South Pacific Studies Vol. 26, No. 2, 2006

Botanical Exploration in Small Islands: 1. Floristic Ecology and The Vegetation Types of Pari Island, West Java, Indonesia

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Abstract

The Pari Island represents a buffer zone of the Seribu Islands Marine National Park (SIMNP), West Java, Indonesia. The vegetation and flora of the Island may be considered as the Barringtonia and Ipomoea pes-caprae components, mangroves, sukun (*Artocarpus atilis*) and coconut (*Cocos mucifera*) trees, a secondary-growth component, ferns and exotic plants (23 species). A 3-year inventory (1984-1987) of the Island documented 315 flowering plant species and 18 fern species. A checklist to support management purposes is presented with remarks. A vegetation analysis of selected sample plots is described and discussed in the context of the biological diversity of the Island.
Key words: conservation, ecotourism, plant diversity, small island flora, weeds.

Introduction

Indonesia belongs to Maleisia region and is an archipelago state consisting of almost 17,508 islands with a coastline totalling some 108,000 km, its territory made up at least as much of sea as it is of land. The 17,508 islands of the archipelago support a wide range and variety of natural community from lowland rainforest and mangroves to savannas grassland, swamp forests and limestone hill vegetation to montane forests, alpine meadows and snow-topped mountains (STEENIS 1957, 1958a, 1972). Indonesia covers only 1.3% of the Earth's surface, yet it harbours 10% of all flowering plants (JACOBS 1974). It is one of the richest countries for floristic diversity in the world (Anon 1995). Many of the Indonesian islands have been isolated for millennia and consequently show high levels of species endemism, and many islands have never been botanised in detail (STEENIS 1950b), e.g., Anambas and Natuna islands (STEENIS 1932), Aru and Buru islands (BALGOOY 2001a, b). Moreover, the varied vegetation types and communities support a rich biodiversity, and the forested ecosystem of Indonesia is unique with a diverse tropical flora and high proportion of endemic species (STEENIS 1972) but is threatened by economical development. Most small islands in Indonesia have never been devel-

Received April 25, 2005
Accepted Dec. 1, 2005
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oped and their vegetation types mostly never described. Their small and isolated ecosystems are nevertheless directly impacted by the successes and failures in managing global change and implementing sustainable development policies all over the country.

In general, it is the rapid growth of the human population and the increasing expectations of human beings that are endangering the Indonesia's plants. Also, the country's marine and coastal assets, and fauna and flora are outstanding. One of the most interesting aspects of natural history on small islands is the distribution of plants and animals, at both the community and ecosystem levels. The plant life of small islands, which are in abundance in Indonesia, includes significant vegetation types (e.g., coral vegetation-strand flora), although these have received little descriptive attention in the literatures (BACKER and BAKHUIZEN VAN DEN BRINK Jr. 1963-1968, STEENIS 1958b, VELDKAMP 1958). Also, these natural resources are increasingly under threat from human activities such as tourism and resort and other development. The flora of Pari Island is less explored. The account of the Pari Island is based on studies made over five visits during 1984-1987, and as small islands within a large Java-Bali biogeographical region, Pari Island may, hypothetically, be said to play a role in the conservation of biodiversity of coastal marine ecosystem. Also, sandy shores throughout the Pari Island constitute a distinctive habitat for certain plants, those able to adapt to the conditions of a nearby sea, such as salt spray, periodic storm-wave flooding, constant wind and changing topography. Then the purpose of this study is to describe the flora and vegetation on Pari Island.

The Study Area

The Pari Islands (Pari, Tengah, Kongsi, Tikus and Burung) are a small island group, and are part of the Kepulauan Seribu district in the Jakarta Bay, West Java. The larger island within the group was Pari Island. The island group is situated between latitudes 106° 34' 30" E and 106° 36' 20" E, and between longitudes 5° 50' S and 5° 52'25" S, approximately 40 km northwest of Jakarta in Java (Fig. 1). The Pari Islands are solid-type reefs with a lagoon, on the Sunda continental shelf.

The distance across and area of the Pari Island are about 5 km and 15 km^2, respectively. Apart from reef-flats, the beaches consist of coarse sand or coral shingle and/or coral fragments, with considerable quantities of humus or other debris in some places. There is no high dune rim.

