The flora, vegetation and conservation value of mesic forest at Dogotuki, Vanua Levu, Fiji Islands

RUNNING HEAD: Mesic forest of Dogotuki, Vanua Levu

GUNNAR KEPPEL

Biology Division

School of Biological, Chemical and Environmental Sciences

Faculty of Science and Technology

University of the South Pacific

Suva, Fiji

Current Address:

School of Integrative Biology

University of Queensland

St. Lucia, Brisbane, QLD 472, Australia

Email: g.keppel@uq.edu.au

ISAAC A. ROUNDS

Institute of Applied Sciences

University of the South Pacific

Suva, Fiji

NUNIA T. THOMAS

Institute of Applied Sciences

University of the South Pacific

Suva, Fiji

Abstract The flora and vegetation of an area in northeastern Vanua Levu that is part of Fiji's last major system of mesic forest were studied and revealed a mosaic of vegetation types, including mesic sclerophyll forest, transition forest, stunted *Dacrydium nidulum* forest, mangrove forest, montane forest, brackish and freshwater wetlands, and disturbed landscapes. This is much more diverse than indicated by the previous "dry forest" label. The flora comprises more than 268 native species, several of which are rare or narrowly distributed. Relatively large and undisturbed stretches of vegetation and the presence of rare and novel species and vegetation types suggest that the landowners should be given every possible assistance in protecting this unique landscape.

Keywords *Dacrydium nidulum*; *Gymnostoma vitiense*; *Fagraea beteroana*; Fiji; Melanesia; mesic forest; sclerophyll; South Pacific; transition forest; vascular flora; vegetation analysis

INTRODUCTION

Originating some 48 and 40 million years ago (Yan & Kroenke 1993), the Fiji Islands are an oceanic island group located between 15º and 22ºS and 177ºW and 177ºE in the South Pacific Ocean (Fig. 1). The archipelago includes more than 500 islands and covers a territory of about 650,000 km^2, less than 3% of which is land area. The two largest islands, Viti Levu (10,338 km^2) and Vanua Levu (5, 535 km^2) constitute more than 80% of the total landmass. On these two islands, and some of the medium-sized islands, a pronounced windward-leeward effect is present due to orographic precipitation of moisture carried in the prevailing SE tradewinds, resulting in a wet SE side and a dry western side (Mueller-Dombois & Fosberg 1998; Keppel & Tuiwawa submitted).

The vascular flora of Fiji has been well explored and described (Seemann 1865-73; Copeland 1929; Brownlie 1977; Smith 1979, 1981, 1985, 1988, 1991, 1996). In a review based on recent taxonomic

literature, 137 families, 484 genera, and 1313 species of seed plants are recognised as indigenous to Fiji (Heads in press). Although only 1 family and 11 genera are endemic to Fiji (Smith 1996), endemism at the species level has been estimated to be about 62% (Watkins 1995; Smith 1996). However, recent taxonomic revisions of various genera and families have reduced the number of species considered endemic to Fiji (Heads in press).

Mueller-Dombois & Fosberg (1998) recognised nine principal vegetation types in a synthesis based on several other treatments of Fiji's vegetation (Smith 1951; Twyford et al. 1965; Cochrane 1969; Parham 1972; Berry & Howard 1973; Smith 1979; Ash 1992), including lowland rain forest, upland rain forest, cloud forest, dry forest, "talasiga" grasslands (a Fijian word meaning "sunburnt land") freshwater wetland vegetation, mangrove forest and scrub, coastal strand vegetation, and smaller island vegetation.

Tropical dry forest was first recognised by Twyford et al. (1965) as one of Fiji's principal vegetation types in areas that receive 1750 to 2250mm of rain. Using aerial photographs and ground truthing, Berry & Howard (1973) recognised nine different forest types within this dry forest, most of which were dominated by *Gymnostoma vitiense*, *Fagraea gracilipes* and *Dacrydium nidulum* (Appendix 1). Species of *Myristica* and *Syzygium*, *Dysoxylum richii*, *Parinari insularum*, and *Agathis macrophylla* may be locally dominant. In addition, a Sapindaceae pole forest and a woodland dominated by introduced raintrees (mostly *Samanea saman* and *Albizia lebbeck*) was recognised. Mueller-Dombois & Fosberg (1998) suggested that this dry forest should be classified as a mesic forest on a global scale. Recent discovery of a "true" dry forest, which has a several deciduous species, supports this (Keppel & Tuiwawa submitted). Therefore, we will henceforth refer to the dry forest of Twyford et al. (1965), Berry & Howard (1973) and Mueller-Dombois & Fosberg (1998) as "mesic forest" (MF), following Keppel & Tuiwawa (in prep.).

MF has mostly been replaced by talasiga grasslands (Smith 1951; Parham 1972) and is now restricted to

small areas on Vanua Levu (Berry & Howard 1973). The need to protect the remaining MF was recognised when a proposed system of national parks was developed for the Fiji Islands (Lees 1989). In particular, the MF around and between the Vunivia and Nasavu Catchments, Fiji's easternmost river systems, on the lower Udu Peninsula (Vanua Levu), about 45 km east-north-east of Labasa (Fig. 1, 2), was identified as possible heritage site and national park. Lees (1989) did not provide a species list but noted the presence of well-developed mangrove forest.

D'Espessis (1941 in Bogiva 1994) was the first to comment on the unique vegetation and physical and climatic features of the Udu Peninsula. Subsequent evaluations of the area all strongly supported the establishment of a national park in the Vunivia and Nasavu Catchments (Weaver 1992a, 1992b; Bogiva 1994). A preliminary survey of the existing archaeological and historical literature also identified the area as potentially interesting (Chabaniuk 1992). Despite the seeming uniqueness of the area, no detailed scientific survey of the flora and fauna of either the catchments or the MF has been conducted. Neither is any MF in Fiji protected, although the need for protection was highlighted by Lees (1989).

We were approached by members of one of the landowning clans (Kawa nei Tagi Tuba) to substantiate the assertion that the two catchments are botanically unique to allow them to consider conservation measures. This paper presents the results of this study and, therefore, constitutes the first detailed description of the structure, composition, and diversity of MF in Fiji. It is also the first extensive survey of the lower Nasavu Catchment and findings are related to the conservation importance of the proposed Vunivia and Nasavu catchment forest reserve. This study hopefully is a step towards a complete survey of the flora and fauna in the two catchment areas and their eventual protection.

METHODS

Study Area

The area studied is the Dogotuki District, Macuata, which is part of the proposed Vunivia and Nasavu Catchment Reserve and is located on the lower reaches of the Nasavu and Vunivia Rivers (Fig. 2). At the nearby Udu Point weather station little seasonality and a total annual precipitation of 2450mm are recorded (Fig. 3). However, the precipitation regime at the study site is likely to differ, because much of the moisture carried by the SE tradewinds is likely to precipitate over the peninsula, thereby creating a minor rainshadow on the northward side of the peninsula. We expect the actual climate at the study side to be similar to that for Udu Point but to have a lower rainfall curve, resulting in a lower total annual precipitation.

Flora

Research was carried out in July 2003. If possible, we identified species in the field using Smith (1979, 1981, 1985, 1988, 1991, 1996), Brownlie (1977), Whistler (1992, 1995, 2000), Purseglove (1972, 1974), and Keppel & Ghazanfar (in press). We also collected other species for identification and deposition at the South Pacific Regional Herbarium (SUVA), Suva, Fiji.

Vegetation

A reconnaissance by walking through the area identified 10 putatively unique vegetation types (entitation, Mueller-Dombois & Ellenberg 2002) (Table 1): five types of undisturbed, terra firma forests (‘Bainivara’, ‘Bereniyalo’, ‘Caudramea’, ‘Nabourewa’, ‘Nautuutu’), disturbed terra firma forest (‘Dareka’), mangrove forest (‘mangroves’), fire-disturbed savanna (‘Bainivara Dist’), and two herbaceous swamp communities (‘mangroves’, ‘Waitabua’).

