REMNANT NATIVE VEGETATION AT A LOWLAND SITE NEAR KIHEI, MAUI

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Native lowland vegetation of the Hawaiian Islands has been so greatly altered by Polynesian colonizers between the 5th and 18th centuries and by urbanization, agriculture, and exotic introductions in the 19th and 20th centuries that its original structure and composition are not known (Rock, 1913; Kirch, 1982; Olson and James, 1982a & b). We have recently explored an area of remnant native vegetation in the lowlands of leeward East Maui which is remarkably intact and which may be a good indication of the nature of the pre-Polynesian vegetation of the lower leeward slopes of Haleakala.

LOCATION, GEOLOGY, SOILS, AND CLIMATE

The location of the major native lowland vegetation remnants is in the Keokea and Waiohuli districts east of Kihei (SW quadrant of USGS Puu o Kali quadrangle) at elevations between 200m and 400m. Two lava flows originating on East Maui's southwest rift zone are minimally weathered downslope from Puu o Kali (Red Hill), a conspicuous cinder cone reaching 452m (1481 ft) elevation. These flows, radiocarbon dated by Crandell (1983) at 4070 and 8650 years old, support primarily native vegetation. Adjacent terrain with relatively deep soils is covered almost entirely with introduced vegetation. Foote et al. (1972) characterize these deeper, reddish-brown soils as extremely stony silty clay loams and silt loams developed from volcanic ash, with depths of 30-75cm to fragmented a'a.

Median annual precipitation at four rainfall stations in the vicinity (within a 4km radius) at elevations of 120-400m (400-1300 ft) ranges from 335mm to 475mm with 86%-100% falling in the November-April period and 78-95% falling in the 4 month period from December through March (State of Hawaii, 1982). January is typically the month of heaviest precipitation. Amounts of precipitation vary greatly from year to year. Kihei, with a mean annual rainfall of 350mm (and a November-April mean of 315 mm) had the following November-April precipitation totals in the six years from 1976-77 through 1981-82: 155mm, 94mm, 589mm, 495mm, 141mm, 624mm (U.S. Department of Commerce, 1976-82).

VEGETATION AND FLORA

Erythrina sandwicensis (wiliwili) is the dominant tree species on the Puu o Kali lava flows. Other native tree species are present

sporadically- Diospyros ferrea (lama), Myoporum sandwicense (naio), Acacia koaia (koaia), and Reynoldsia sandwicensis (ohe). Common native shrubs include Sida fallax, Lipochaeta rockii var. dissecta, Dodonaea eriocarpa, Chenopodium oahuense, Achyranthes splendens, Nototrichium sandwicense, Euphorbia celastroides var. mauiensis, Cassia gaudichaudii, Capparis sandwichiana, and Wikstroemia sp. Rare shrubs include Abutilon menziesii and Hibiscus brackenridgei var. brackenridgei, as well as the vine-like shrubs Canavalia haleakalensis and Bonamia menziesii. The native vines Sicyos sp. (seasonal), Ipomoea congesta, and Ipomoaea tuboides are abundant. Native grasses include Panicum xerophilum, Panicum beecheyi, Panicum cfr. pellitum, Eragrostis variabilis, and Heteropogon contortus. Argemone glauca, Plumbago zeylandica, and Peperomia leptostachya are native herbs. The native fern Doryopteris decipiens is common. Boerhavia diffusa, a rambling shrub, is present below 250m on the Puu o Kali flows. Waltheria indica, a plant which may or may not be native (St. John, 1978), is common.

Exotic plants common on the lava flows include the trees Prosopis pallida, Acacia farnesiana, and Leucaena leucocephala; the shrubs Indigofera suffruticosa and Abutilon grandifolium; the vines Merremia aegyptia, Momordica charantia, and Cucumis dipsaceus; the forbs Bidens pilosa, Bidens cynapifolia, Galinsoga parvifolia, and Reichardia picroides; and the grasses Cenchrus ciliaris and Rhyncheletrum repens.

On the deeper soils adjacent to the slightly weathered flows, the exotics Prosopis pallida (kiawe) and Cenchrus ciliaris (buffelgrass) dominate the overstory and understory respectively. Sida fallax is the only commonly associated native species.