The island falls within a relatively small area of low rainfall along the northern coast of West Java. The mean annual rainfall during 1970-1987 was 2154 mm, with the driest months (less than 50 mm per month) during July to October and the wettest (more than 100 mm per month) from December to March. Some parts may receive more rain but accurate documentation is lacking. Though rainfall is very irregular, it is scanty from July till November. During the rainy season, from December to February, the rains come in heavy short-lived showers, which are often of local importance only. The mean annual temperature on the islands is 29.90 °C (± 1.40), August to October is consid-

ered to be the hottest period with an average of 30.10 °C, and February as the coolest month with an average of 26.5 °C. The climate of this region corresponds to the A-B types of SCHMIDT and FERGUSON (1951). Consequently, the vegetation is tropical with marked variation in structure and species composition depending on geological and physiographic factors.

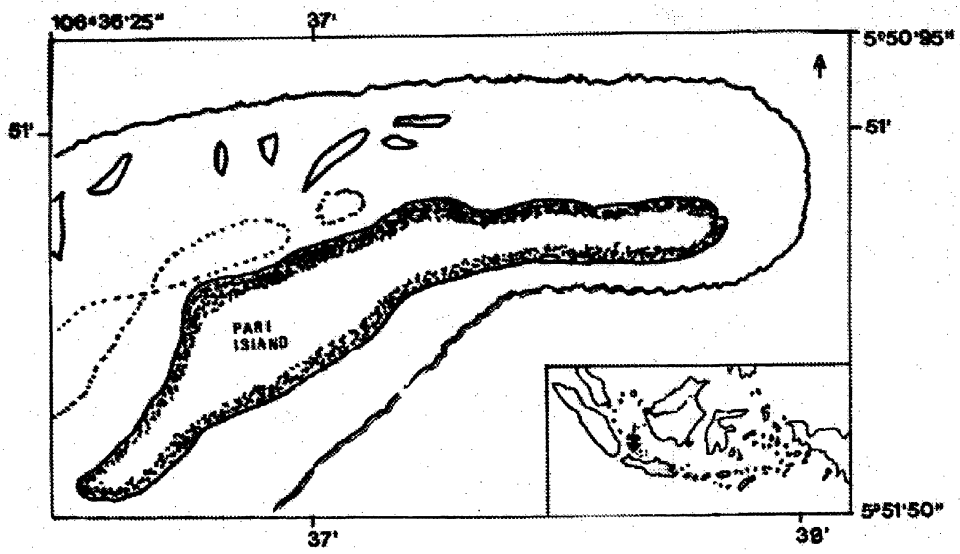

Fig. 1. A map of Pari Island.

Methods

Between April 1984 and April 1987 a number of general collecting trips were made to Pari Island. I visited the island 5 times, on April 1984, January 1985, August 1985, June 1986, and April 1987, respectively. The plant specimens were identified and the scientific names of species follows BACKER and BAKHUIZEN VAN DEN BRINK Jr. (1963-1968) wherever possible, and deposited at the Laboratory of Marine Botany of the Centre for Oceanological research and development, Indonesian Institute of Sciences (LIPI), Jakarta. During each visit I measured water and soil salinity, and observed the conditions of the vegetation and its composition. A floristic analysis is also presented to show the phytogeographic position of Pari Island in the two major realms. A brief sketch of the main vegetation types will be given.

Vegetation analysis was made in the islands based on the transects with plot size of 10m × 10m, 5m × 5m and 1m × 1m for trees (Diameter at Breast Height, DBH>10 cm), sapling (diameter 2-9.99 cm) and ground vegetation, respectively. The belt transects were laid at random in physiognomically homogenous stretches of vegetation at the 9 localities. At each locality, the phytosociological characters were noted in the field, and voucher specimens were collected for identification by a taxonomist. The pres-

ence and absence of each plant species in each locality were denoted by p and a, respectively. Finally percentage class was calculated. The Sorensen index of similarity was used for the quantification of communities. Sorensen index of similarity (SORENSEN 1948) was calculated as follows: IS = [c/0.5 (a + b)] × 100 where a = Total number of the species in releve A, b = Total number of the species in releve B, c = Number of the species common to both releve.

Soil water was sampled from shallow pits dug to the water table and the salinity was measured with a portable refract-meter calibrated against a Bisset Berman salinometer. Surface water salinity was measured when present.

