mu — 6 mu). Mean intercolporal distance 13 mu. Amb convex. Sexinal part of

exine projected outward, and devoid of any ornamentation. Mean apocolpium diam. 11 mu. Prolate-spheroidal to spheroidal, P/E about 32 mu x 31 mu (range 27.5 mu — 36 mu x 26.5 mu — 36 mu). Exine 3.5 mu thick. Sexine 2.5 mu thick, reticulate, intectate, muri simplibaculate, rarely duplibaculate, heterobrochate, lumina polygonal, dimension gradually becomes smaller towards the aperture. Bacula provided with distinct globular knoblike head. Nexine 1 mu thick, tenuiexinous. NPC classification 345."

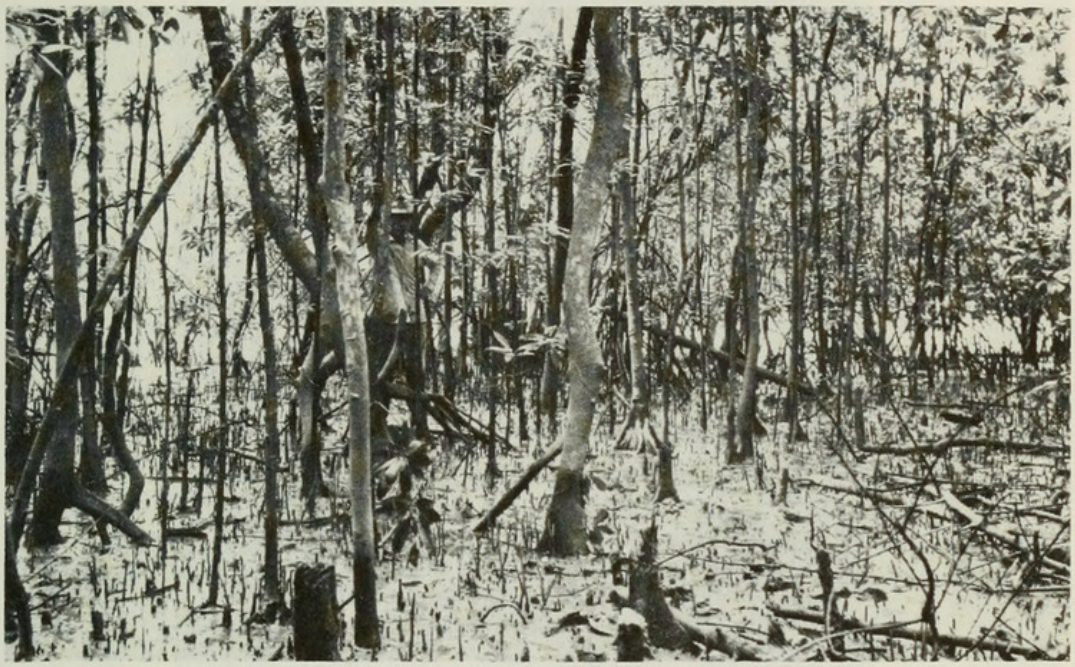

Fig. 5. General view of Avicennia officinalis forest in Sarawak (photograph courtesy of P. Chai)

Chai (1972) describes A. officinalis as it occurs in Sarawak: "Small to medium-sized tree —55 ft. tall. No buttresses but stilt roots may be present. Bark surface brownish-grey to chocolate-brown, lenticellate, may be narrowly cracked. Leaf spatulate or spoon-shaped, lower surface very light brown; salt excretion from upper surface. Fruit more or less heart-shaped, slightly flattened, beaked, covered in soft, brown tomentum. Occurrence: Commonly inland but not gregarious, along river or creek banks on stiff heavy soils; absent or very rare on the sea face. Associated with low and light crowned species like Nypa and young Rhizophora and Bruguiera." He keys out the three species known to him in Sarawak as follows:

1. Small shrub (3 feet tall) to large tree (to 60 feet tall), the old bark grayish-pink or pinkish-brown, coming off in patches of irregular thin flakes, revealing the green new bark; leaf-shape elliptic; inhabiting sandy soil.....A. marina.

1a. Medium to large tree, to 70 feet tall, the bark dark-gray to

black, not flaky; leaf-shape lanceolate; inhabiting soft mud.....A. alba.

1b. Small to large tree, to 55 feet tall, the bark gray to chocolate-brown, often lenticellate; leaf-shape spatulate or oblong-obovate; inhabiting inland areas often on firm riverbanks.....A. officinalis.

Fig. 6. Avicennia officinalis, showing prop-roots and pneumatophores (photograph courtesy of P.Chai)

Fosberg found A. officinalis "common in interior of swamp" at Singapore, while Mcnae reports it "at rear of Avicennia fringe along lagoons" in Sri Lanka. Puri (1960) and Chapman (1970) aver that A. officinalis sometimes grows in A. alba Blume communities in the Sunderbans of Bangladesh. There it may occur in association with Bruguiera gymnorrhiza, Carapa moluccensis, Heritiera minor, Sonneratia apetala, and S. arida.