In each putatively unique vegetation type a species list was prepared, except for the mangrove back swamp, which could not be properly surveyed because of the swampy conditions and was therefore excluded from the analyses. At each site with undisturbed terra firme forest, we set up a 10 × 60 m plot

in a representative, homogenous portion to document the structure and composition of the vegetation present. In each plot we recorded the dbh, bole height, crown height, crown width, and position of every tree with dbh ≥ 10 cm. We also recorded climbers, epiphytes, and species in the understorey.

Analysis

We assessed the uniqueness of the different putative vegetation types using agglomerative clustering of the Community Analysis Package (CAP, Henderson & Seaby 2002) using average linkage based on the Jaccard coefficient. CAP was also used for a two-way indicator species analysis (TWINSPAN) to identify the species characteristic for each vegetation type. Data sets used for analysis are available from GK upon request. In addition, profile diagrams for the five sites with 10 × 60m plots were drawn.

RESULTS

Flora

A total of 336 species were recorded, 268 (80%) of which are indigenous (Table 2; Appendix 2). This list is comprehensive but by no means complete. Endemism of the native flora is about 34% (90 species). Rubiaceae is the most diverse family, with 20 native species, followed by Euphorbiaceae and Orchidaceae with 13 species each and Cyperaceae with 10 species. Other common families include Moraceae, Myrtaceae, Poaceae and Sapotaceae (Table 3; Appendix 2).

Several of the endemic species are rare or have a narrow distribution. The endemic grass *Leptaspis angustifolia* has a very narrow range, restricted to the Macuata Province on Vanua Levu. Plants that are only found on Vanua Levu (and in some cases also on the adjacent island of Taveuni) are: *Cyathocalyx vitiensis* (Annonaceae), *Parsonsia smithii* (Apocynaceae), *Veitchia filifera* (Arecacaceae), *Macaranga membranacea* (Euphorbiaceae), *Airosperma vanuense*, *Ixora myrtifolia* and *Psychotria argantha* (all

Rubiaceae). Three additional species were classified as rare because there are 5 or less cited specimens in Smith's (1979, 1981, 1985, 1988, 1991, 1996) *Flora Vitiensis Nova*: *Garnotia linearis* (Poaceae, 5 collections), *Maniltoa vestita* (Caesalpiniaceae, 3 collections) and *Syzygium simillimum* (Myrtaceae, 2 collections). In addition, one of the *Psychotria* (Rubiaceae) collected from Mt. Cavanavula, differs from all other species in the genus described from Fiji and is possibly new to science.

Vegetation

Jaccard coefficients ranged between 0 (no similarity) and 0.25 (Fig. 4), showing low similarities between the different putative vegetation types, confirming our assessment based on visual reconnaissance and entitation. TWINSPAN produced a dendogram with clusters similar to those of the cluster analysis in Fig. 4 and is not shown. However, we used the TWINSPAN output to determine characteristic species for the various clusters. For example, wetlands are clearly differentiated from forests, sharing no common species. The wetland species *Acrosticum aureum*, *Stenochlaena palustris*, and *Pandanus tectorius* were characteristic for the two wetlands ('mangroves' and 'Waitabua'), which had low similarities (J = 0.2).

The fire-disturbed vegetation at 'Bainivara Dist' and the stunted vegetation of 'Bereniyalo' are distinct (Fig. 4). Several species that are in Fiji often associated with frequent fires, such as *Casurina equisetifolia*, *Dodonea viscosa*, *Pennisetum polystachyon*, and *Pteris ensiformis*, are only recorded from 'Bainivara Dist'. Early successional species, such as *Alstonia pacifica*, *Commersonia bartramia*, and *Geniostoma rupestre* were unique to 'Dareka', which is possibly related to recent swidden agriculture, e.g. we found a small plantation of kava (*Piper methysticum*) in one location. Other species unique to 'Dareka' are *Centotheca lappacea*, *Dichapetalum vitiense*, *Exocarpus vitiensis*, *Serianthes melanesica*, and *Adenanthera pavonia*. Because our study focused on native, undisturbed vegetation types, we considered the vegetation on 'Bainivara Dist' and 'Dareka' together as "disturbed vegetation". 'Bereniyalo' has stunted vegetation characterised by several unique species, including *Acacia richii*,

Gahnia aspera, *Garcinia adiantha*, Hibbertia luccens, and *Leucopogon septentrionalis*, and is considered a separate vegetation type.

In addition, the plots of 'Bainivara' and 'Caudramea' form a distinct cluster and are here considered as mesic forest (MF). They uniquely share *Alpinia vitiensis*, *Syzygium decussatum*, *Connarus pickeringii*, *Phyllanthus heterodoxus*, *Podocarpus neriifolius*, *Syzygium fijiense*, *Tapeinospermum grande*. *Dacrydium nidulum* and *Fagraea beteroana*. 'Nautuutu' and 'Nabourewa' also form a distinct cluster and are here considered to be "transition forest" (TF) because they have physiognomic and taxonomic characteristics that are intermediate between MF and lowland tropical rain forest (see below). Only *Buchanania vitiensis*, *Cordyline fruticosa*, *Dillenia biflora*, and *Garcinia pseudoguttifera* are unique to this group, showing that it is less clearly defined. *Gymnostoma vitiense* and the climbers *Freycinetia impavida*, *Flagellaria gigantea*, *Flagellaria indica*, and *Lygodium reticulatum* commonly occur in both, MF and TF.

An additional vegetation type, montane forest, is recognised on Mt. Cavanavula based on specimens collected and vegetation descriptions. However, this vegetation type was not studied in detail. Therefore, we identified eight vegetation types:.

1. Mesic forest (MF)

This is the most common vegetation type in the study area and is dominated by *Gymnostoma vitiense*, *Dacrydium nidulum*, and *Fagraea gracilepes*, which are present in different proportions in different locations. The forest is similar to but more diverse (Fig. 5) than the "dry forest" of Berry and Howard (1973). Species composition differs on ridges (Fig. 6), with gymnosperms being more diverse and dominant and the legume *Intsia bijuga* becoming an important component of the forest. This forest type lacks deciduous species but about a quarter of its species are sclerophyllous (Keppel & Tuiwawa submitted).

2. *Stunted* Dacrydium nidulum *forest*

This is an interesting variant of MF and is found at ‘Bereniyalo’, where *Dacrydium nidulum* forms low-growing, monodominant stands (Fig. 7). In some places only a few sedges or no vegetation at all persist. *Gahnia aspera, Garcinia adiantha, Garcinia myrtifolia, Hibbertia luccens, Leucopogon sepentrionalis, Lycopodiella cernua* are restricted to this vegetation type.

3. *Transition forest* (TF)

This has a species composition intermediate between MF and the lowland rainforest described by Mueller-Dombois & Fosberg (1998). It contains several species (*Amaroria soulameoides, Dillenia biflora, Garcinia pseudoguttifera, Gironniera celtidifolia*) that are usually associated with lowland rainforest and species (*Fagraea gracilipes, Gymnostoma vitiensis*) that are dominant in MF. In addition this forest has some common rainforest features (stilt roots, buttresses, palms; Fig. 8, 9). The composition of transition forest seemingly varies greatly. For example, while the forest at ‘Nabourewa’ is dominated by *Gymnostoma vitiensis* (Fig. 8), that at ‘Nautuutu’ is dominated by *Myristica gillespieana* (Fig. 9).