Results and Discussion

General description of floristic in Pari Island

The forests of Pari Island have gone through the anthropogenic perturbation. Today, Pari Island of the Jakarta Bay represents ones of a buffer zone of Seribu Islands Marine National Park (SIMNP), and are the Marine Research Station of LIPI (MRS-LIPI). No definitive work has ever been written on the flora of Pari Island, nor indeed for any other part of SIMNP. However, Flora Malesiana, the definitive work for the whole region has covered the plant families and has been used as a basis for those that are included here. Floristic collection numbers are given in Table 1, and 315 flowering plants of 77 families and 18 fern species of 5 families are identified. Sorensen similarity index show in the range of 85 to 95 % for 9 locations and indicating of their closed floristic affinities. These collection records on the flora dominated by 5 families of flowering plants (Fabaceae: 20 genera and 28 species, Poaceae: 16 genera and 20 species, Asteraceae: 14 genera and 14 species, Euphorbiaceae: 11 genera and 16 species, Rubiaceae: 9 genera and 11 species) and one family of fern (Polypodiaceae: 12 genera and 12 species). Fabaceae (Leguminosae) was the most abundant family in the Pari Island, and thus played an important role in the floristic richness (WHITMORE 1972). Because the islands belong to the bio-geographical region of Java and Bali, the Pari floras has a high similarity with that of the coastal flora in Java (BAKER and BAKHUIZEN VAN DEN BRINK Jr. 1963-1968). Also, this is a marked contrast with the strong floristic affinity of angiosperms between Java and Sumatra beaches (STEENIS 1979). Pari Island is inhabited and visited frequently by tourist parties from Pulau Putri and Ancol Marina Jakarta. Throughout the Kepulauan Seribu district, coastal and marine resources are used intensively by people. These activities contribute to tree floristic degradation and the present of ornament and/or exotic plants (e.g., *Delonix regia, Kalanchoe pinnata, Ricinus communis*) in Pari Island. Also, weed plant infestation increased, e.g., *Imperata cylindrica, Eupatorium odoratum, Phyllanthus* spp. (Tables 2 & 3). It is therefore, weeds are plants of the future (VELDKAMP 2001). For instance, the Asteraceae (Compositae) is one of the largest and most familiar families of flowering plants, 14 species recorded from Pari Island, and occurs in all agricultural land in both Java and Sumatra.

Thus ecologically, the Asteraceae represents one family which have both widespread and spatial distributions.

The flora (Table 1) is more-or-less typical of coral vegetation (STEENIS 1957), together with a large number of coconut trees, and the grasses *I. cylindrica* and *Ischaemum muticum* (Table 2), forming a carpet over the land. It is interesting to note that, in spite of increased visitation of the island since the present survey of the author, apparently weed species have become established (Table 3), and form an important element in the flora. All of these weed species are able to colonize available substratum quickly and then prevent its colonization by competitors. I refer to species, *Panicum repens* and *Paspalum commersonii* as competitive ruderals and I noted that they are found commonly in wetland environments, and become the worst weeds in the rice fields (HOLM 1963). Of the 58 species recorded from the coconut stands (Table 3), 4 species were reported to be troublesome weeds (e.g., *Eupatorium odoratum, I. cylindrica, Lantana camara, P. repens*) and 5 species other belong to the principal weed (e.g. *Phyllanthus niruri, Borreria* sp.) in the agricultural land in Indonesia (SOERJANI *et al.* 1986). It is suggested that a considerable loss of species in Pari Island was caused by competition from aggressive weeds. There were ferns on the islands (18 species), mainly *Pteris sp.* and *Psilotum nudum*, and seen in a few places and poorly developed. Sometimes, ferns occur on the lower side of leaning *Pandanus* trunks. The occurrences of *Pandanus* in Pari Island, however, help to explain their much wider geographical distribution, and the higher number of species (STONE 1976).

