

VIII. FLORA AND VEGETATION

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The indigenous flora of Jaluit Atoll is an enriched strand flora, typical of that of wetter atolls in the west central Pacific. In addition to most of the ordinary widely distributed strictly strand species that are to be expected in tropical maritime situations, wet sheltered forest sites have permitted the establishment of certain more mesophytic species not ordinarily found on strands. Peperomia ponapensis, Procris pedunculata, and Vittaria elongata are examples of these. The Marshallese made their contribution to the flora by bringing in such economic plants as the breadfruit, the taros, at least some kinds of pandanus, the coconut and others as well as a few weeds. Since the arrival of the first Europeans many weeds, some new food plants, and an array of ornamentals have been introduced, either deliberately or accidentally. The only peculiarity of the Jaluit flora is the presence of an unusually large number of these exotics resulting from the fact that the atoll was the site of the German and Japanese administrations and of a short-lived agricultural experiment station started by the present administration. A list of the known flora is to be published in another number of the Atoll Research Bulletin (see also Appendix I).

The islets of Jaluit Atoll, before the typhoon, had mostly been planted to coconuts and breadfruit. Except for the plantations only a few important vegetation types were present, and these in small areas. They were Pemphis forest or thicket, Pisonia forest, mangrove depressions, taro pits, and fringes of dense scrub along the windward sides of some islets, outside the plantations. A few open grassy areas represented abandoned gardens, as on Kinajon Islet and possibly Pinlep Islet.

The plantations (Pl. V-a, -b, -c) were either coconut, coconut and breadfruit, or rarely just breadfruit. The trees were from 15 to 25, rarely 30 m. tall, closely spaced, usually less than 6 m. apart. A scattered understory of Pandanus (Pl. V-c) up to 5 to 8 m. tall occurred in most parts, most of the trees being of varieties yielding edible fruits. Other small trees and shrubs, especially Morinda and Allophylus, were present but irregularly distributed, depending on the local productivity of the land and on the diligence of the plantation owners in clearing out the undergrowth. A ground cover of grasses, sedges, Wedelia, ferns, and other herbs was general. Epiphytic mosses and ferns were common, especially in denser parts of the plantations.

Around the edges of the plantations, especially on the gravel ridges on the windward sides of the islets, was usually a narrow zone of scrub composed of Scaevola sericea, Tournefortia argentea, Guettarda speciosa, Terminalia samoensis, and other woody species. In some very rocky areas, both in the scrub and in the coconut groves, Fleurya ruderalis, Boerhavia tetrandra, and Euphorbia chamissonis were common, forming a scattered ground layer. In a few spots in the coconut plantations near the windward side were groups of large trees of Barringtonia asiatica. Intsia bijuga and Ochrosia oppositifolia were also present in small groups.

Around villages, isolated dwellings, and grave yards were a few species of ornamentals, planted as scattered trees or bushes, hedges or borders, or in small gardens. Most of them produced flowers used for leis or garlands. Especially common were Pseuderanthemum, Plumeria, Crinum, Acalypha, Zephyranthes, Polyscias, Mirabilis, Catharanthus, Asclepias, Gomphrena, and Ocimum. Such food plants as Pandanus (Pl. V-a), bananas, papayas, and squashes, also were very common in the vicinity of dwellings.

On Jabor, the northern extremity of Jaluit Islet, where both the Germans and the Japanese had their headquarters, a great many cultivated exotic species were planted. Volcanic soil was brought from Ponape and spread in certain spots, making possible gardens with many species not commonly found cultivated on atolls. Certain weeds also became established in Jabor. Several years ago the U. S. Administration started an agricultural experiment station on Jabor, and more plants were brought in. Over a hundred species of cultivated plants and several weeds not normally found on atolls in this part of the world have been reported from Jaluit by German, Japanese, and later writers. Many of these have not persisted, but up to the time of Typhoon OPHELIA a substantial number were reported by Boyd Mackenzie to be growing on Jabor and some had been carried to other islets of the atoll.