4. *Mangrove forest*

This covers almost the entire coastline. It is composed of coastal *Rhizophora* (*R. stylosa, R. mangal*, and the sterile hybrid *R.* × *selala*) formations and landward *Brugiera gymnorrhiza* formations and associated species (*Acrostichum aureum, Dalbergia candatensis, Excoecaria agallocha, Lumnitzera littorea*, species of *Xylocarpus*). In addition to these typical mangrove species, the climbers/epiphytes *Abrus precatorius, Davallia solida, Derris trifoliata*, and *Hoya australis* were restricted to mangrove vegetation. The mangrove forest is extensive, intact, and unique because trees of the lowland forest, such as *Agathis macrophylla,* are found on the inner margins of this forest in some places.

5. *Brackish swamps*

These are mainly herbaceous communities found on the inner margins of mangroves and dominated by *Eleocharis dulcis* with occasional trees of *Pandanus tectorius* and, rarely, *Barringtonia racemosa*. The inner margins of these swamps, which presumably have a very low salinity, have been used to plant dalo (*Colocasia esculenta*; also known as taro), a major staple food. Such areas differ in species composition, with native (*Acrostichum aureum*, *Diplazium esculentum*, *Nephrolepis biserrata*, *Barringtonia racemosa*) and invasive species (*Ludwigia occidentalis*, *Mikania micrantha*, *Paspalum conjugatum*, *Merremia peltata*) co-dominate.

6. *Freshwater wetlands*

A freshwater lake, Waitabua, was the only freshwater wetland in our study area. Its centre is open water, which is surrounded by a band of *Eleocharis dulcis* (Cyperaceae) up to 5 m wide. On the periphery of this lake is a very thin band (< 50 cm wide) consisting of several other sedges, the ferns *Acrostichum aureum* and *Stenochlaena palustris*, and *Pandanus tectorius*. Several of the epiphytic orchids were collected from trees facing this inland lake, and *Eleocharis dulcis* and *Rynchospora corymbulosa* are unique to this vegetation.

7. *Montane forest*

This is restricted to the top of Mt Cavanavula (C. 400m), as indicated by the collection of species typical of montane vegetation. In addition the forest is stunted and gnarled (M. Fox, D. Jackson & L. Cokanasiga pers. comm.), which is typical of montane or cloud forest. The mountain is isolated and this suggests that it could have new, endemic species, an assertion substantiated by the collection of a species of *Psychotria* aff. *macrocalyx* (Rubiaceae) not listed in Smith (1988) and different from *Psychotria volii* (Gardner 1997).

8. *Disturbed vegetation and anthropogenic landscapes*

These have been caused by five major factors (fire, agriculture, settlements, cyclones, logging). While

agriculture and settlements are more permanent disturbances that result in complete transformation of the original vegetation, other disturbances are usually followed by gradual recovery. However, food gardens often replace logged forests. Agriculture may have several effects on the vegetation, depending on the duration and extensiveness of cultivation. Swidden agriculture at 'Dareka' appeared to maintain forest cover but to change species composition. Extensive agriculture over long periods of time was observed to result in soil degradation and dominance of introduced species. A few uprooted trees and several broken branches, likely the result of Cyclone Ami, which passed close by the study site in January 2003, covered the forest floor in some locations. Some locations showed evidence of relatively recent fires (e.g., 'Bainivara Dist') and a displacement of MF species by more fire-resistant species such as *Casurina nodiflora* and *Dodonaea viscosa* was observed (both of which were unique to the Bainivara Dist side in the TWINSPAN analysis). Bracken ferns (*Dicranopteris linearis*, *Gleichenia oceanica*, and species of *Pteris*) dominate this landscape.

Discussion

The flora of Dogotuki, with 274 native species (about 34% are endemic), is diverse. Tuiwawa (1999) found a more diverse flora (366 native species), similar percentage of indigenous species (86%) but much higher percentage endemism (49%) in moist rainforest on Viti Levu. This may indicate that the endemism in Fiji's MF is lower than in the wet forests and corresponds to the theory of increased diversity with increased precipitation (Gentry 1988). The flora includes 12 rare or narrowly distributed species. In addition, some species, such as *Hibbertia lucens* and *Sacromelicope petiolaris*, are mainly restricted to dry zone habitats and are, therefore, likely to be endangered through habitat destruction. MF is more diverse than andticipated based on previous work. For example, the profile diagram of MF by Barry & Howard (1973; and reproduced in Mueller-Dombois & Fosberg 1998, pg. 124) has only five labelled taxa and *Fagraea gracilepes* is much more common than in our plots.

Relationships between the different forest sites portrayed by the dendogram based on agglomerative clustering (Fig. 4) and TWINSPAN (similar to Fig. 4 but not shown) must be considered with caution, because they are solely based on presence/absence data and do not take into account the abundance of the different species. In particular, 'Bereniyalo', which is almost monodominant, and 'Dareka', which has a great number of unique species, may have clustered differently, if sufficient abundance data had been collected.

The previously reported homogenous MF (Lees 1989) of the Vunivia and Nasavu catchments is here shown to be a unique and diverse mosaic of different vegetation types, at least in the lower Nasavu catchment. This mosaic is likely to be caused by a combination topographical, microclimatic, and fine-scale geological differences. Differences in species composition were so pronounced that we divided MF into 3 distinct forest types: MF, TF, and stunted *Dacrydium nidulum* forest. While MF is the predominant forest type, other vegetation types, the extent of which should be mapped, cover substantial areas.

The heterogeneity of Fiji's MF was first recognised by Berry & Howard (1973). They reported eight diiferent forest types, most of them dominated by *Gymnostoma vitiense, Dacrydium nidulum, Fagraea gracilepes*, or a combination of these species (Appendix 1). These three species or a combination of two of them also dominate the MF in this study. In some places MF has been removed for logging and agricultural purposes or disturbed by burning. There are also pockets of an apparently moister forest type (TF), which have species common in tropical lowland rainforest in addition to those characteristic of MF. An interesting feature is the abundance of conifers, mainly *Dacrydium nidulum* and *Agathis macrophylla*, at low altitudes.

Monodominant stands, such as the stunted *Dacrydium nidulum* forest at Bereniyalo, are rare in the tropics and can be caused by nutrient-poor soils or compounds impairing plant growth (Richards 1996).

In the Pacific, monodominant forests have been found in mangroves (Thaman et al. 2005), swamps (Whitmore 1969; Ash & Ash 1984) and some terra firma sites, some of which, but not all, have a history of previous anthropogenic disturbance (Whitmore 1969; Bayliss-Smith et. al. 2003). Further studies are required to determine the causative factors of this stunted, monodominant growth.

In addition to these vegetation types, there are large stretches of mangrove forest along the coast and several wetlands. The latter includes brackish swamps bordering mangroves and inland lakes. Wetlands are generally highly disturbed in Fiji (Ash & Ash 1984) and in Oceania (Scott 1993). Mangrove forests have disappeared rapidly in Fiji over recent years and are now considered to require management (Lal 1990). We found extensive and relatively intact mangrove forests [similar in structure and composition to those described by Ghazanfar et al. (2001) and Thaman et al. (2005)] that, like the other wetlands, had few invasive species. In some places, trees usually associated with terra firma forest grew on the inner margins of mangrove forests, a phenomenon previously observed by IAR in some places along the SE coast of Viti Levu.

MF was probably very common on Viti Levu and Vanua Levu in pre-historic times (Southern 1986) but has been reduced to small remnant pockets on Viti Levu and Vanua Levu and is possibly entirely extirpated on latter island (Twyford et al. 1965; Berry & Howard 1973). The MF in the Vunivia and Nasavu Catchments is the last extensive stand of this vegetation type remaining in Fiji (Lees 1989). Extensive, well-developed stretches of mangrove forest are also found. In addition, we observed herbaceous freshwater and brackish wetlands that had very few invasive species and a stunted forest dominated by *Dacrydium nidulum*. The latter forest type has not been previously reported. We also identified several species that are rare or have a restricted distribution. All these findings underline the conservation value of the area. We therefore concur with previous authors (d'Espessis 1941 in Bogiva 1994; Lees 1989; Weaver 1992a, 1992b; Bogiva 1994) regarding the uniqueness of the vegetation of the Vunivia and Nasavu Catchments.