PHENOLOGY AND LIFE CYCLES OF THE FLORA

The phenology and life cycles of the plants of lowland leeward East Maui are keyed to a very severe and prolonged dry season and a variable wet season. The adaptations of Erythrina sandwicensis, the dominant tree, are representative of those required. It is one of the few deciduous trees in the Hawaiian flora. (Reynoldsia is another.) Erythrina is summer deciduous, flushing new leaves in November-December and losing leaves in April-June. It flowers while leafless during the summer. Seeds mature and are dispersed primarily in late-fall and early winter, just as the winter rains normally begin. Seedlings must develop deep roots prior to cessation of rains in the spring if they are to survive.

Some species of this habitat are annuals, including the native Sicyos sp. and Panicum spp. and the exotic Bidens spp., surviving the 6 month dry season as seeds and germinating with the first major rains in November or December. Growth of Sicyos is luxuriant in years of ample rainfall, with abundant seed set. However, in growing seasons when early rains are meagre and are not followed by later rains, ripe seed may not be produced

abundantly. Presumably, some mechanism exists to prevent all seeds from germinating simultaneously. Annuals may be extremely susceptible to disturbance- especially fire, since most seeds could be destroyed by a fire at the beginning of the dry season. They are also highly susceptible to displacement by perennials or by faster-developing annuals.

Ipomoea tuboides, I. congesta, and Boerhavia diffusa, are perennials which die back vegetatively during the dry season and restore leaves and herbaceous stems when the wet season commences.

REPRODUCTIVE STATUS OF NATIVE SPECIES

In most plant communities of leeward East Maui, reproduction of native species is minimal (Medeiros, Loope, and Holt, 1984). Reproduction was observed for many of the native species on the Puu o Kali lava flows, including the following: Erythrina sandwicensis, Achyranthes splendens, Chenopodium oahuense, Dodonaea eriocarpa, Euphorbia celastroides, Hibiscus brackenridgei, Lipochaeta rockii, Ipomoea congesta, Ipomoea tuboides, Sicyos sp., Panicum pellitum, Canavalia haleakalensis (one seedling only), and Acacia koaia (vegetative root suckers only). This reproductive success of natives would undoubtedly be much greater were it not for displacement by Bidens and other exotics. We tentatively attribute the notably high reproductive success of native plants on the Puu o Kali flows to the sparsity of browsing by introduced ungulates.

COMPARISON WITH OTHER NATIVE VEGETATION REMNANTS ON EAST MAUI

The Puu o Kali flows have 33 native species, only three of which were not recorded elsewhere on leeward East Maui in a survey by Medeiros, Loope, and Holt (1984)- Abutilon menziesii, Achyranthes splendens, and Hibiscus brackenridgei. The Puu o Kali flows, apparently because of their protection from browsing, have a native vegetation much more intact than that at any other lowland leeward site on East Maui. Yet not surprisingly, in view of their small area (total of no more than 300ha), their flora is missing species found in the same elevational zone elsewhere. The total extant native flora of leeward East Maui above the strand zone and below 400m elevation numbers about 45 species. Those not yet recorded from the Puu o Kali flows are Bidens mauiensis, Canthium odoratum, Cassytha filiformis, Cenchrus agrimonioides, Jacquemontia sandwicensis, Lipochaeta kamolensis, Lipochaeta lavarum, Nothocestrum latifolium, Panicum torridum, Portulaca cyanosperma, Portulaca sclerocarpa, and Rauvolfia mauiensis.

DISCUSSION

Native vegetation has survived on the lava flows apparently because of their unsuitability for Polynesian agriculture, partial or complete protection from fire by tracts of unvegetated

lava, and fortuitous protection from goats. Since no evidence of Polynesian irrigation systems is apparent in the area, ancient agricultural use would have involved dry land cultivation. Kirch (1982) suggests that almost all topographically suitable lowland sites with more than 500mm of annual precipitation were used for agriculture by Polynesians. Although the area in question averages only 300-400mm of annual rainfall, we would speculate that successful use for shifting agriculture was a possibility during the wet seasons of many wet years. Even if the native vegetation of areas with deeper soil was not directly obliterated by shifting cultivation, the use of fire (Kirch, 1982) in conjunction with shifting cultivation in moister areas upslope undoubtedly led to conflagrations in the vicinity of Puu o Kali. Fires repeated at frequent intervals may have quickly led to the conversion of the pristine native vegetation surrounding the lava flows to grasslands dominated by Heteropogon contortus (pili grass). In more recent times, domestic livestock grazing has influenced the vegetation and Prosopis, Cenchrus, and other introduced species have come to dominate.