According to Uphof (1941) A. officinalis has been cultivated (in pots) in the Hamburg Botanical Garden, Germany. Chapman (1970) proposes the ecologic association Avicennietum officinale. The embryology of the species is thoroughly discussed by Padmanabhan (1964): "The first division of the primary endosperm nucleus is followed by a transverse wall. The upper chamber again divides transversely leading to the formation of a row of three cells including the primary chalazal chamber which forms a uninucleate

Fig. 7. Avicennia officinalis, showing prop-roots (photograph courtesy of P. Chai)

chalazal haustorium. The micropylar chamber divides vertically to give rise to a two-celled micropylar haustorium while the middle cell forms the endosperm proper. The micropylar haustorium cells become multinucleate, one of them containing eight and the other having four nuclei. The cell with eight nuclei forms an aggressive haustorium growing through the ovular tissues towards

the chalaza putting forth numerous lateral branches and then into the placental column where the branches become much more extensive and ramify into the tissues. The endosperm proper grows out of the ovule carrying the embryo with it; thus a major part of the cellular endosperm and the embryo embedded in it come to lie in the locule, where their further development takes place. In older stages of development, the two cells of the micropylar haustorium develop plasmodesma-like connections. Similar connections are also established with the contiguous endosperm cells. The growth of the haustorial branches in the ovule and placental column is strictly intercellular."

Fig. 8. General view of Avicennia officinalis forest in Sarawak (photograph courtesy P. Chai)

Avicennia officinalis is the type species of the genus. Gunawardena (1968) reminds us that the medicinal value of the species was recognized even in Linnaeus' day, as is shown by his use of the specific epithet, officinalis (from officina, a druggist's shop, indicating that the plant was to be found in pharmacies in his time).

Clarke (1885) gives the species' distribution as "Mangrove swamps of the Deccan Peninsula [of India] and Ceylon, common; less frequent in the Malay Peninsula.....Malaya, Shores of the Indian and Pacific Ocean." Benoist (1931, 1933) mistakenly records it from French Guiana — it does not occur in the New World. Guha Bakshi & Sen (1969) record it from Sagar Island (West Bengal, India), citing their no. 53. Santapau & Shah (1969) list it from Salsette Island. Foreman (1972) records it from Bougainville Island, citing Rechinger 4927. The Foreman work is

sometimes cited in bibliographies as "1971", the title-page date, but it was not actually published until 1972. Inamdar (1971) lists A. officinalis from Gujarat, India.

Agarwal (1970) gives its range as "Distributed in Bengal, Coastal and tidal forests of India & Burma, Andaman and Nicobar Islands". He describes the wood as "brownish gray, hard", with a weight of 26.30 kgm. per cubic foot, asserting that it is "Used generally as fuel or firewood and in Andaman Islands for rice-pounders." Gaussen and his associates (1967) affirm its value in serving as a colonizer of intertidal zones and estuaries. Hartwell (1971) asserts that the fruit is used in India to make plasters used in the treatment of tumors. In Thailand, according to Rativanich & Dietrichs (1971) the heartwood is employed as a vomitive and poison counteractive, as well as to treat coughs, asthma, rickets, diabetes, dropsy, gonorrhea, diarrhea, and dysentery, the sapwood is used as a snake venom counteractive, and the bark is employed in the treatment of leprosy.

Cook (1906) tells us that "Though the bark possesses tanning properties and is said to be used as a tanning material in Rio Janeiro, it does not seem to be so employed in India." Actually, the species does not occur in Brazil, nor anywhere else in the New World. The Rio de Janeiro species here referred to is probably A. schaueriana Stapf & Leechman, the commonest species in the vicinty of that port city. Similarly, Sonohara and his associates (1952) report that the bark of A. officinalis yields a resin on Okinawa, but the species does not occur there -- the species to which he is here referring is A. marina (Forsk.) Vierh.

Thwaites & Hooker (1861) report A. officinalis "Not uncommon near the sea" in Sri Lanka, but Alston (1931) regards it as "rare" there, A. marina being the common species there. Arulchelram (1968) describes A. officinalis as it occurs in Sri Lanka as "A small tree with a straight trunk. Bark, gray or black, young twigs quadrangular and finely pubescent. Leaves yellowish green above and silvery white beneath, with dense, fine pubescence. 2 1/2 to 4 inches long by 1 1/2 to 2 1/2 inches broad. Elliptical, apex rounded with 6 to 9 opposite or subopposite lateral veins. Other characters similar to Avicennia marina." He completely misses the very important differences in flower size.