At present, logging is the single largest threat to this forest system. Several forests in close vincinity have already been cut and there is considerable interest in continuation of timber extraction (E. Kosoluva & Y. Roberts pers. comm.). While logging would provide cash for the local communities, it would also damage the forest almost irreversibly. Although no data on regeneration of mesic forest are available, it is likely, based on the slower growth rates of forests in drier regions, that it would take longer than for lowland tropical rainforest, which requires several centuries (Riswan et al. 1985). Other threats are invasive plant species, with the raintrees (*Albizia lebbeck* and *Samanea saman*) and the African tulip tree (*Spathodea campanulata*) posing the biggest threats. Recent wotk by Rolett & Diamond (2004) has pointed towards a high susceptibility of dry zone vegetation to disturbance. Thus, the demise of MF in Fiji therefore probably commenced soon after the arrival of human beings.

This study shows that botanical surveys ca be a powerfull tool in conservation and environmental management. By identifying species and vegetation types, richness in species and vegtation can be determined, species that are rare or have a restricted range identified, and spots with unique vegetation located. This is especially true on isolated oceanic islands like Fiji, where the fauna is depauperate (Flannery 1995, Watling 2001, Morrison 2003) and the flora relatively well known.

Considering the uniqueness and the relatively pristine condition of the Nasavu and Vunivia catchment, the protection of its ecosystems and biodiversity should be considered a conservation priority. Although the site has been proposed to become a forest reserve (Lees 1989) and was, after work by Weaver (1992b), incorporated into a list of priority areas for protection under Fiji's National Environment Strategy (Watling & Chape 1993), the proposed reserved is still not formalised and logging is occuring within its intended boundaries.

As already mentioned by Weaver (1992b), protection would require careful consideration of the needs of

landowners. A possible way of addressing this would be by creating a mosaic of protected (pristine) and usage (disturbed) areas. In addition, alternative sources of income for the inhabitants of the two catchments need to be ensured. Any road construction or development projects should be carefully planned to avoid the introduction and spread of alien species.

ACKNOWLEDGMENTS

This study was made possible by Emma Adi Kosoluva and Yvonne Roberts, who hosted the visit and covered the travel expenses of the team members. Several members of the Kawa nei Tagi Tuba family helped with transportation, cooking, as guides, and in many other ways.

REFERENCES

Ash J 1992. Vegetation ecology of Fiji: past, present and future perspectives. Pacific Science 46: 111-127.

Ash JE, Ash W 1984. Freshwater wetland vegetation of Viti Levu, Fiji. New Zealand Journal of Botany 23, 377-391.

Bayliss-Smith T, Hvding E, Whitmore TC 2003. Rainforest composition and histories of human disturbance in Solomon Islands. Ambio 32: 346-352.

Berry MJ, Howard WJ 1973. Fiji Forest Inventory. Volume 1. The Environment and Forest Types. Land Resource Study No. 12. Surbiton, Surrey, England, Land Resource Division

Bogiva A 1994. Vunivia Catchment Reserve Proposal, Dogotuki, Macuata. A Field Investigation Report. Unpublished Report.

Brownlie G 1977. The Pteridophyte Flora of Fiji. (Beihefte zur Nova Hedwigia, Heft 55). Vaduz,

Liechtenstein, J. Cramer.

Chabaniuk S 1992. The Archaeology of the Vunivia Catchment, Dogotuki Tikina, Macuata Province, Vanua Levu. A Preliminary Study. Unpublished Report.

Cochrane GR 1969. Problems of vegetation change in western Viti Levu, Fiji. In: Gale F, Lawton GH ed. Settlement and encounter: Deographical studies presented to Sir Grenfell Price. Melbourne, Australia, Oxford University Press.

Copeland EB 1929. Ferns of Fiji. Honolulu, Hawaii, USA, Bernice P. Bishop Museum.

Flannery TF 1995. Mammals of the South-west Pacific and Moluccan Islands. Ithaca, New York, USA, Cornell University Press.

Gardner RO 1997. New and noteworthy plants from Fiji. NewZealand Journal of Botany 35: 487-492.

Gentry AH 1988. Changes in plant community diversity and floristic composition on environmental and geographical gradients. Annals of the Missouri Botanical Garden 75: 1-34.

Ghazanfar SA, Keppel G, Khan S 2001. Coastal vegetation of small islands near Viti Levu and Ovalau, Fiji. New Zealand Journal of Botany 39: 587-600.

Heads M in press. Seed plants of Fiji: an ecological analysis. Biological Journal of the Linnean Society.

Henderson PA, Seaby RMH 2002. Community Analysis Package. *Version 2.15*. Pennington, Lymington, Hants, UK, PISCES Conservation Ltd.

Keppel G, Ghazanfar SA (ed.) 2006 (in press): A Guide to 100 Indigenous Fijian Trees. Suva, Fiji, Department of Forestry and the Fiji German Forestry Project.

Keppel G, Tuiwawa M submitted. Native forests in the dry zones of the Fiji Islands. New Zealand Journal of Botany.

Lal PN 1990. Conservation or conversion of mangroves in Fiji : an ecological economic analysis. Occasional paper (East-West Environment and Policy Institute) No. 11. Honolulu, Hawaii, USA, Environment and Policy Institute, East-West Center.

Lees A 1989. A Representative National Park and Reserves System for Fiji's Tropical Forests. Maruia Society Policy Reports Series No. 9, May 1989. Nelson, New Zealand, Maruia Society.

Morrison C 2003. Field guide to the herpetofauna of Fiji. Suva, Fiji, University of the South Pacific.

Mueller-Dombois D, Ellenberg H 2002. Aims and methods of vegetation ecology. Caldwell, New Jersey, Blackburn Press.

Mueller-Dombois D, Fosberg RF 1998. Vegetation of the Tropical Pacific. New York, USA, Springer Verlag.

Parham JW 1972. Plants of the Fiji Islands (revised edition). Suva, Fiji, Government Printers.

Purseglove JW 1972. Tropical crops: Monocotyledons (Volumes 1 and 2 combined). Harlow, UK, English Language Book Society and Longman.

Purseglove JW 1974. Tropical crops: Dicotyledons (Volumes 1 and 2 combined). Harlow, UK, English Language Book Society and Longman.

Richards PW 1996. The tropical rain forest. Cambridge, UK, Cambridge University Press.

Riswan S, Kenworthy JB, Kartawinata K 1985. The estimation of temporal processes in tropical rain forest: a study of primary mixed dipterocarp forest in Indonesia. Journal of Tropical Ecology 1: 171-182.

Rolett B, Diamond J 2004. Environmental predictors of pre-European deforestation on Pacific Islands. Nature 431: 443-446.

Scott DA 1993. A directory of wetlands in Oceania. Kuala Lumpur, Malaysia, International Waterfowl and Wetlands Research Bureau.

Seemann B 1865-73. Flora Vitiensis: A description of the plants of the Viti or Fiji Islands, with an account of their history, uses and properties. London, UK, L. Reeve & Co.

Smith AC 1951. The vegetation and flora of Fiji. Scientific Monthly 73: 3-15.

Smith AC 1979. Flora Vitiensis nova: A new flora of Fiji (spermatophytes only). Vol. 1. Lawai, Kauai, Hawaii, USA, Pacific Tropical Botanical Garden.

Smith AC 1981. Flora Vitiensis nova: A new flora of Fiji (spermatophytes only). Vol. 2. Lawai, Kauai, Hawaii, USA, Pacific Tropical Botanical Garden.

Smith AC 1985. Flora Vitiensis nova: A new flora of Fiji (spermatophytes only). Vol. 3. Lawai, Kauai,

Hawaii, USA, Pacific Tropical Botanical Garden.