In certain places, either interior depressions or marginal places where gravel ridges have cut off areas of reef flat, the water table reaches the surface of the ground. Here coconuts do not thrive well and other vegetation is found. On Pinlep two such interior depressions have been converted to taro pits where the giant taro, Cyrtosperma, is the principal vegetation, along with several weeds characteristic of such habitats. These are, especially, Echinochloa crus-galli, Cyperus odoratus, and Eleocharis geniculata. There may have been others before the typhoon. Other such depressions have mangrove vegetation of one sort or another. Most of the depressions studied have essentially a pure stand of Bruguiera gymnorhiza or Bruguiera with some Pemphis acidula. One had Lumnitzera littorea. Another had Bruguiera with a dense understory of Hibiscus tiliaceus. Still another had Hibiscus only.

Along both seaward and lagoon shores are areas of rock flats of limestone conglomerate with little or no soil. Some such areas were bare or almost so. Others were covered by thickets or scrub forests of Pemphis acidula. One area of rock flat on the lagoon shore near Sydneytown had, in 1946, a sparse stand of a mangrove, Sonneratia alba, almost the easternmost known occurrence of this species.

On several tiny islets coconuts have never been planted in large numbers. Two of these, Ribon and Lijeron, have been examined briefly. The vegetation was largely Pisonia grandis, with Tournefortia, Guettarda, Intsia, and Terminalia samoensis around the shore ridges and Pemphis on rock flats. In the interior of Ribon is an open area dominated by Asplenium nidus. Lijeron is the home of large numbers of sea birds, some of which nest in the trees.

The very small islets, though less disturbed, had a very restricted flora, as has been observed elsewhere on atolls (cf. Kapingamarangi, acc.

Niering, 1956). Of the larger islets the broad ones tend to have a larger flora than the narrow ones.

The effects of Typhoon OPHELIA, even on the same vegetation type, or on the same plant, were by no means identical in all localities and parts of the atoll. In general, the islets on the east side of the atoll suffered much more damage to their vegetation than those on north, south, and west. Also, as might have been anticipated, narrow islets or parts of islets were far more affected than broad parts. This was well illustrated on Jaluit Islet, where the narrow parts south of Jabor were in places completely stripped of vegetation (Pl. V-b). Also on Jaluit Islet the difference in damage depending on orientation of the islet is well shown. At the southeast corner of this islet (see Fig. 1) the part running north suffered very severe loss of coconut trees, this continuing southward to the point. On the leg of the islet running westward from the southeast point the damage was conspicuously less, the difference at the time of examination being between a barren expanse of coral with scattered trees and a solidly green islet. The islets along the south and west sides and around the north loop of the reef were generally green, while along the east side only the wider islets were green. This seems well correlated with the exposure of the eastern side of the atoll to a combination of strong winds and great waves which swept over the narrower islets and parts of islets. Some of the broader islets here were only partly inundated, while on the other sides of the atoll most islets escaped serious flooding by the salt water.

This combined action of wind and large waves had several effects on vegetation. Many trees were uprooted, either completely so (Pl. VI-a) and sometimes swept away, or partly so (Pl. VI-b) and remaining in place and frequently still alive. Some were snapped off (Pl. V-d). Branches were broken or torn off of most of those that remained standing (Pl. VI-c). Some exotic plants were killed or their above ground parts killed by salt. In places large scale burial of plants by gravel occurred (Pl. III-a, VII-b). Elsewhere the soil with its vegetation was scoured away (Pl. V-b). Many tree trunks were seen in the lagoon on the shallower slopes along the east side. Masses of vegetable debris were strewn at random on areas that were inundated (Pl. VI-d). Some of this seemed to have washed around and become very worn and battered before it was finally stranded. Enormous amounts of such debris were washed into some of the mangrove depressions (Pl. V-c). It was impressive that not only trees but even shrubs and coconut seedlings were knocked down or dismembered in these areas. However, no particular evidence of abrasion of bark by wind- or water-driven sand and gravel was seen. Defoliation, according to reports, was at least in places complete. Root systems were extensively exposed (Pl. II-c, -d, VII-a).