Hallier (1918) found A. officinalis growing in association with Ceriops roxburghiana, Allophylus sp., Clerodendrum inerme, Hibiscus sp., Wedelia biflora, Cerbera odollam, Heteropterys sp., Glochidium sp., Acanthus ilicifolius, Pluchea indica, Premna foetida, and Acrostichum aureum. He cites Wight 2328 and Hohenacker 68 from India, Hallier B.271 from Borneo, Junghuhn s.n. from Java, Teijsmann 1753 from Madura, Elbert 2701 from Buton, Versteeg 1887 from New Guinea, and Hallier 3521 and Perrottet s.n. from Luzon. Interestingly he gives the following argument for discarding Linnaeus' epithet for this species: "Daraus, dass Linné seine A. officinalis in die Klasse Tetrandria gestellt hat, zog Buch.-Hamilton den Schluss,

dass ersterem thatsächlich Blütenzweige einer Art der Gattung Avicennia aut. vorgelegen hatten. Da aber keine Art dieser Gattung jemals offizinell war, so kann sich die Arbeitzeichnung officinale nur auf das Synonym Anacardium Bauh. (=Semecarpus Anacardium L. f.) beziehen. Der von Linné gegebene Artname ist also nicht brauchbar und Hamilton hat der Pflanze von Vorderindien mit vollem Recht einen neuem Name gegeben. Durch wiedereinführung des letzteren wird die ganz später noch erheblich vermehrte Unsicherheit der Namengebung beseitigt." I regard Anacardium Bauhin as a synonym of Avicennia alba Blume.

Rao, Aggarwal, & Mukherjee (1963) found A. officinalis growing with Atriplex repens in an inland creek habitat on soil that was "dull white coloured with a pinkish tinge" and with a pH of more than 8.2, with 0.503 percent organic matter, 0.177 percent soluble salts, 0.12 percent NaCl, and 70.59 percent calcium carbonate.

Santapau (1967) records the species from Saurashtra, India. Esfandiari (1967) and Parsa (1949) list it from Iran ("Kerman" and "S-E Baloutchestan"), but, although I have not as yet seen any Avicennia material from Iran, it seems most probable that the taxon to which reference is here made is A. marina var. acutissima Stapf & Moldenke, the only form known from neighboring Sind in Pakistan, from which I have seen abundant material.

Backer & Bakhuizen (1965) list A. officinalis as one of the species "sometimes planted between and along coastal fish-ponds" in Java and comment that "The wood is of very inferior quality, and is almost exclusively used for fuel. This tree is often spared in localities where producers of better wood are continually felled, consequently in the course of time there may locally arise an almost pure Avicennia forest. Such forests are in Java always anthropogenous; they constitute a climax-form of selective devastation of litoral forests coupled with spontaneous regeneration, and are found only in inhabited regions."

These authors describe the species well: "Expanded flowers 10—15 mm across; corolla from the base of the tube up to the tops of the segments measuring 7—10 mm; posterior segment broadest, shallowly bilobed; stamens (inclusive of anthers) 3.5—4.5 mm long; ovary densely appressed-pubescent throughout; style subulate, pubescent throughout or at least at base, 3—4 mm long; stigmatic lobes much shorter than the rest of the style, often unequal; fruit acuminate, densely short-hairy. Flowers to the number of 2—12 congested into a head; lowermost pair of flowers often distant from the other ones. Leaves obovate, oblong-obovate or elliptic-oblong, narrowed into the petiole, rounded or very obtuse, yellowish green or bluish gray beneath, 4—12.5 cm by 2—6 cm." They assert that in Java it grows "especially along riverbanks" in the coastal area.

Monsalud and his associates (1966) assert that in the Philippines the fruits and leaves of this species are "Eaten either raw or cooked", and describe the tree as it occurs there as "of the

outer part of the swamp. Bark usually light gray or brown and rather smooth but finely checked by small cracks. Air roots numerous, small, conical and 8 to 20 cm. long. Leaves leathery, opposite, dark green above, very pale and hairy beneath, usually somewhat rounded at apex, narrow at base, midrib stout and very prominent. Flowers small without individual stalks and in small heads on stiff angular flowering stalks. Flowers 3 to 7 in each head. Corolla orange yellow. A capsule fruit 2.5 to 4 cm long and contains a single seed which completely fills the capsule. Found throughout the Philippines along muddy shores and tidal streams." Actually, its flowers are the largest of all the Philippine species.

Burkill (1966) describes A. officinalis as "A tree attaining 60 feet in height, sporadic on the banks of rivers in their course through the mangrove-belt. Outside Malaya, it extends from Persia to Hong Kong and to New Guinea." However, this species is not actually known from Persia [see above] or Hong Kong — A. marina (Forsk.) Vierh. being thus misidentified in the latter case and A. marina var. acutissima Stapf & Moldenke in the former.

Rao & Sastry (1972) affirm that in at least some parts of the Indian coast A. officinalis grows in association with Pemphis acidula, Cordia subcordata, Atriplex repens, Salicornia brachiata, and Suriana maritima under seawater imundation.