Smith AC 1988. Flora Vitiensis nova: A new flora of Fiji (spermatophytes only). Vol. 4. Lawai, Kauai, Hawaii, USA, Pacific Tropical Botanical Garden.

Smith AC 1991. Flora Vitiensis nova: A new flora of Fiji (spermatophytes only). Vol. 5. Lawai, Kauai, Hawaii, USA, Pacific Tropical Botanical Garden.

Smith AC 1996. Flora Vitiensis nova: A new flora of Fiji (spermatophytes only): Comprehensive indices. Lawai, Kauai, Hawaii, USA, Pacific Tropical Botanical Garden.

Southern W 1986. The Late Quartenary environmental history of Fiji. Unpublished PhD thesis, Australian National University, Canberra, Australia.

Thaman RR, Keppel G, Watling D, Thaman B, Naikatini A, Thaman B, Bolaqace N, Sekinoco E, Masere M 2005. Nasoata mangrove island, the PABITRA coastal study site for Viti Levu, Fiji Islands. Pacific Science 59: 193-204

Tuiwawa MV 1999. The Flora, Ecology and Conservation of Botanical Biodiversity of Waisoi and the Southeastern Slopes of the Korobasabasaga Range in Namosi Province, Fiji. M.Sc. Thesis, Biology Department, School of Pure and Applied Sciences, The University of the South Pacific, Suva, Fiji.

Twyford IT, Wright ACS, Parham JW, Loweth N 1965. Plant Cover. In: Twyford IT, Wright ACS ed. The soil resources of the Fiji Islands. Volume 1. Suva, Fiji, Government Printers. Pp. 19-86.

Watling D 2001. A Guide to the Birds of Fiji and Western Polynesia - including American Samoa, Niue, Samoa, Tokelau, Tonga, Tuvalu and Wallis and Futuna. Suva, Fiji, Environmental Consultants Ltd.

Watling D, Chape S 1993. The National Environment Strategy-Fiji. Suva, Fiji, Government of Fiji; and Gland, Switzerland, IUCN.

Watkins AJ 1995. A biogeographic database for seed plants of Fiji: A preliminary communication. South Pacific Journal of Natural Sciences 46: 111-127.

Weaver SA 1992a. Nature Tourism as a means of protecting indigenous forest resources in Fiji. Journal of Pacific Studies 16: 63-73.

Weaver SA 1992b. The Vunivia Catchment: an ecologically sensitive area case study. Resource Report,

Fiji National Environment Management Project. Department of Town and Country Planning, Fiji.

Whistler WA 1992. Flowers of the Pacific Island Seashore: A guide to the littoral plants of Hawai'i, Tahiti, Samoa, Tonga, Cook Islands, Fiji and Micronesia. Honolulu, Hawaii, USA, Isle Botanica.

Whistler WA 1995. Wayside plants of the islands: A guide to the lowland flora of the Pacific Islands including Hawai'i, Samoa, Tonga, Tahiti, Fiji, Guam and Belau. Honolulu, Hawaii, USA, Isle Botanica.

Whistler WA 2000. Tropical Ornamentals. A Guide. Portland, Oregon, USA, Timber Press, Inc.

Whitmore TC 1969. The vegetation of the Solomon Islands. Philosophical Transaction of the Royal Society, Series B 255: 259-270.

Yan CY, Kroenke LW 1993. A plate tectonic reconstruction of the SW Pacific 0-100 Ma. In: Berger T, Kroenke LW, Mayer L et al. ed., Proceedings of the Ocean Drilling Program, Scientific Results 130. Texas A&M University, College Station, Texas. Pp. 697-709.

Table 1 Location and vegetation of study sites. See Fig. 2 for location of locality names.

Site	Location*	Vegetation of Plot
Bainivara	Bainivara	mesic forest (c. 15º slope)
Bainivara Dist	Bainivara	Savanna with remnant trees of mesic forest and fire resistant species, several trunks charred, indicating recent fire.
Bereniyalo ("footprints of the spirit")	Bereniyalo	stunted forest
Caudramea	Caudramea	mesic forest (ridge)
Dareka	Dareka	disturbed mesic forest adjacent to Dareka settlement and Dogotuki village
Mangrove Forest	Dareka	mangroves
Mangrove Back Swamp	Dareka	herbaceous swamp
Nabourewa	Nabourewa	forest with elements of mesic and rain forest
Nautuutu	Nautuutu	forest with elements of mesic and rain forest
Waitabua	Waitabua	lake with mainly herbaceous swamp vegetation on margins

Table 2 Summary of the classification, origin and distibution of the species identified. * = includes endemic species.

	Endemic	Indigenous*	Introduced	TOTAL
Ferns & Fern Allies	4	42	-	**42**
Gymnosperms	-	4	-	**4**
Dicotyledons	78	177	51	**228**
Monocotyledons	8	45	17	**62**
TOTAL	**90**	**268**	**68**	**336**

Table 4 List of all families with more than five indigenous species identified, stating the number of native and introduced species.

Family	Indigenous	Introduced	Total
Rubiaceae	20	4	24
Euphorbiaceae	13	5	18
Orchidaceae	13	-	13
Cyperaceae	10	2	12
Poaceae	8	7	15
Moraceae	8	1	9
Myrtaceae	8	1	9
Sapotaceae	7	-	7
Apocynaceae	6	4	10
Caesalpiniaceae	6	1	7
Meliaceae	6	-	6
Rhamnaceae	6	-	6
Rhizophoraceae	6	-	6
Verbenaceae	5	2	7
Adiantaceae	5	-	5
Anacardiaceae	5	-	5
Clusiaceae	5	-	5
Davalliaceae	5	-	5

Fig. 1 The Fiji Group. The rectangular area is the enlarged in Fig. 2.

Fig. 2 Nasavu and Vunivia Catchment systems and an insert (left corner; location indicated by rectangle with dashed lines) showing the locations of the study sites.

Fig. 3 Climate diagram of the weather station at Udu Point from 1994 to 1999 (Fig. 2). Altitude: 62m. Average annual temperature: 26ºC. Average annual rainfall: 2451mm.

Fig. 4 Grouping of the nine sample sites using agglomerative clustering and average linkage based on Jaccard coefficient.

Fig. 5 Mesic slope forest. Profile diagram of trees with a dbh of 10cm or more in a 60 × 10 m plot on a c. 15° slope at Bainivara, Dogotuki, Macuata, Vanua Levu. Buat = *Buchanania attenuata*, Cavi = *Canarium vitiense*, Crha = *Crossostylis harveyi*, Cyin = *Cyathocalyx insularis*, Gmvi = *Gmelina vitiensis*, Gyvi = *Gymnostoma vitiense*, Hafl = *Haplolobus floribundus*, Magr = *Maniltoa grandiflora*, Mygi = *Myristica gillespieana*, Pafi = *Palaquium fidjiense*, Poga = *Pouteria garberi*, Plti = *Pleiogynium timoriense*, Syfi = *Syzygium fijiense*, Sysp = *Syzygium* sp.

Fig. 6 Mesic ridge forest. Profile diagram of trees with a dbh of 10cm or more in a 30 × 10 m plot on a ridge at Caudramea, Dogotuki, Macuata, Vanua Levu. Agma = *Agathis macrophylla*, Cace = *Calophyllum cerasiferum*, Dani = *Dacrydium nidulum*, Dysp = *Dysoxylum* sp., Gyvi = *Gymnostoma vitiense*, Inbi = *Intsia bijuga*, Madi = *Manilkara dissecta*, Syfi = *Syzygium fijiense*, Syru = *Syzygium rubescens*, Sysp = *Syzygium* sp..