Surprising absence amongst the flowering tree plants are Chisocheton petandrus (Meliaceae) and *Diospyros maritima* (Ebenaceae), both of which reported from Pulau Rambut and Pulau Dua, respectively (KARTAWINATA and WALUYO 1977, BUADI 1979). These species would be expected to occur in the outer-most fringe of vegetation above the sandy beach, and with narrowed bands and more subtle zonation patterns beginning from the near shore zone (e.g. *Rhizophora stylosa* and *Pemphis acidula*) and travelling landward. Moreover, their absence at the present time probably indicated an illegal cutting for village housing. Also, it is apparent that many native trees (e.g. *Planchonia valida, Planchonella obovata, Sterculia foetida*) are rapidly disappearing over much of the islands. Their status in the region become extinct, and need further clarification. In Pari Island, the local commercially significant Moraceae are emergent trees, *Artocarpus altilis*. A few were still in occupation. Weedy species are therefore becoming important as the natural vegetation of the Pari Island is being destroyed.

As a small island ecosystem, Pari Island is better represented in their flora (Tables 1-4). In most of the enumeration of floristic composition, there is an evidence that pantropical strand flora occurred predominantly both in natural state (e.g., Frequency: *Tridax procumbens* = 28.39%, *Wedelia biflora* = 12.90%, *Premna obtusifolia* = 9.68%) and with the help of man (e.g., Frequency: *Euphorbia atoto* = 3.23%, *E. hirta* = 0.65%, *Phyllanthus sp.* = 7.10%) (Table 3). It follows this that generally the dominant genera in the intertidal zone (ITZ) or on sea level of Pari Island are the same as these seen in other sites of coral islands and/or atoll in Indo-Pacific coasts (FOSBERG 1976).

Pari Island located in the typical of tropical region with high rainfall (2154 mm/year). Based on Table 1, a number of ecological groups of the species characteristic of the islands can be distinguished:

1.Halophytes.

1.1. Mangrove species: e.g. *Avicennia marina, Rhizophora stylosa, Pemphis acidula.*

1.2. *Sesuvium portulacastrum, Alternanthera* sp., *Salicornia* sp.

2. Species of the sandy soils: e.g., *Canavalia maritima, Ipomoea pes-caprae, Spinifex littoreus, Sporobulus javensis.*

3. Species occurring in areas under influence of salt-spray only: e.g., *Scaevola taccada, Crinum asiaticum, Calophyllum inophyllum.*

4. Species common in the interior but also salt-resistent: *Sporobulus* sp., *Tephrosia* sp., *Suaeda maritima.*

5. Species of the coral shingles or having a preference to these habitats: e.g., *Cyperus difformis, Fimbristylis polytrichoides* and probably also *Carex* sp.

6. Species of the cultivated as crop/exotic plants: *Carica papaya, Colocasia esculenta, Bougainvillea spectabilis.*

Apart from the terrestrial species, the following marine angiospermae have been collected in this area: Hydrocharitaceae (e.g. *Thalassia hemprichii, Halophila*) and Potamogetonaceae (e.g. *Cymodocea, Halodule, Syringodium*). Probably these species occur most frequently in the shallow lagoon and/or reef flat, where a layer of muddy sand covers the under lying rock. Also possibly that, the littoral seagrass community in this region will be dominated by, *Thalassia hemprichii and Enhalus acoroides*. Both species have been frequently cited as mangrove associates.

Vegetation

In Kepulauan Seribu district of the Jakarta Bay, the islands where the vegetation was well studied are Pulau Rambut (KARTAWINATA and WALUYO 1977) and Pulau Dua (BUADI 1979). No description of the vegetation of Pari Island has been done. Based on the results of both botanical exploration and vegetation analysis in the selected sites (Tables 1-8), the general feature of the vegetation is that of coral island vegetation (FOSBERG 1976). However, the vegetation is poor and monotonous. The most important tree component of this vegetation was coconut tree (*Cocos* nucifera) which was widespread throughout the islands. Therefore, the vegetation of the most Pari Island is replaced predominantly by coconut groves; make only an imperfect reconstruction of the original vegetation, even on a generalized level. Based on the herbarium specimens (Table 1), relict occurrence of species, geographical position and the climate parameter, the interpolation and extrapolation from species present in the few remaining relatively unaltered fragment, however, interpretation can be made and the vegetation types can be identified. These vegetation types occupy a proper habitats (Table 9), especially sand and gravel beaches, beach ridge and flats, and is also subject to differing interpretations, including ideas on classification and dynamics (JOHNS 1986). Unfortunately, the littoral vegetation is difficult to differentiate from the former, due to lack of collection and/or

inventory.