Angely (1971) is in error when he states that A. officinalis is "Pantropical" in distribution — actually it does not occur in the American or the African continents at all. Lamberti (1969) also makes the error of including the distribution of A. marina and A. marina var. resinifera with that of A. officinalis — A. officinalis does not occur in East Africa, Madagascar, Japan, China, or the "Ilhas sul Japonesas" as he says that it does!

Patel (1971) asserts that in Gujarat, India, A. officinalis is a tree, contrasted to A. marina var. acutissima being only a "shrub". He describes the former as "A small tree with smooth bark, shining leaves and yellow flowers. Grows in muddy creeks along the coast. The leaves are eaten by cattle." He aserts that in Gujarat it flowers from March to June and fruits from June to September. Cooke (1906) avers that in Bombay it flowers from April to June.

Troup (1921) provides another interesting description: "A large evergreen shrub or small tree of the mangrove swamps along the coasts and tidal creeks of India and Burma. It is one of the commonest of the Indian mangrove species, growing gregariously, and often forming an extensive bushy growth, conspicuous from its grey foliage [this applies far better to A. alba and A. marina with which it is often associated!], and when in flower from its bright yellow inflorescences. In the Sunderbans it occurs in the inland parts of the littoral forest, and is characteristic of bhils, or moist depressions. It is common along the coasts of both sides of the Indian Peninsula as well as of Chittagong [Bangladesh], Arakan, and Burma. In the Sittang estuary it sometimes forms 60 or 70 per-

cent of the stock, and reaches a height of 25—30 ft. with a girth of 2—3 ft.

"The wood has a peculiar structure, consisting of alternate layers of pore-bearing tissue and loose large-celled tissue without pores. It is brittle, and is used only as fuel, but in some localities it is an important fuel species.

"The panicled heads of yellow flowers appear from March to June, and the fruit ripens from August to October.....The seeds germinate immediately they fall, or even on the tree....The seeds are buoyant, and are thus able to spread by the agency of water; about October the tidal creeks are often full of the large seeds floating on the surface of the water, and most of this seed will be found to be germinating. To collect the seeds for artificial reproduction, the best method is to drag with a small net, and throw the seed into a canoe, partly filled with water, which should then proceed straight to where the seed is to be sown without delay. In Madras it is usual to sow the seed broadcast, the best time being between new moon and full moon, when the tides are lowest; the sowing is done when the tide has run out and there is no water on the ground, otherwise there is danger of the seed floating away.

"Under favourable conditions the tree regenerates freely from seed. The necessary conditions appear to be frequent flooding and absence of dense low cover, which the seedlings do not tolerate. Thus the lowering of the water-level results in a cessation of reproduction, while a dense growth of Acanthus ilicifolius, prevalent in some localities, tends to kill out the seedlings. The tree does not coppice well. Its lateral roots spread in all directions through the mud in which it grows, and send up a plentiful crop of pneumatophores. Mr. A. W. Lushington has observed that in the Kistna mangrove forests these ultimately develop leaves and become trees. This has not been recorded in any other locality, but in view of the poor coppicing power of the species it is a question of importance which requires further investigation in different localities."

Kräusel (1931), quoting Emould's (1921) detailed work on respiratory roots, speaks of the anatomy of the "Luftwurzeln" of mangroves: "Sie weisen gewisse gemeinsame Merkmale auf. So besteht die Rinde stets aus einem reich entwickelten Parenchym mit zahlreichen Interzellularen, die bei manchen zu grossen radialen Spalten werden können, und ebenso ist stets eine Verbindung mit der Aussenluft vorhanden.....durch Lenticellen [Avicennia officinalis, Bruguiera gymnorrhiza, Lumnitzera, Carapa] oder Pneumathoden [palms]."

Sen Gupta (1938) reports the measured osmotic pressure in Avicennia officinalis as 25.92. Cooper & Pasha (1935) found that the "suction pressure" is greatest in the leaves, medium in the stem, and lowest in the roots, with a marked increase noticed from August to October in India. They agree with other workers that in halophytes such as this there is a more vigorous transpiration than is found in mesophytes. It is possible that the rise in the

suction pressure is brought about by this vigorous transpiration rate which may bring about greater absorption of salts along with the water in the cells. The physiological anatomy, as compared to that of A. alba and of mangroves of other genera, was also reported on in detail by Mullan (1932).

Estores Anzaldo and his associates (1958) found that the leaves of A. officinalis give a negative hemolysis test for saponins, but that the stems give a positive saponin test with an estimated steroidal sapogenin content of 0.52 percent.

Nairne (1894) says of the species: "Very common in salt marshes [of western India]; in black rocks covered by every tide it grows as a stunted shrub, and is said to grow in the same way on the coasts of the Red Sea, Africa, Australia, and S. America." This, of course, is not true, since A. officinalis does not grow in either the Red Sea area, Africa, or South America -- the Red Sea and African plant is A. marina, while that of South America may be any of six species and varieties.