Fig. 7 Stunted *Dacrydium nidulum* forest. Profile diagram of trees with a dbh of 10cm or more in a 60 × 10 m plot of stunted *Dacrydium nidulum* forest on a flat at Bereniyalo, Dogotuki, Macuata, Vanua

Levu. Acri = *Acacia richii*, Dani = *Dacrydium nidulum*, Gaad = *Garcinia adiantha*, Gyvi = *Gymnostoma vitiense*, Madi = *Manilkara dissecta*, Pone = *Podocarpus nerifolius*, Sysp = *Syzygium* sp..

Fig. 8 Transition forest. Profile diagram of trees with a dbh of 10cm or more in a 60 × 10 m plot on a c. 25° slope at Nabourewa, Dogotuki, Macuata, Vanua Levu. Buvi = *Buchanania vitiensis*, Crha = *Crossostylis harveyi*, Dibi = *Dillenia biflora*, Fagr = *Fagraea gracilipes*, Gasp = *Gardenia* sp., Gyvi = *Gymnostoma vitiense*, Myca = *Myristica castaneifolia*, Mygi = *Myristica gillespieana*, Pain = *Parinari insularum*, Syru = *Syzygium rubescens*, Vefi = *Veitchia filifera*.

Fig. 9 Transition forest. Profile diagram of trees with a dbh of 10cm or more in a 50 × 10 m plot on a c. 10° slope at Nautuutu, Qaranivai, Macuata, Vanua Levu. Amso = *Amaroria soulameoides*, Anlu = *Anacolosa lutea*, Buvi = *Buchanania vitiensis*, Dibi = *Dillenia biflora*, Gaps = *Garcinia pseudoguttifera*, Inbi = *Intsia bijuga*, Mygi = *Myristica gillespieana*, Pafi = *Palaquium fidjiense*, Sysp = *Syzygium* sp., Vaam = *Vavaea* cf. *amicorum*, Vefi = *Veitchia filifera*.

APPENDIX 1 - Forest types in the dry zone of Fiji described in the forestry inventory by Berry & Howard (1973). ViL = Viti Levu, VanL = Vanua Levu, Kan = Kandavu, lim = limited distribution

Forst Type	Location	Dominant Species	Other Common Species and genera
Sapindaceae pole forest	VanL, Kan	*Gymnostoma vitiense, Aryterya brackenridgei, Vavaea amicorum, Elattostachys falcata, Dysoxylum* spp., *Endospermum* spp.	
Buabua forest	VanL	*Fagraea gracilipes*, *Myristica* spp., *Syzygium* spp.	*Palaquium* spp., *Parinari insularum, Dysoxylum richii*
Moderately stocked velau-yaka dry-zone forest	VanL	*Gymnostoma vitiense*, *Dacrydium nidulum, Parinari insularum*, *Calophyllum* spp., *Syzygium* spp.	
Low-stocked dry-zone forest on long, very steep slopes	VanL	*Gymnostoma vitiense*, *Calophyllum* spp., *Syzygium*/*Cleistocalyx* spp., *Agathis macrophylla*	*Canarium* spp., *Parinari insularum, Palaquium porphyreum, Palaquium* spp., *Myristica* spp., *Serianthes melanesica, Intsia bijuga, Dacrydium nidulum, Fagraea*

			gracilipes
Kaudamu-velau woodland	VanL, ViL (lim)	*Myristica* spp., *Gymnostoma vitiense*, *Syzygium* spp., *Intsia bijuga, Parinari insularum, Agathis macrophylla*	*Canarium* spp., *Palaquium porphyreum, Palaquium* spp., *Calophyllum* spp., *Dysoxylum richii, Endospermum* spp., *Xylopia pacifica*
Raintree woodland	VanL, ViL	*Albizia lebbeck, Samanea saman*	
Velau woodland	VanL, ViL	*Gymnostoma vitiense, Acacia richii, Dacrydium nidulum, Myristica* spp., *Fagraea gracilipes, Dysoxylum richii, Endospermum* spp., *Garcinia pseudoguttifera, Semecarpus vitiensis*	*Parinari insularum, Canarium* spp., *Palaquium* spp., *Agathis macrophylla, Podocarpus neriifolius, Brackenridgea nitida, Crossostylis pedunculata,* Sapindaceae
Moderately stocked velau-buabua forest	VanL	*Gymnostoma vitiense, Fagraea gracilipes, Dysoxylum richii*	*Parinari insularum, Syzygium*/*Cleistocalyx* spp., *Dacrydium nidulum*, *Podocarpus neriifolius*, *Intsia bijuga*, *Trichospermum* spp.
Velau-vesi forest	VanL	*Gymnostoma vitiense, Intsia bijuga, Parinari insularum, Canarium* spp.	

Appendix 2 – Annotated Checklist of Vascular Plants

Notes: All species are indigenous, unless marked as follows: [E] = endemic to Fiji; * = recently (historically) introduced species

PTERIDOPHYTA (Ferns and Fern Allies)

LYCOPSIDA

LYCOPODIACEAE

Lycopodinella cernuum (L.) Pic.Serm.

Huperzia phlegmaria (L.) Rothm.

Huperzia squarrosa (G.Forst.) Trev.

SELAGINELLACEAE

Selaginella breynioides Baker [E]

Selaginella laxa Spring

Selaginella viridangula Spring [E]

FILICOPSIDA

ADIANTACEAE

Taenitis pinnata (J.Sm.) Holttum var. *pinnata*

ASPIDIACEAE

Tectaria latifolia (G.Forst.) Copel.

ASPLENIACEAE

Asplenium australasicum Hook.

Asplenium polydon G.Forst.

ATHYRIACEAE

Diplazium esculentum (Retz.) Sw.

Callipteris prolifera (Lam.) Bory

BLECHNACEAE

Blechnum orientale L.

Stenochlaena palustris (Burm.) Bedd.

CULCITACEAE

Calochlaena straminea (Labill.) M.D. Turner & R.A. White

CYATHACEAE

Cyathea lunalata Copel.

Cyathea propinqua Mett. [E]

DAVALLIACEAE

Davallia solida var. *fejeensis* (Hook.) Nootenboom

Davallia solida (G.Forst.) Sw. var. *solida*

Humata heterophylla (Sm.) Desv.

Nephrolepis biserrata (Sw.) Schott

Nephrolepis hirsutula (G.Forst.) C.Presl.

DENNSTAEDTIACEAE

Pteridium esculentum (Forst.) Cockayne

GLEICHENIACEAE

Dicranopteris linearis (Burm. f.) Underw.

Gleichenia oceanica Kuhn

HYMENOPHYLLACEAE

Cephalomanes atrovirens (Kunze) Copel.

Selenodesmium dentatum (Bosch) Copel.

Nesopteris intermedia (Bosch) Copel.

LINDSACEAE

Tapeinidium melanesicum Kramer

LOMARIOPSIDACEAE

Lomagramma polyphylla Brack.

MARATTIACEAE

Angiopteris evecta (Forst.) Hoffm.

POLYPODIACEAE

Drynaria rigidula (Sw.) Bedd.

Pyrrosia lanceolata (L.) Farw.

Microsorum grossum (Langsd. & Fisch.) S.B.Andrews

PTERIDACEAE

Acrostichum aureum L.

Pteris ensiformis Burm.

Pteris pacifica Hieron.

SCHIZAEACEAE

Lygodium reticulatum Schkuhr

Schizaea dichotoma (L.) J.E.Sm.

THELYPTERIDACEAE

Sphaerostephanos invisus (G.Forst.) Holtt.

VITTARIACEAE

Halopteris elongata (Sw.) H.E.Crane

Monogramma acrocarpa (Holttum) D.L. Jones

GYMNOSPERMAE (Gymnosperms)

CONIFERALES

ARAUCARIACEAE

Agathis macrophylla (Lindl.) Masters

PODOCARPACEAE

Dacrydium nidulum de Laub.