The descriptions of the vegetation types, based on sample plot in selected sites, are as follows;

1. Beach and strand vegetation.

The beaches on Pari Island consist either of sand of calcareous rock or of coral shingles, and are not stable entities, but rather dynamic landforms which are constantly subjected to forces promoting erosion and/or accretion. Sandy beaches are mainly to be found on the lee-sides where they are mostly villages and as a consequence the vegetation has been badly affected. The vegetation of the sandy beaches in Pari Island is clearly serial in character ranging from herbaceous strand vegetation to open littoral woodland:

1.1. The beach vegetation.

Generally there are two kinds of beach vegetation in Indonesia (STEENIS 1957, 1958b). The vegetation series on beaches is quite different and starts on the sandy with open plant growth. Based on the vegetation analysis in the beaches of Pari Island, four vegetation communities can be identified and found abundantly, namely: The *Ipomoea pes-caprae - Canavalia maritima* community, the *Canavalia - pes caprae - Spinifex* association, the *Sesuvium - Euphorbia - Canavalia* association and the *Ischaemum muticum - Imperata cylindrica* community, and 46 species were found (Table 4). Not all of these species will be present in each community. Only 6 species present in all of the three communities, and considered as a common species: *I. pes-caprae, C. maritima, C. ensiformis, S. littoreus, Sesuvium portulacastrum* and *Euphorbia atoto*. The fourth herbaceous strand community is in a zone of active geomorphic processes where the sand surface can be altered or destroyed by water and wind. Also this community begins above the tidal limits with very open vegetation in which the typical sand binders *I. pescaprae* and *S. littoreus* are frequent in their occurrences and well adapted to surving in the sandy beach environment, where as the associate *C. maritima* is sparse. Although *C. maritima* is known from two localities only (Table 4), it is preferred to denote the community after *Canavalia* and *Ipomoea* because these species are characteristic of the sandy beaches in both Old and New World Tropics (BACKER and BAKHUIZEN VAN DEN BRINK Jr. 1963-1968, CHAPMAN 1944, SCHIMPER 1891). Since in four vegetation communities of the leguminous genus *Canavalia* are almost as constantly present as the *Ipomoea*, the termed of the beaches vegetation in Pari Island would be *pes-caprae - Canavalia* associes. Both species has the same geomorphic significance. The differences among the four communities of sandy beaches are obvious. Minor differences in species composition reflect the origin of the sand and the new sand being deposited. There are some specific species which present in the one community only, for example *Sida acuta* are found only in the *Sesuvium-Euphorbia-Canavalia* association (Table 4). Also, a fragmentary development of the community is a common feature. In small depressions *S. portulacastrum* and *E. atoto* occur but always as small or open patches. The patches are

several sq.m in size. Judging from the sites where the community is found in relation to patches, the species such as *Cyperus iria, Fimbristylis cymosa* and *Sporobulus* sp. under the influence of salt-loaded winds is of great importance. A further ecological consequence of the reduced flooding is an increase in the abundance of *S. portulacastrum* and *Paspalum vaginatum.* I point out, however, that the belt of *I. pes-caprae* formation is often broken by patches of other species, notably the grass *I. cylindrica* and *I. muticum* (Table 4). Above high water level, however, or on part that receive only the high spring tides, occurs a characteristic belt of *I. muticum - I. cylindrica* community (Table 4), and other grasses e.g., *Thuarea involuta* gives way to sedges species, then *Panicum repens* and finally *Sporobulus javensis* or *P. vaginatum* before *Pemphis acidula* is reached. *P.vaginatum* is especially good for stabilizing sandy beaches. Thus grasses are the important members of the herbaceous formation. In conclusion, the four communities or association (Table 4) were indicated as a common sand beach vegetation (SCHIMPER 1891) and are always supra littoral in Pari Island (LEWIS 1964); And the three of which (*Ipomoea pes-caprae - Canavalia maritima, Canavalia - pes caprae - Spinifex*, and *Sesuvium - Euphorbia - Canavalia*) are considered to be the pioneer of the sand dune vegetation.

1.2. *Casuarina* community.