Trimen (1895) found A. officinalis "in shallow salt water or sandy tidal flats on the coast [of Sri Lanka]; common". He claims that it flowers there from August to October, with "pale dull yellow" flowers. He also makes the claim that its natural distribution is "Throughout Tropical Asia, Africa, and America", but, again, the species does not occur in either Africa or America. He continues: "There is no specimen or drawing in Herm. Herb. This is one of the trees known as mangroves, and is often called 'white mangrove'. The large embryo usually germinates in the fruit before it falls, but the tree has no stilts. It often occurs over large tracts of tidal or flooded shore to the exclusion of all other plants, as dwarf bushes half covered at high water. Its roots bear great numbers of erect processes (like those of Sonneratia), the points of which stand above the shallow water; these are capable of producing leaves and growing up into bushes, but rarely do so.....When dry, the leaves turn black above and silky-white beneath [this statement applies to A. marina, not to A. officinalis!]. The bark is astringent, and might be used for tanning purposes."

Dymock (1893) comments that "The green fruit mixed with butter and boiled is made into a plaster, which is used for softening and maturing tumours, and to promote the healing of the ulcerations caused by small-pox. This property of the fruit is alluded to by Camoens in the 'Lusaid' --

'Wide forests there beneath Maldivia's tide
From withering air their wondrous fruitage hide.
The green-hair'd Nereids tend the bowery dells
Whose wondrous fruitage poison's rage expels.'

"The bark is astringent and is used by tanners. In Madras the ashes of the wood are used by washermen for washing clothes. The wood is valued on account of its durability under water, and as a fuel for heating furnaces it is preferred to other kinds of wood on the West Coast of India. The seeds are bitter, but are sometimes eaten.....The bark of A. officinalis is used in Madras as

a dyeing agent rather than as a tan. It contains a red colouring matter striking a greenish colour with ferric chloride but giving no precipitate with gelatine. The colouring matter is precipitated by acids and redissolved by alkalies. The ash of the air-dried bark amount to 11.4 per cent. and is deliquescent." Van Katesan (1966) reports 5 percent of tannin in the stems and bark.

Rageau (1957) quotes Verguin (1956) to the effect that "à Madagascar, l'infusion de feuilles est préconisées contre la fièvre jaune", but A. officinalis does not occur in Madagascar -- the species there is A. marina.

It is of interest to note that, according to Scopoli (1777), Osbeck gives this description of the fruit of A. officinalis: "Avicenniaee. offic. Fructus nuci similis, nuclei loco fovens succum nigrum."

Paul Chai, Forest Botanist in the Office of the Conservator of Forests, Sarawak, has very kindly sent me some excellent photographs taken by him of specimens of A. officinalis in Sarawak, herewith published with his permission. In letters to me dated September 14, 1971, May 25, 1973, and August 11, 1973, he states that from his own observations in the field A. alba var. latifolia Moldenke has "lenticellate bark surface throughout the main trunk", a feature not exhibited by A. marina or A. officinalis in Sarawak. He also avers that he has "found in Sarawak some individuals of all 3 species (alba, marina and officinalis) [which] possess stilt roots. These individuals were found to be confined to soft muddy soils.....Unlike the stilt roots of Rhizophora, stilt roots of Avicennia are more slender and soft. They arise in the same way as aerial roots which extend and reach the mud eventually. A. officinalis which is found on firm soil along river banks further inland produces aerial roots from about the middle of the trunk way above the ground. In this case they seldom reach the ground and eventually dry off and die but those that are formed nearer the ground do reach the soil." He continues: "I agree with you that A. marina cannot be distinguished from A. intermedia."

Janssonius (1926) investigated the microscopic characteristics of both the cross- and tangential sections of the wood of A. officinalis, based on Koorders 12938β, 12944β, 20623β, 20633β, 39760β, & 29800β from Java. The wood anatomy is also discussed by Baker (1916).

Basu (1965) describes cultivation experiments with this species in the Indian Botanic Garden where there was 67 percent seed germination and seedling survival to 7.5 cm. height and the production of 4 leaves per plant.

Manjunath (1948) describes A. officinalis as "a shrub or small tree of the salt marshes and tidal forests of India, Burma, Ceylon, and the Andaman Islands. In the Sunderbans, it grows to a fairly big tree, 40--60' high, with a girth of 12--15'. On the Coromandel coast it is generally a bush. It is also common along the

coasts or Burma. Two or three varieties are differentiated by the colour of the bark, which may be black, white or mottled. The wood is brittle and coarse-grained, and is used only as fuel [in India]. On account of its attractive grain, the wood may find a place in small cabinet work, and is recommended for trial as creosoted paving blocks."

