## MANGROVES IN FRESHWATER

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## SUMMARY

Non-saline occurrences of Acanthus ilicifolius L. and Acrostichum aureum Sw. in Vanuatu, Avicennia marina (Forsk.) Vierh. var. resinifera (Forst. f.) Bakh. in New Zealand, Rhizophora apiculata Blume in the Solomon Islands, and R. stylosa Griff. in Malaysia are reported.

Van Steenis (1984) has recently drawn attention to the occurrence of the mangrove trees Bruguiera gymnorrhiza (L.) Sav., B. sexangula (Lour.) Poir. and Heritiera littoralis Ait. round a freshwater spring on Christmas Island (Indian Ocean). Previously (Van Steenis, 1963; Van Steenis & Schippers-Lammertse, 1965) he had recorded Sonneratia caseolaris (L.) Engl. in freshwater in West New Guinea, and the herbaceous species Acanthus ilicifolius L. and Acrostichum aureum Sw. in freshwater in Java. It should be noted that all these species are usually found in the back, less saline mangrove areas.

I observed Acanthus ilicifolius and Acrostichum aureum in freshwater streams (conductivity  $(18^{\circ}C)$ :  $120-260 \text{ uScm}^{-1}$ ; chloride: 2.6-5.3 mg  $1^{-1}$ ) on the island of Efate, Vanuatu (New Hebrides) in 1973. The former was noted up to 2.5 km inland. This freshwater occurrence forms an interesting comparison with the behaviour of this species in Hong Kong, where it occurs on the outside of the mangrove fringes in apparently fully saline conditions (personal observations, 1978). In this respect it parallels the distribution of *Typha domingensis* Pers. in French Polynesia. This species was introduced into Tahiti in 1830 and now occurs on intertidal muds as well as in freshwater situations on several islands. Crossland (1928) suggested that it was rooted in freshwater lenses in the otherwise marine muds, but observations and analyses which I made in 1976 showed that this was not the case. Comparison of mud analyses from marine and freshwater habitats showed that *T. domingensis* has a wide range of chloride tolerance.

Bunt, Williams & Clay (1982), as the result of an analysis of the distribution of mangrove trees along several rivers in North Queensland, Australia, suggested that the lack of correlation of *Avicennia* sp., *Bruguiera gymnorrhiza* and *Xylocarpus granula*tum with salinity indicates that they can grow over almost the complete salinity range from fresh water to sea water. Of these three species, Van Steenis (1984) has recorded *Bruguiera gymnorrhiza* from freshwater and Beard (1967) Avicennia marina (Forsk.) Vierh. from an inland station in Western Australia. In the Firth of Thames, North Island, New Zealand, *Avicennia marina* var. *resinifera* (Forst. f.) Bakh. grows in pasture land where the chloride of the soil does not exceed 38 mg 100 d dry weight<sup>-1</sup>. Here it would appear that agricultural reclamation of the area at the back of the mangroves has not eliminated them. Although the trees flower and produce propagules, regeneration is poor because of cattle grazing.

However, there do not appear to be records in the literature of the other conspicuous mangrove genus, *Rhizophora*, growing in fresh water, though Anno (1972) in phytotron experiments, reported maximum growth of *R. racemosa* Meyer seedlings in the absence of chloride. In June 1984 I observed several trees of *R. stylosa* Griff. growing in three lagoons in the permatang vegetation zone near Rantau Abang on the eastern coast of Peninsular Malaysia. Plants of *Utricularia* sp. were growing in the mud around the *Rhizophora* roots and the lagoon also contained waterlilies. Expressed interstitial water from the mud had a conductivity  $(18^{\circ}C)$  of 360 uScm<sup>-1</sup> and a chloride content of 28 mg 1<sup>-1</sup>.

Earlier, in September 1982, I had noted the occurrence of *Rhizophora apiculata* Blume growing up to 20 m inland and rooted 1-2 m vertically above high tide level on the edge of secondary forest near Tambea, Guadalcanal, Solomon Islands. The trees were up to 8 m tall, surrounded by seedlings and growing in a carpet of *Ipomoea pes-capraea* L., which was growing over the trees. Although the lowermost roots of the tallest trees could have been rooted in saline ground water, the smaller trees and seedlings were in soil which was dry and non-saline (water conten: 187% dry weight; chloride content: 42 mg 100 g dry weight<sup>-1</sup>).

It would appear that most of the inland and freshwater occurrences of mangrove trees are relict populations, though their continued existence means that the progeny must have developed under non-saline conditions. The large size of *Avicennia*, *Bruguiera* and *Rhizophora* propagules precludes any accidental long distance dispersal by any means other than water. A detailed comparative physiological study of these relict populations could be useful in supplementing laboratory studies of the effect of salinity on the growth of mangrove tree species and in determining whether it is salinity *per se* or some other associated factor which is important in controlling their distributions.

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