The most seaward chenier is typically colonized just above high water mark by a narrow zone, often only one to four trees in width, of *Casuarina equisetifolia.* These trees also occur in similar single series on relatively sandy coastline of the islands. The narrow zone of *Casuarina* formation with both low density (N: 30 seedlings/155 m^2) and low frequency (2.58%) of its seedling give to impression of having planted by man. Other tree seedlings occur scattered in the *Casuarina* formation with low density per 155m^2 are *Pongamia pinnata, Premna obtusifolia* and does not seem to affect the diversity of the flora in the formation. Floristically, 17 species are to be found as predominant species (Table 2). Common herbs are *Tacca leontopetaloides* and only one species of climber, *Passiflora foetida* are recorded.

1.3. *Barringtonia* formation.

Judging from existing remnants trees (Table 1), the *Barringtonia* formation in Pari Island is mixtures of 20 species with 10 species being trees (Table 5). The width of the community is not very great, being only a few meters. Assumes that man has disrupted the community pattern and their habitat features, as can be learned and see from their broken canopy and less tree species present. This phenomenon is unusual in the tropics, where vegetation is noted for its rich composition (BACKER and BAKHUIZEN VAN DEN BRINK Jr. 1963-1968). A fragmentary development of the community is a common feature and open. The vegetation is known as strand scrub associes typified by species of less than 10 cm DBH and 6.15 m ($\pm$ 0.57) height (Table 5). On the higher grounds *S. portulacastrum*, also a succulent, and *Portulaca oleracea* are the most prominent species. Some of the most constant and characteristics trees of this community having

natural regeneration spread up to the coconut stand (Table 3): *Calophyllum inophyllum, Pongamia pinnata, Hibiscus tiliaceus, Thespesia populnea, Erythrina variegata* var. *orientalis, Desmodium umbellatum* and *Pandanus tectorius*. On the islands, as elsewhere, the trees of *C. inophyllum* and *Barringtonia asiatica* are generally cut down for firewood or cleared to make a room for coconut plantation making reconstruction of this type difficult. These provided an important key to understanding the concepts on the biological nomad theory (STEENIS 1958c).

1.4. Mangrove community.

Mangrove records in Pari Island are presented in Table 6 along with their average diameter, height and life form. The common Old World mangrove species *Rhizophora stylosa, Avicennia marina*, and *Heritiera littoralis* are present and their habitats in Kepulauan Seribu district are quite unique (Table 7). In Pari Island, *H. littoralis* are in the sapling stage. The mangrove assemblage is restricted to a few localities: along inland-lagoons and scattered on the lee-side of the islands. They do not occupy vast regions and have a simple structure. Moreover, they have been badly affected by human interference in particular by cutting to obtain firewood. In regards to the environment characters, the mangrove in Pari Island considered as a single association, dominated by *R. stylosa*. Some environmental control appears to be limiting growth, and this is most probably a nutrient limitation. The *Rhizophora* community exists as a pure community and their structural character mostly depending on the sites where they occur (substrate, relative elevation, and exposure) (Table 8). The mangrove found in Pari Island is a closed to open, broad sclerophyll, up to 5 m tall, without undergrowth, but frequently the lower 1-2 m is a tangle of arching forked aerial or prop roots. It is apparent that the habitats of individual mangrove species on Pari Island are not necessarily equivalent to their habitat in the mainland (Java) tidal forest, then allowing for differences in interpretation. The habitat specificity (or lack of it) in the Kepulauan Seribu district for individual mangrove species is relevant not only to present-day biogeography, but also to paleo-ecological and stratigraphic interpretations. In small islands, particular mangroves are associated with particular geomorphic units buried mangrove peat and mangrove pollen or macro-fossils in tidal mud can provide useful tools for reconstructing paleo-environmental parameter, such as sea-level and coastal morphology (BIRD 1993). Therefore, the precise substrate as in the case of *R. stylosa* (SUKARDJO *et al.* 1987, AZKAB and SUKARDJO 1987, AZKAB *et al.* 1988) was the key factor controlling the growth of particular mangrove species in Pari Island. Though dominant, substrate specificity is not the only determinant of mangrove distribution in the Kepulauan Seribu district. Monospecific stands of *R. stylosa* are common in Parian mangroves at different locations. The high overall but low site, total species diversity in the Parian mangroves is difficult to explain. There is no evidence of active succession in Pari Island mangroves most are remarkably stable, reductions being mainly attributed to man's activities. The ecology of mangrove forest in Pari Island is still far from complete (BUADI 1979, KARTAWINATA and WALUYO 1977). The proposed studies in detail are outline: Firstly, habitat appears to be