Then he apparently confuses this taxon with A. marina, for he goes on to say "The wood from Tanganyika was found to contain cellulose, 54.7 percent and ash, 2.3 percent of moisture-free wood. In paper-making trials, it was readily pulped by the soda process, on account of the shortness of its fibres. The pulp, however, was not easily bleachable. Besides, the wood chipped badly producing a large proportion of waste.....Wells has examined the tar prepared from the wood.....(1917), and the wood-ash is reported to be rich in alkali.....The tannin content of the bark is only 2.5 percent.....with 12 percent of non-tannins. The kernel of the fruit, though bitter, is reported to be edible. The leaves are used as cattle fodder in Australia....The green, bitter and somewhat aromatic resin which oozes from the bark is said to possess medicinal properties." It is not clear just how much of this information applies to the African tree (A. marina), the Australian tree (probably A. marina var. resinifera), or the Indian tree (A. officinalis).

Pételot (1953) provides a very lengthy review of reputed uses of A. officinalis in various parts of the tropics then under French influence, with quotations from local physicians, but in his report there are quotations which most certainly do not apply to A. officinalis, but rather to A. marina, A. marina var. resinifera, A. germinans, and perhaps even other taxa. Among the uses ascribed by him to what may actually be A. officinalis are the following: in Vietnam "L'écorce est ordinairement employée contre les maladies de la peu et principalement contre la gale". In India "les racines possderaient des propriétés aphrodisiaques et que les graines immatures seraient employées en cataplasme pour faire mûrir les abcès. Il signale également que les cendres du bois seraient employées en guise de savon.....L'écorce d'Avicennia n'a aucune action sur le coeur, elle augmente la diurèse. Quelquefois on rencontre de l'intolérance, l'effet le plus constant est marqué par des nausées et des vomissements. A une dose assez élevée (7 à 8 g. d'extrait mou), it se produit des céphalées opiniâtres et insupportables.....Dans son travail, Bocquillon-Limousin [1911] calque les préparations galéniques d'écorce de Palétuvier sur celles d'écorces de quinquina. On peut donc en fabriquer un vin et un extrait mou." He gives two detailed chemical analyses which may apply to this species, but the lengthy description of its use in the treatment of leprosy in Cuba, and its uses in French Guiana, Australia, New Caledonia, Guadeloupe, and Mexico obviously apply to other taxa than this one.

Watt & Breyer-Brandwijk (1962) have also mixed data applying to A. marina with data applying to A. officinalis, but of the informa-

tion which they give and which may well apply to the latter taxon is the following: "The bark which is astringent contains tannin.. is used as [a] dyeing agent in India and in Madras the ash from the wood has been used for washing clothes....The fruit is eaten as an ordinary article of diet by the fishermen of Java and the Celebes....but....in the Celebes the fruit is a famine food, being soaked in water for a fortnight and then boiled for use. The seed is bitter but edible.....The sapwood yields a resin...which is used in the Philippines as a local application in snake-bite.. and in western Java as a contraceptive.....In India as well as in the Philippines the seed cooked in water is applied as a maturative poultice and as a cicatrizing agent in ulcers....The cortical portion of the wood yields a crystalline substance, identical with lapachol...."

Uphof (1968) also affirms that the astringent bark is used as a tanning material, ashes of the wood are employed for washing and cleaning clothes and mixed by painters with their paints in order to make the paint adhere more firmly, while the wood itself is used for fuel, for making cheap beams and door-frames, the green fruits are used in India as a poultice in the treatment of boils, etc.

It should be noted here that the "A. tomentosa" of Blanco, referred to in the synonymy of A. officinalis, is a synonym of A. marina var. rumphiana (H. Hallier) Bakh., while the homonym of it credited to Blume is a synonym of A. alba Blume, that of Brown and of Sieber (in part) is A. marina var. resinifera (Forst. f.) Bakh., that credited to Jack, to Jacquin, to Linnaeus & Jacquin, to Meyer, to Nuttall, to Nuttall & Brown, to Sieber (in part), to Swartz, and to Weigelt is A. germinans (L.) L., that credited to Linnaeus, to Vahl, and to Wallich is A. marina (Forsk.) Vierh., and that credited to Schauer, to "Jacq. sensu Schau.", to "sensu Marc.", and to "sensu Mayc." is A. schaueriana Stapf & Leechman.

Avicennia tomentosa (mostly credited to Jacquin) is given as a synonym of A. officinalis by Watt (1889), by Trimen (1895), by Baker (1900), by Prain (1903), by Cooke (1906), by Glover (1947), by Parsa (1940), and by Hartwell (1971), but actually only A. tomentosa Roxb. and A. tomentosa Willd. belong in the synonymy of A. officinalis L., although the "E. [sic] tomentosa Roxb." of Mukherjee & Chanda (1973) is probably A. alba Blume. Boissier (1879) regards "A. tomentosa Wall." as a synonym of A. officinalis, but actually it belongs in the synonymy of A. marina (Forsk.) Vierh. Clarke (1885) not only includes A. tomentosa Jacq. in the synonymy of A. officinalis, but also A. resinifera Forst. and Halodendron thouarsii Roem. & Schult. and comments that "Mr. Bentham considers the American and African A. tomentosa not specifically separable" -- thus apparently adding A. germinans (L.) L. and A. africana P. Beauv. to its synonymy, a completely untenable disposition.