Podocarpus neriifolius D.Don

GNETALES

GNETACEAE

Gnetum gnemon L.

ANGIOSPERMAE (Angiosperms)

DICOTYLEDONAE (Dicotyledons)

ACANTHACEAE

Graptophyllum insularum (A.Gray) A.C.Sm.

Pseuderanthemum laxiflorum (A.Gray) C.E.Hubb. [E]

**Hemigraphis alternata* T.Anders.

AMARANTHACEAE

**Alternanthera sessilis* (L.) R. Br. ex Roem. & Schult.

**Celosia argentea* L.

ANACARDIACEAE

Buchanania attenuata A.C.Sm. [E]

Buchanania vitiensis Engl. [E]

**Mangifera indica* L.

Pleiogynium timoriense (DC.) Leenh.

Semecarpus vitiense (A.Gray) Engl.

ANNONACEAE

Cyathocalyx cf. *vitiensis* A.C.Sm. [E]

APOCYNACEAE

**Allamanda cathartica* L.

Alstonia pacifica (Seem.) A.C.Sm.

Alstonia costata (G.Forst) R.Br.

Alyxia stellata (J.R. & G. Forst.) Roem. & Schult.

**Catharanthus roseus* (L.) G.Don

Cerbera manghas L.

Ervatamia obtusiuscula Markgraf

Parsonsia smithii (A.Gray) Markgraf [E]

**Plumeria obtusa* L.

**Plumeria rubra* L.

ARALIACEAE

Plerandra vitiensis (Seem.) Baill. [E]

Polyscia multijuga (A.Gray) Harms

**Polyscias scutellaria* (Burm.f.) Fosberg

ASCLEPIADACEAE

Hoya australis R.Br.

Tylophora sp.

ASTERACEAE

**Bidens pilosa* L.

**Conyza bonariensis* (L.) Cronquist

**Mikania micrantha* H.B.K.

**Pseudoelephantopus spicatus* (Juss. ex Aubl.) C.F.Baker

**Synedrella nodiflora* (L.) Gaertn.

**Vernonia cinerea* (L.) Less.

BIGNONIACEAE

**Spathodea campanulata* Beauv.

BORAGINACEAE

Cordia subcordata Lam.

BURSERACEAE

Canarium cf. *vitiense* A. Gray

Haplolobus floribundus subsp. *salomonensis* (C.T.White) Leenh.

CAESALPINIACEAE

Caesalpinia bonduc (L.) Roxb.

Cynometra insularis A.C.Sm. [E]

Intsia bijuga (Colebr.) Kuntze

Kingiodendron platycarpum Burtt [E]

Maniltoa grandiflora (A.Gray) Scheffer

Maniltoa vestita A.C.Sm. [E]

**Senna alata* (L.) Roxb.

CARICACEAE

**Carica papaya* L.

CASUARINACEAE

Casuarina equisetifolia L.

Gymnostoma vitiense L.A.S.Johnson [E]

CHRYSOBALANACEAE

Atuna racemosa Raf.

Parinari insularum A.Gray

CLUSIACEAE

Calophyllum cerasiferum Vesque [E]

Calophyllum vitiense Turr. [E]

Garcinia adiantha A.C.Sm. & S.Darwin [E]

Garcinia myrtifolia (A.Gray) Seem.

Garcinia pseudoguttifera Seem.

COMBRETACEAE

Lumnitzera littorea (Jack) Voigt

Terminalia catappa L.

CONNARACEAE

Connarus pickeringii A.Gray [E]

CONVOLVULACEAE

Ipomoea indica (Burm.) Merr.

Ipomoea littoralis Bl.

Merremia peltata (L.) Merr.

CUNNONIACEAE

Geissois ternata A.Gray [E]

DICHAPETALACEAE

Dichapetalum vitiense (Seem.) Engl.

DILLENIACEAE

Dillenia biflora Martelli

Hibbertia luccens Brogn. & Gris ex Sébert & Pancher

ELAEOCARPACEAE

Elaeocarpus storckii Seem. [E]

EUPHORBIACEAE

Acalypha repanda var. *denudata* (Muell.Arg.) A.C.Sm.

**Acalypha wilkesiana* Roxb. f. *wilkesiana*

Baccaurea stylaris Muell.Arg. [E]

**Chamaesyce hirta* (L.) Millsp.

Claoxylon echinospermum Muell.Arg in DC. [E]

Claoxylon fallax Muell.Arg.

**Codiaeum variegatum* (L.) Jussieu

Endospermum macrophyllum (Muell.Arg.) Pax & Hoffm. [E]

Excoecaria agallocha L.

Glochidion amentuligerum (Muell.Arg) Croizat [E]

Glochidion cordatum Seem. [E]

Homalanthus nutans Benth. & Hook.f. ex Drake

Macaranga membranacea Muell.Arg. [E]

Macaranga seemannii var. *capillata* A.C.Sm.

Macaranga vitiensis Pax & Hoffm. [E]

**Manihot esculenta* Crantz

Phyllanthus heterodoxus Muell.Arg. [E]

**Phyllanthus virgatus* G.Forst.

Decaisnina forsteriana (Schult. & Schult.f.) Barlow

FABACEAE

Dalbergia candenatensis (Dennst.) Prain

**Derris malaccensis* (Benth.) Prain

Derris trifoliata Lour.

**Desmodium triflorum* (L.) DC.

Inocarpus fagifer (Parkinson) Fosberg

**Pueraria lobata* (Willd.) Ohwi

Vigna marina (Burm.) Merr.

FLACOURTIACEAE

Flacourtia subintegra A.C.Sm. [E]

Homalium vitiense Benth. [E]

LAMIACEAE

**Hyptis pectinata*. (L.) Poit.

**Ocimum basilicum* L.

LAURACEAE

Cassytha filiformis L.

LECYTHIDACEAE

Barringtonia edulis Seem.

Barringtonia racemosa (L.) Spreng.

LOGANIACEAE

Fagraea berteroana A.Gray ex Benth.

Fagraea gracilipes A.Gray

Geniostoma rupestre J.R. & G.Forst.

Neuburgia cf. *corynocarpa* (A.Gray) Leenh.

LORANTHACEAE

LYTHRACEAE

**Cuphea carthagenensis* (Jacq.) J.F.Macbr.

MALPHIGIACEAE

Hiptage myrtifolia A.Gray [E]

MALVACEAE

**Hibiscus rosa-sinensis* L.

Hibiscus tiliaceus L.

**Malvastrum coromandelianum* (L.) Garcke

**Sida rhombifolia* L.

Thespesia populnea (L.) Sol. ex Correa

**Urena lobata* L.

MELASTOMATACEAE

Astronidium cf. *parviflorum* A.Gray [E]

**Clidemia hirta* (L.) Don

Melastoma denticulatum Labill.

Memecylon vitiense A.Gray

MELIACEAE

Aglaia cf. *greenwoodii* A.C. Sm. [E]

Dysoxylum sp. [E]

Dysoxylum richii (A.Gray) C.DC.

Vavaea amicorum Benth.

Vavaea harveyi Seem. [E]

Xylocarpus moluccensis (Lam.) M.Roem.

MIMOSACEAE

Acacia richii A.Gray [E]

**Adenanthera pavonina* L.

Entada phaseoloides (L.) Merr.

**Leucaena leucocephala* (Lam.) de Wit

**Mimosa pudica* L.

Serianthes melanesica Fosberg var. *melanesica*

MORACEAE

**Artocarpus altilis* (Park.) Fosberg

Ficus barclayana (Miq.) Summerh. [E]

Ficus fulvo-pilosa Summerh. [E]

Ficus obliqua Forst.

Ficus prolixa G. Forst.

Ficus theophrastoides Seem.

Ficus vitiensis Seem.

Malaisia scandens (Lour.) Planch.