a major control of growth pattern in the more complex assemblages of the small islands (FOSBERG 1961, KARTAWINATA and WALUYO 1977). Secondly, habitats determine mangrove distribution within individual islands: *Avicennia* on exposed ramparts, *Rhizophora* on sheltered lee mud, etc. (WOODROFFE 1982). Thirdly, it is appearing to be the over-riding factor controlling which mangroves occur on which islands: the presence of its preferred habitats and for commoner species at least, if the habitat is available there is a high probability that the species will be present (Table 10) (WOODROFFE 1983).

2. Mixed forest.

A mixed forest is a closed, evergreen, orthophyll, but in Pari Island those condition may difficult to identify. Now this mixed forest has disappeared and is replaced by village housing. Though in small number, scattering saplings (DBH<10 cm) on the bare ground can be found in several places along the coast at salina margin, never far from the sea: *Guettarda speciosa, Allophylus cobbe, Hernandia peltata, Morinda citrifolia and Cordia subcordata.*

3. Sukun stands.

Sukun (*Artocarpus altilis*) trees are a tall, closed, macrophyllous, evergreen, orthophyll to sclerophyll. The stands often associated with ground cover of vines (*Piper* sp.), ferns (*Adiantum* sp.) or grasses, especially *Cynodon dactylon, Eleusine indica*, and shrub (*Piper aduncum*). The remnant sukun trees usually single and large sizes (both in height and diameter, 20-30 m and 15-35 cm DBH, respectively). No sample site of the sukun stands can be established for their reconstruction. It is found associated with fruit trees such as *Mangifera indica, Spondias dulcis* in the interiors of moderately wet to quite wet substrate, and important source for food and timber locally. An investigation on the ecology of sukun for their protection is therefore badly needed.

4. Coconut stands.

Coconut (*Cocos nucifera*) stands in Pari Island is a closed to, less often, open evergreen, megaphyllous sclerophyll, usually with grasses, shrub, or shrub forest undergrowth. It is left untended for a long-time. The aspects of coconut stands that are encountered are the areas affected by extensive grazing and/or cultivation (e.g., *Colocasia esculenta, Ananas commosus*) supporting mainly weedy plants (e.g., species of *Asteraceae*). From the sample plots shown that the flora of coconut stands consist of 26 families, 54 genera and 58 species (Table 3). Among the undergrowth the common species (Frequency >10%) are *Wedelia biflora, Phyllanthus virgatus, Cyperus javanicus, Tridax procumbens, Imperata cylindrica* and *Ischaemum muticum.* In places where bare ground is exposed several broad-leafed weedy herbs may be common. Thus weeds are the most important group of flowering plants in the Coconut stands. The coconuts are used for various purposes, and some of the coconut varieties that still persist from former plantings, perhaps, make possible the invasion of other weed (e.g., *Lantana camara, Mimosa invisa, M. pigra*); And a more diverse ground vegetation would probably de-

velop e.g., the lower of a dense thicket of *L. camara* 1-2 m high, but perhaps too slowly to be significant. What the ultimate consequences of this will be not yet apparent. In fact, weeds are continuously increasing in dominance and importance.

Concluding Remarks

Indonesia is the distinct region with floristically rich bio-geographic region. And the most diverse floras occur in their islands where trees are usually the dominant life form. Even in Pari Island, my result (Table 1) suggests that the tree life form occurs as main vegetation features. These and other qualities of the flora and vegetation are gradually conveying a greater sense of floristic and phytogeographical distinctness in western Maleisia (Sunda Shelf)(STEENIS 1979). The flora of Pari Island has two forms representative of a specific small island ecosystem, and their vegetation types supported by the proper habitat (Table 9). These natural ecosystems play an important role in supporting human activities (ODUM 1989). Also the different bio-region support various different life form of the flora, and much of which having economic values. Pari Island is floristically typical of strand flora in Maleisia. Thus Pari Island is still seldom explicitly recognized as such assets in environmental management, despite the fact that their continuous support is a prerequisite for economic activity.

