THE VESSELS IN THE WOOD OF JAVAN MANGROVE TREES

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In the course of my study on the wood-anatomy of Javan woods (Mikrographie des Holzes der auf Java vorkommenden Baumarten), I examined also many woods from mangrove-trees.

Mangrove has been the subject of much investigation; the community is usually described as xeromorphic. Mangrove woods proved to be different from woods belonging to species growing in other stations even if those species belonged to the same family or even genus. The data may be traced in my "Mikrographie" but it seems more convenient to review them here.

It is currently believed that the area occupied by the wood vessels to the mm² in transverse section is an indication of the water supply towards the higher parts of the tree. When comparing mangrove and non-mangrove species of one genus or of one family, it appears that the number of vessels to the mm² is much larger in the former. This was demonstrated in my "Mikrographie" and it was further confirmed by Panshin (Philipp. J. Sci. 48, 1932, 143). In the mangrove species, however, the diameter of individual vessels in transverse section is considerably smaller. Surface calculations show that notwithstanding this smaller diameter the total area occupied by the openings of the vessels in mangrove woods is generally distinctly larger.

I have composed some tables from the data found in the "Mikrographie". The mangrove species have been indicated with an asterisk, the capitals R and T indicate the radial and tangential diameters.

TABLE 1.

Combretaceae (Mikrogr., vol. 3)

diam. in μ R	diam. in μ T	vessels per mm²	Species and varieties
50—210	65—185	3—6	Terminalia bellerica var. laurinoides, T. javanica, T. bialata
„	„	c. 7	T. catappa
„	„	→ 15	T. teijsmannii
25—90	40—100	40—75	*Lumnitzera coccinea, *L. racemosa, *L. racemosa var. pubescens

TABLE 2.

Lythrarieae (Mikrogr., vol. 3)

diam. in μ R	diam. in μ T	vessels per mm²	Species and varieties
90—225	65—135	5—8	Crypteronia paniculata, C. paniculata var. leptostachya
40—320	50—360	5—10	Lagerstroemia speciosa, L. ovalifolia
130—400	130—330	4—5	Duabanga moluccana
35—175	45—130	35—50	*Sonneratia acida, *S. alba

The species of *Sonneratia* show the same figures although *S. alba* seems to occur further from the beach (reefs) than *S. acida* (A. Kint in De Trop. Nat. 23, 1934, 173; F. Grewe in Wiss. Veröff. Deutsch. Mus. f. Länderk., Neue Folge 9, 1941).

TABLE 3.

Rhizophoreae (Mikrogr., vol. 3)

diam. in μ R	diam. in μ T	vessels per mm²	Species and varieties
25—100	45—105	20—25	*Rhizophora conjugata
"	"	→ 45—50	*Rhizophora mucronata
55—120	60—115	c. 13	*Bruguiera eriopetala
"	"	→ c. 25	*Bruguiera caryophylloides
"	"	→ 25 ←	*B. gymnorrhiza
"	"	→ 30—40	*B. parviflora
50—180	50—185	c. 9 or c. 17	Carallia integerrima
90—270	125—230	c. 7	Gynotroches axillaris
"	"	c. 10—12	G. axillaris var. obtusa

TABLE 4.

Meliaceae (Mikrogr., vol. 2)

diam. in μ R	diam. in μ T	vessels per mm²	Species and varieties
25—300	20—270	c. 5	Melia azedarach, M. azedarach var. javanica, M. composita
"	"	→ c. 10	Melia bogoriensis
30—140	60—110	c. 10	Sandoricum indicum, S. nervosum
25—200	40—110	8—15	Dysoxylum densiflorum
"	"	→ 25	D. densiflorum var. minor
"	"	→ 10	D. caulostachyum

TABLE 4 (continued).

diam. in μ R	diam. in μ T	vessels per mm²	Species and varieties
25—200	40—110	5—10	D. ramiflorum
„	„	c. 5	D. excelsum, D. excelsum var. parvifolia
„	„	8—15	D. hasseltii, D. macrocarpum, D. alliaceum, D. alliaceum var. lanceolatum, D. alliaceum var. pauciflorum, D. arborescens, D. amooroides var. otophora, D. amooroides var. pubescens, D. amooroides, D. mollissimum, D. nutans, D. blumei
„	„	c. 5	D. mollissimum var. teysmannii, D. simile
„	„	c. 25	D. biloculare
30—200	50—160	c. 10	Chisocheton sandoricocarpus, Ch. microcarpus
„	„	c. 5	Ch. divergens, Ch. macrophyllus
25—220	70—200	10—15	Amoora aphanamixis
40—150	60—160	c. 15	Lansium humile, L. javanicum
50—160	75—140	c. 15	Aglaia argentea var. cordulata, A. argentea var. multijuga, A. odoratissima, A. odoratissima var. parvifolia, A. heptandra, A. aspera, A. latifolia, A. acida, A. roxburgiana, A. roxburgiana var. balica. A. elaeagnoidea
„	„	→ 10	A. argentea var. splendens, A. eusideroxylon
„	„	c. 8 or c. 15	A. ganggo
20—100	30—80	c. 30	Walsura pinnata
25—110	30—90	15—25	*Carapa obovata, *C. moluccensis, *C. moluccensis var. elliptica, *C. moluccensis var. obtusifolia
15—420	35—290	c. 3	Cedrela febrifuga, C. febrifuga var. glabrior, C. febrifuga var. velutina