Griffith (1854) keeps A. tomentosa Jacq. as distinct and places "A. tomentosa Roxb." in the synonymy of what he calls A. obovata W. Griff. [obviously conspecific with the older A. officinalis, for which it was merely a new name]. The "A. tomentosa L." of Don (1830) probably applies to A. marina, but the A. tomentosa of Good (1964) appears actually to refer to A. officinalis L.

Baker (1900) gives the extralimital distribution of what he calls A. officinalis as "Also in Egypt, Natal, and the tropical shores of both hemispheres" — again, an obvious mixture of the distributions of several taxa, since A. officinalis does not occur either in Africa nor in the Western Hemisphere.

Schubert (1969) notes that, under the present International Code, Bontia germinans L., Syst. Nat., ed. 10, 2: 1122 (1759) "was nomenclaturally superfluous when published since it included Avicennia officinalis Linn. 1753 (the Asiatic mangrove). However, according to Art. 63, Note, since the American mangrove is considered to be specifically different from the Asiatic, the name A. germinans is the correct name [for the American portion of the material included in Bontia germinans]."

It should also be noted here that the "Avicennia officinalis L." of Harvey (1868), of Baker (1900), of Almagia (1903), of Dunn & Tutcher (1912), of Parthasarathy (1927), of Sasaki (1928), of Wangerin & Krause (1941), of Glover (1947), of Verguin (1952), of Montasir & Hassib (1956), of Watt & Breyer-Brandwijk (1962), of Khattab & El-Hadidi (1971), of Weiss (1972), and of Por (1973) actually is A. marina (Forsk.) Vierh., while that of Ostenfeld (1918), of Cockayne (1921), of Wangerin (1923, 1926, 1935), of Laing & Blackwell (1927), and of Rageau (1957) is A. marina var. resinifera (Forst. f.) Bakh. and that of Khan (1961) is A. marina var. acutissima Stapf & Moldenke.

Parsa (1949) includes "A. resinifera Forst." and Halodendron thouarsii Roem. & Schult. in the synonymy of A. officinalis L. Burman (1768) erroneously regarded Oepata Rheede as a synonym of the American Avicennia germinans (L.) L. Melchior (1946), DeWit (1967), and Amico & Bavazzano (1968) mistakenly reduce A. officinalis L. to the synonymy of A. marina, while Corner & Watanabe (1969) take the equally erroneous opposite course and reduce A. marina to the synonymy of A. officinalis! Both dispositions are palpable incorrect — the two taxa are separate, distinct, and valid species!

Hallier (1918) adopts the name, "Avicennia oepata Ham.", for A. officinalis L. and includes as synonyms A. officinalis L., A. tomentosa Lam., A. obovata Griff., "Avicennia L., Fl. Zeyl. 23. 1748", Bontia germinans L., and Oepata Rheede. Burkill (1966) places what he calls the "A. officinalis, of many authors" in the synonymy of A. lanata Ridl.

Crevost & Pételot (1934) actually include A. alba Blume, A.

africana P. Beauv., A. floridana Raf., A. elliptica Thunb., A. lamarckiana Presl, A. meyeri Miq., A. oblongifolia Nutt., A. tomentosa Jacq., and A. resinifera Forst. in the synonymy of A. officinalis L.! Of these, 3 are themselves valid species, one is a variety of A. marina, and the other 5 are synonyms of A. germinans. The reputed medicinal uses listed by these authors is similarly a hodgepodge of data applying to various of these taxa.

Kuntze (1891) divided A. officinalis into varieties as follows:

α nitida (with "A. africana Beauv. non Schauer" as a synonym), with "Folia anguste lanceolata (1: 4—8) rarius obtusiuscula", from St. Thomas (West Indies);

β lanceolata, with "Folia late lanceolata (1: ±3)", from Trinidad and "Auch in den anderen Erdtheilen innerhalb des heissen Zone nicht selten";

γ ovatifolia, with "Folia ovata acuta obtusiuscula (1: ±2)" from Cochinchina and Java;

δ spathulata, with "Folia ovata (1: ±2) apice rotundata vel retusa basi attenuati";

ε spathulata f. tomentosa, with "Pubescentia pulerulenta [=puberulenta? pulverulenta?] densior subvelutina" from Singapore (with "Avic. tom. auct. pl. vix L. ex Jacq. l.c. [am. t. 112] f. 2 foliis 'cordato' ovatis");

ζ spathulata f. glandulosa, with "Folia glabra glandulis pellucidis crebris punctiformibus munita. Calyx cum bracteis viscosis" from Java.