My five-time visits were sufficient to make a detailed inventory of the plants on Pari Island, and my survey included all of the mangrove areas. These suggest that plant resources of Pari Island have been relatively well botanised. Human populations on Pari Island group, as on any other type of small islands in the Jakarta Bay, have traditionally relied on the sea for much of their nourishment. Also, in the context of aspects of the management for biodiversity, Pari Island belongs to the buffer zones of the SIMNP or frontier of the bio-geographic range of Java Bali. Thus play a vital role in the social, economic and ecological well being of coastal communities in Kepulauan Seribu district. They are also subject to rapidly increasing pressures associated with ecotourism development in the SIMNP of the Jakarta Bay. Conservation of the vegetation is essential in this island, and mangroves are most important to prevent erosion. Removal of the mangroves would be disastrous. Review of existing literature and information from this investigation suggest that vegetation of Pari continue in a state of degradation. There is now growing recognition that sustainable utilization of these islands resources will require both a fundamental change in traditionally exploitative altitudes and greater coordination of management actions.

In accordance with the Convention on Biological Diversity, biodiversity management not only can occur in strict nature or wildlife reserves, but also within anthropometric (used by man) ecosystem (e.g. Pari Island). Since the adoption by GOI (Government of Indonesia) of the Rio Convention on Biological Diversity, it has become apparent that intensified research and/or botanical exploration efforts to document the Indonesian biological diversity are needed. Despite increasing interest in the study of biodiversity in the country, there has been very little published work on the small is-

land ecosystem in Indonesia as well as Seribu Islands in Jakarta Bay, and large scale development for tourism activities in those regions has not been attempted. Therefore, the present status of botanical richness in Pari Island means there is some need to conserve the islands through strengthened the Marine Research Station capability (MRS-LIPI). The thrust of the MRS-LIPI would be building an organization for effective Integrated Coastal Zone Management (ICZM). Moreover, the requirement for baseline information in Pari Island was carried out to the extent that time permitted.

My findings are preliminary and limited to flora. The checklist of species (Table 1) is reasonably complete, with names brought up to date. The remarks on species per trip status, based on short-term reconnaissance (10 day per trip), must be regarded as tentative indeed. However, this inventory and survey contributes toward a baseline for conservation and management of this resource. Such ideas on remarks may, therefore, be accepted as educated guessing and as an element for managing the islands in terms of ICZM. To the best of my knowledge, no species in Pari Island are endangered, or likely to be considered so, or even threatened (LUCAS and SYNGE 1978). Unfortunately, most of the apparent effects of the listed human activities are changes in the characters of both floras and the vegetation types. These can be learned from a few tree species present with DBH over 10 cm diameters and/or the rare status of species (Table 1), and uncomplete of their forest reconstruction. Clearly some factors in the environment are very favourable. The present vegetation of Pari Island still contains most of the species belonging to strand flora. No information is available on former vegetation of these islands. The only one that is documented to any extent is the mangrove forest (SUKARDJO et al. 1987, AZKAB and SUKARDJO 1987). So the understanding of vegetation dynamics on Pari Island is based principally on both the results of botanical exploration and vegetation analysis. The proportions of the species present in the sample plots have undoubtedly changed but with no records of previous species composition this cannot be assessed. For example most noticeable, perhaps in Pari Island, of all human effects is the abundance and composition of the exotic (23 species), or weed vegetation. I noted an increase in exotics plant introduced to Pari Island, and my result took part in documenting the weeds. It is interesting that the weeds is cosmopolitan and several weedy *Borreria* sp. *Phyllanthus niruri, P. virgatus, Imperata cylindrica* are unusually abundant (Frequency >5%).

It can be concluded generally, that Pari Island unique variety of plant species, and coastal ecosystem, and its associated marine biodiversity, represents a national treasure, and such must be continuously protected and sustainable managed. The records of flora in Pari Island are necessary first step to review the conservation problems. Moreover, the process of establishing effective marine and coastal environmental management of small islands reached an important milestone with the recognition of this environment as a new sector in Repelita VI (Five years Development Plans). The marine sectors as well as small islands ecosystem, is now officially a key element in Indonesia's present and future economic development, especially for the ecotourism sector.

Acknowledgements

I am indebted to Prof. A.V. Toro, keeper of the Pari Marine Research Station - LIPI, for his continued encouragement and support of my research in Pari Island.

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