It is to be noted that the radial and tangential diam. of the vessels in *Aglaia argentea* var. *splendens* are wider than indicated in the table; in *A. eusideroxylon,* and *A. heptandra* both diameters are somewhat narrower.

In *Urticaceae* I examined *Streblus asper* which has been said to occur in temporarily very dry stations and also in mangrove. I found far more numerous and narrower vessels in its wood than in closely related species of the same family.

In *Euphorbiaceae, Excoecaria agallocha* is a mangrove tree. *Ex-*

coecaria virgata is not found in the mangrove. The former has 9 to 14 vessels to the mm² in transverse section, the widest are radially 105 μ and tangentially 80 μ. In the latter occur 3—6 vessels to the mm² in transverse section, the radial diam. is 30—185 μ and the tangential diam. 40 to 150 μ.

In *Rubiaceae* I examined 5 species of *Ixora*. Only one species, *I. paludosa*, grows in saline soils (Koorders & Valeton, Bijdr. 8, 1902, 156), in the inner zone of the mangrove. *Ixora paludosa* has 65 vessels to the mm² in transverse section. The 4 other, non-mangrove species have resp. 20—30, c. 40, c. 50 and c. 45—55 vessels to the mm². It may be noted that the species of *Ixora* alluded to in this here which has c. 45—55 vessels to the mm² (*I. grandifolia*) is a species occurring on rocks on the beach.

The remarkable increase in number and in total area of the vessels in the wood of mangrove trees suggests that the transpiration of the trees is accordingly larger. A high rate of transpiration was stated to exist by Von Faber (Jaarb. Dep. Landb., Nijv., Handel Ned.-Ind., 1913, 16; Ber. Deutsch. Bot. Ges. 31, 1913, 277; ibid. 41, 1923, 227), and Schimper (Pflanzengeogr. physiol. Grundl. 3rd ed., 1935).

On the other hand, Th. Arzt (Ber. Deutsch. Bot. Ges. 54, 1936, 259, footnote) wrote that he was informed by Prof. Dr Walter that the transpiration of mangrove plants was much lower than Von Faber believed it to be and that the data of Von Faber on the osmotic properties of mangrove species needed to be corrected also. He reached the conclusion that the xeromorphic habit of the mangrove leaves was more or less an expression of their ecological circumstances. This is supported by Walter and Steiner (Zeitschr. f. Botanik 30, 1939, 111) who find that mangrove species are referable to plants with a low rate of transpiration.

I think it probable that the resistance to the transport through the narrower vessels is considerably larger than expected. It seems likely that the perforation rims of the division walls in the narrower vessels may offer additional resistance to the transport of water.

In this connection I wish to refer to J. H. de Haan's work on the mangrove forests of Tjilatjap (Tectona 24, 1931, 39). He divided the mangrove area into zones which are different by the number of days of inundation monthly. The three species of *Bruguiera* are confined each to a different zone. *B. parvifolia* grows in the area inundated 10—20 times monthly, *B. gymnorhiza* in the area inundated 9 times (or less) monthly, and *B. caryophylloides* only in rarely inundated areas. I found a correlation between the number of vessels and the frequency of inundation. The more frequent the area is inundated in which the species grows, the larger the number of vessels to the mm².

De Haan refers both the *Rhizophora* species I examined to the same area of inundation (l. c., p. 49). He found, however, that *R. mucronata* dominates in an outer fringe and *R. conjugata* occupies the inner parts. *R. mucronata* has a distinctly larger number of vessels to the mm² than *R. conjugata*.

Anna M. Starr (Bot. Gaz. 54, 1912), in her study on the comparative anatomy of dune plants concluded that there was a tendency for the vessels to be larger in the mesophytic forms, more numerous in the xero-

phytic ones, the area still being greater in the xerophytic (p. 301), and she stated in addition: "plants generally growing in mesophytic situations, when found also on the dunes, show the following modifications: of the stem, increase in the number of vessels and in the area of their cross-section giving greater conductive space."

Ficus pisifera, as regards its wood, was described in "Mikrographie" vol. 6, p. 190. It is nearly always epiphytic; only on very dry soils it may become terrestrial. It is a xeromorphic species (Koorders & Valeton, Bijdragen 9, 1906). Compared with related non-epiphytic species, it shows the same characters as mentioned above.

The mangrove species vary as regards their general wood-structure, their woods belong to different types.