There are numerous lava flows at low elevations on the south slope of East Maui where native vegetation has not been subjected to Polynesian fire and agriculture. However, these sites have been and continue to be browsed by herds of feral goats. A crucial feature of the Puu o Kali site which has led to exceptional protection of the leeward low elevation native flora has been the sparsity of goat browsing pressure. At present, goats do not seem to be present in the area- undoubtedly because it is such a small tract of "wildland" surrounded by lands managed for cultivation, livestock grazing, and residential use. Cattle, although present, seem to generally avoid the rough lava. Axis deer (Axis axis), introduced to the area by the State of Hawaii in the early 1970's, are currently present only in low numbers in the area. Browsing damage to native shrubs seems minimal.

The major deterrent to survival of native species on the flows currently may be displacement by exotic plants- especially Bidens spp., Cenchrus ciliaris, Rhyncheletrum repens, and Prosopis pallida. Bidens pilosa, the most effective competitor in the shallow soils of the flows (along with the very similar B. cynapifolia), was collected in Hawaii as early as 1845-47 (St. John, 1973). Annuals are particularly susceptible to displacement by exotic herbs because of their frequently recurring requirement for seed production and seedling reestablishment.

The surviving vegetation and flora of the Puu o Kali lava flows may or may not be highly indicative of the composition of pristine (pre-Polynesian) vegetation of much of lowland leeward Maui. Since the habitat is extremely rocky and thus not representative of most of Maui's isthmus and the lower west slope of Haleakala, it may not be at all typical. The site may represent a living botanical analogue of the fossil bird bones analyzed by Olson and James (1982a & b). It is entirely possible that numerous plant species were eliminated by Polynesian

agriculture and fire as suggested by Olson and James (1982b). That many additional species were eliminated by grazing and browsing of feral and domestic ungulates following arrival of Caucasians is suggested by an interesting analysis by St. John (1978) of the earliest plant collections of David Nelson in 1779. Certainly any native lowland species which required a habitat with deep soil was eliminated long ago. All that is certain is that the vegetation of Puu o Kali is the best indication we have of the nature of the pristine lowland leeward vegetation of East Maui.

LITERATURE CITED

Crandell, D.R. 1983. Potential hazards from future volcanic eruptions on the island of Maui, Hawaii. U.S. Geol. Survey, Misc. Investigations Map I-1442.

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stevens. 1972. Soil survey of the islands of Kauai, Oahu, Maui, Molokai and Lanai. U.S.D.A., Soil Conservation Service, in coop. with Univ. of Hawaii Agric. Expt. Sta. 232p. & maps.

Kirch, P.V. 1982. The impact of the prehistoric Polynesians on the Hawaiian ecosystem. Pacific Science 36(1): 1-14.

Medeiros, A.C., L.L. Loope, and R.A. Holt. 1984. Status of native flowering plant species on the south slope of Haleakala, East Maui. Univ. Hawaii, Dept. of Botany, Cooperative Natl. Park Resources Studies Unit, Tech. Rept.

Olson, S., and H. James. 1982a. Fossil birds from the Hawaiian Islands: evidence for wholesale extinction by man before western contact. Science 217: 633-635.

Olson, S., and H. James. 1982b. Prodromus of the Fossil Avifauna of the Hawaiian Islands. Smithsonian Contributions to Zoology, No. 365. 59p.

Rock, J.F. 1913. The Indigenous Trees of the Hawaiian Islands. Reprinted in 1974 by Charles E. Tuttle Co., Tokyo, Japan. 548p.

St. John, H. 1973. List and Summary of the Flowering Plants in the Hawaiian Islands. Pacific Trop. Bot. Garden, Memoir 1, 519p.

St. John, H. 1978. The first collection of Hawaiian plants by David Nelson in 1779. Pacific Science 32(3): 315-324.

State of Hawaii, Department of Land and Natural Resources. 1982. Median Rainfall, State of Hawaii. Division of Water and Land Development. Circular C88. 44p. & maps.

U.S. Department of Commerce. 1976-82. Climatological Data, Hawaii and Pacific. National Oceanic and Atmospheric Administration. Issued monthly.