On parts of the wider islets of the east reef and on the islets on the other sides most or all of the damage to vegetation was by wind. Here the ground vegetation was little hurt. The trees and larger shrubs, however, were seriously damaged, locally almost all trees being uprooted or broken, usually a substantial proportion even in the less affected areas. In some places, as on Majurirek (Elizabeth) and Imroj, trees had fallen in at least three main directions (Pl. VII-c). More usually they were predominantly pointing in one direction. The direction of fall of the

trees, and its significance in terms of the storm, have been discussed above by Blumenstock and Wiens. Particular mention may be made of mangrove swamps and Pemphis thickets. Although the trees in these were in places uprooted, more often they were still standing but with their upper parts or branches dead (Pl. IV-d, VIII-c). A significant fact emerging from the observations on these islets that were not covered by salt water is that very serious damage to vegetation may result from wind alone (Pl. VII-d, VIII-a, -b).

Impressions gained of the comparative resistance to wind of different tree species are not very clear, as conditions varied so much locally. No kind completely escaped uprooting and breaking, but Pemphis, Cordia, Calophyllum, and Casuarina* perhaps stood up best, except for Bruguiera, which occurred in dense stands in low spots, where there was some protection. Pandanus (Pl. VII-d, X-c), breadfruit, and Terminalia catappa perhaps fared worst. Very few breadfruit trees with trunks 30 cm. or more in diameter remain standing, and the smaller ones which do remain have most of their branches torn off (Pl. VI-a, VIII-a, -b). Where inundated by salt water, breadfruit trees were killed or almost so. Of the larger shrubs Terminalia samoensis fared by far the best, suffering little damage. Small Pemphis bushes in some places escaped completely; others were snapped off (Pl. IX-a). The reactions of individual species are discussed in detail later on.

Smaller plants suffered perhaps less than others on the islets that were not inundated, but were enormously reduced in numbers on the ones swept by waves.

Recovery was well under way at the time of the survey, little over $3\frac{1}{2}$ months after the typhoon. Most of the dismembered and defoliated trees were putting out an abundance of leafy sprouts (Pl. VIII-b, -c). This was not true of Pandanus, which was scarcely sprouting at all (Pl. VII-d). In the badly hit areas of the east reef most of the breadfruit trees were either dead or very slow in showing signs of recovery, possibly because of the salt water. Elsewhere they were sprouting actively. Many of the trees of all kinds that were completely down but had some roots still in the ground were still growing, some even flowering. Abundant seedlings were seen of Tournefortia, Scaevola, Guettarda, Morinda, and, very locally, Barringtonia, and Pandanus. Many of the herbaceous plants had come up from seed after the typhoon in great profusion in favorable habitats, some of them doubtless greatly increasing their numbers as a result of the thinning of the forest and the consequent lessened shade.

Recovery of individual species is discussed below. In general, native atoll plants and those long cultivated on atolls show active recuperative powers. Some of the planted species came back well enough. Others were doubtless lost. It is difficult to say what, if any, species were completely eliminated, as only a part of the atoll was examined. In addition to such planted things as several palms, two native mangroves, Sonneratia alba and Lumnitzera littorea, may have disappeared. They were

* But see Wiens, p. 27.--F.R.F.

known on Jaluit Islet only, from one small colony each, and these places were examined without finding a trace of the plants. Of course they may still exist on other islets which have not been explored botanically.

Native agriculture and subsistence plants were badly hit, especially Pandanus (Pl. VII-d), breadfruit (Pl. VI-a, VIII-a, -b), and coconut (Pl. IX-c, -d), but no other food plants of consequence were more than temporarily damaged. Banana shoots and papaya seedlings were coming up in abundance. Squash were growing well. The taro pits were not seriously hurt (Pl. IX-b). These matters will be considered more in detail in the chapter on economic consequences.