Of these, I regard var. nitida as A. germinans (L.) L., A. africana P. Beauv. as valid, var. lanceolata as A. germinans var. guayaquilensis (H.B.K.) Moldenke, var. ovatifolia as A. marina (Forsk.) Vierh., var. spathulata and its f. tomentosa as A. lanata Ridl., and var. spathulata f. glandulosa as possibly A. marina var. resinifera (Forst. f.) Bakh. or true A. officinalis L. (more probably). Kuntze reduces "A. officinalis 'S. Kurz' Fl. Burma non L.", "A. alba Miq.", and "A. officinalis var. alba Clarke" to synonymy under what he calls A. spicata Kuntze (and which I regard as the true A. alba Blume).

It should also be noted here that as yet I have not been able to see copies of the two additional illustrations listed for A. officinalis on a previous page of this paper, and feel that probably they will be found to represent, not A. officinalis, but A. marina instead.

The Chai S.30643 collection, cited below, is accompanied by wood samples in at least some herbaria; Collector undetermined s.n. [Panadura, Oct. 27, 1881] and G. Gardner s.n. [Thwaites C.P.1961] are mixtures of A. officinalis L. and A. marina (Forsk.) Vierh. The Neth. Ind. For. Serv. bb.24925, cited below, is placed here doubtfully.

Some material of A. officinalis has been misidentified and dis-

tributed in herbaria as A. marina (Forsk.) Vierh. or as A. marina var. resinifera (Forst. f.) Bakh. On the other hand, the Falconer 241 and J. Schmidt 141, distributed as A. officinalis, actually are A. alba Blume, H. M. Curran 240 & 252 and L. H. MacDaniels 2010 (in part) are A. germinans (L.) L. or one of its varieties, Schimpff 30 is probably A. germinans var. guayaquilensis (H.B.K.) Moldenke, Backer s.n. [3-XII] & s.n. [Batavia], H. H. Bartlett 13706, Forster 117, Hildebrandt 3234, Holst 3059, Kurz 107 & s.n. [South Andamans], Loher 4450, Meebold 12828, Pappi 3168, Prain's Collector 74, Schimper s.n., Schlieben 5787, G. Schweinfurth 966, Sieber Fl. Nov. Holl. 268, Surapat 358, and Tirvengadum & Waas 465 are A. marina (Forsk.) Vierh., Baas Becking 6185, Balansa 1337, J. H. Davis s.n. [May 1950], Doore & Earle 276, MacDaniels 2010 (in part) & 2504, McKee 2114 & 3153, Meebold 3402, 5233, & 7304, F. Mueller s.n. [Northern part of York Peninsula], Vieillard 1050, and K. Wood s.n. [22-6-52] are A. marina var. resinifera (Forst. f.) Bakh., and Chai 4 & PC.3 and Fosberg 43820 are A. marina var. rumphiana (H. Hallier) Bakh.

Additional citations: INDIA: Kerala: Collector undetermined 2599/1837 (Pd); Manilal 9 (Ac). SRI LANKA: Collector undetermined s.n. [Panadura, Oct. 27, 1881] (Pd); Davidse & Sumithraarachchi 8978 (Ld); G. Gardner s.n. [Thwaites C.P.1961, in part] (Pd); Jayasuriya 1356 (Ld, N, W—2765419); Macnae s.n. (W—2680242); Moldenke, Moldenke, & Jayasuriya 28249 (Ac, E, Gz, Kh, Ld, Pd, Tu); Tirvengadum, Cramer, & Balasubramium 245 (W—2764111); Worthington 529 (Pd). BURMA: Tenasserim: Falconer 383 (Pd), 388 (Pd). MALAYA: Penang: Wallich 1742/1 (Pd). Selangor: Kasi bin Rajab 103 (Kl—1103, Kl), 4631 (Kl—4631); Khoo & Ming N.K.068 (Kl—8637); B. C. Stone 5930 (Kl—5616). Singapore: A. M. Gill 20 (Ac, Ba, Ft—9688), 21 (Ft—9692, Z); F. R. Fosberg 36953 (W—2584970a). GREATER SUNDA ISLANDS: Java: Koorders 20698β (Pd). Sarawak: Chai S.29942 (Ac), S.30643 (Ld); Chai & al. S. 26712 (Ld). MOLUCCA ISLANDS: Weda: Neth. Ind. For. Serv. bb. 24925 (N). NEW GUINEA: Papua: Darbyshire 784 (Ba); Womersley NGF.46469 (Mu). NEW GUINEAN ISLANDS: Daru: Streitmann & Lelean 18468 (Mu). AUSTRALIA: New South Wales: A. M. Gill s.n. [7 April 1970] (Ba).

[to be continued]