Strebulus pendulinus (Endl.) F.v.Muell.

MYRISTICACEAE

Myristica castaneifolia A.Gray [E]

Myristica gillespieana A.C.Sm. [E]

MYRSINACEAE

Maesa corylifolia A.Gray [E]

Maesa insularis Gillespie [E]

Maesa persicifolia A.Gray [E]

Tapeinosperma grande (Seem.) Mez [E]

MYRTACEAE

Decaspermum vitiense (A.Gray) Niedenzu [E]

**Psidium guajava* L.

Syzygium curvistylum (Gillespie) Merr. & L.M.Perry

Syzygium decussatum (A.C.Sm.) Biffin & Craven [E]

Syzygium effusum (A.Gray) C. Muell.

Syzygium eugenoides (Merr. & L.M.Perry) Biffin & Craven [E]

Syzygium fijiense L.M.Perry [E]

Syzygium rubescens (A.Gray) C.Muell. [E]

Syzygium simillimum Merr. & L.M.Perry [E]

NYCTAGINACEAE

**Bougainvillea* x *buttiana* Holttum & Standl.

**Bougainvillea glabra* Choisy

OLACEAE

Anacolosa lutea Gillespie

OLEACEAE

Jasminum didymum G.Forst. f. subsp. *didymum*

Jasminum simplicifolium G.Forst. f.

ONAGRACEAE

**Ludwigia octovalvis* (Jacq.) Raven

PIPERACEAE

Macropiper puberulum f. *glabrum* (DC.) A.C. Sm.

PITTOSPORACEAE

Pittosporum arborescens A.Gray

Pittosporum rhytidocarpum A.Gray [E]

POLYGALACEAE

**Polygala paniculata* L.

RHAMNACEAE

Alphitonia franguloides A.Gray [E]

Alphitonia zizyphoides (Spreng.) A.Gray

Colubrina asiatica (L.) Brongn.

Gouania richii A.Gray [E]

Smythea lanceata (Tul.) Summerh.

Ventilago vitiensis A.Gray

RHIZOPHORACEAE

Bruguiera gymnorrhiza (L.) Lam.f.

Crossostylis harveyi Benth. [E]

Crossostylis richii (A.Gray) A.C.Sm. [E]

Rhizophora mangle L.

Rhizophora × *selala* (Salvoza) Toml.

Rhizophora stylosa Griff.

RUBIACEAE

Airosperma vanuense S.Darwin [E]

Antirhea incospicua (Seem.) Christoph.

**Gardenia augusta* (L.) Merr.

Gardenia gordonii Baker [E]

Gardenia hillii Horne ex Baker [E]

Gynochtodes epiphytica (Rech.) A.C.Sm. & S.Darwin

**Ixora coccinea* L.

Ixora elegans Gillespie [E]

**Ixora finlaysoniana* Lam.

Ixora cf. *myrtifolia* A.C.Sm. [E]

Mastixidendron flavidum (Seem.) A.C.Sm. [E]

Morinda citrifolia L.

Morinda myrtifolia A.Gray [E]

Ophiorrhiza leptantha A.Gray

Pelagodendron vitiense Seem. [E]

Psychotria amoena A.C.Sm.

Psychotria argantha A.C.Sm. [E]

Psychotria gibbsiae S.Moore [E]

Psychotria hypargyraea A.Gray [E]

Psychotria tephrosantha A.Gray [E]

Psychotria sp. nov. (aff. *P. macrocalyx* A.Gray) [E]

Psydrax odorata (G.Forst.) A.C.Sm. & S.Darwin

**Spermacoce assurgens* Ruiz & Pavon

Tarenna seemanniana A.C.Sm. & S.Darwin [E]

RUTACEAE

**Citrus sinensis* (L.) Osbeck

**Euodia hortensis* J.R. & G.Forst.

Micromelum minutum (G.Forst.) Seem.

Sacromelicope petiolaris (A.Gray) A.C.Sm. [E]

SANTALACEAE

Exocarpos vitiensis A.C.Sm. [E]

SAPINDACEAE

Dodonaea viscosa (L.) Jacq.

Elattostachys falcata (A.Gray) Radlk.

SAPOTACEAE

Manilkara dissecta (L.f.) Dubard

Manilkara smithiana H.J.Lam & Mass Geest. [E]

Palaquium fidjiense Pierre ex Dubard [E]

Palaquium porphyreum A.C.Sm. & S.Darwin [E]

Pouteria cf. *garberi* (Christophers.) Baehni

Pouteria grayana (H.St.John) Fosberg

Pouteria membranacea (L.J.Lam) Baehni

SIMAROUBACEAE

Amaroria soulameoides A.Gray [E]

STERCULIACEAE

Commersonia bartramia (L.) Merr.

Firmania diversifolia Marsili [E]

Heritiera ornithocephala Kosterm.

Melochia grayana A.C.Sm. [E]

THYMELAEACEAE

Phaleria glabra (Turrill) Domke

Phaleria montana (Seem.) Gilg [E]

Wikstroemia foetida var. *vitiensis* A.Gray

TILIACEAE

Grewia crenata (J.R. & G.Forst.) Schinz & Guill.

Trichospermum richii (A.Gray) Seem.

ULMACEAE

Gironniera celtidifolia Gaud.

URTICACEAE

Leucosyke corymbulosa (Wedd.) Wedd.

VERBENACEAE

Clerodendrum inerme L.

Faradaya ovalifolia (A.Gray) Seem. [E]

Gmelina vitiensis (Seem.) A.. Sm. [E]

**Lantana camara* var. *aculeata* (L.) Moldenke

Premna protrusa A.C.Sm. & S.Darwin [E]

**Stachytarpheta urticaefolia* (Salisb.) Sims

Vitex trifolia var. *bicolor* Moldenke

MONOCOTYLEDONAE (Monocotyledons)

AGAVACEAE

**Aloe vera* L.

Cordyline fruticosa (L.) Kunth

ARACEAE (Arum Family)

**Colocasia esculenta* L.

Epipremnum pinnatum (L.) Engl.

**Syngonium podophyllum* Schott

ARECACEAE

Cocos nucifera L.

Veitchia filifera (Wendl.) H.E.Moore [E]

BROMELIACEAE

**Ananas comosus* (L.) Merr.

CANNACEAE

**Canna indica* L.

CYPERACEAE

Carex dietrichiae Boeck.

**Cyperus haspan* L.

Eleocharis dulcis (Burm.f.) Trin ex Henschel

**Eleocharis geniculata* (L.) Roem. & Schult.

Fimbrystylis dichotoma (L.) Vahl.

Gahnia aspera (R.Br.) Spreng.

Hypolytrum nemorum subsp. *vitiense* (C.B.Clarke) T.Koyama

Machaerina falcata (Nees) T.Koyama

Mariscus javanicus (Houtt.) Merr. & Metcalfe

Rhynchospora corymbosa (L.) Britton

Scleria lithosperma (L.) Sw.

Scleria polycarpa Boeck.

DIOSCOREACEAE

Dioscorea alata L.

Dioscorea nummularia Lam.

FLAGELLARIACEAE

Flagellaria gigantea Hook.f.

Flagellaria indica L.

MUSACEAE

**Musa* (AAA or AAB Group) Simmonds (banana)

**Musa* (AB Group) (lady's finger banana)

**Musa* (AAB) Group (plantain)

ORCHIDACEAE

Appendicula reflexa Bl.

Bulbophyllum gracillimum (Rolfe) Rolfe

Bulbophyllum cf. *hassallii* Kores [E]

Bulbophyllum rotriceps Reichenb.f.

Dendrobium catillare Reichenb.f. [E]

Dendrobium platygastrium Reichenb.f.

Dendrobium tokai Reichenb.f. ex Seem.

Luisia teretifolia Gaud.

Malaxis sp.

Oberonia heliophila Reichenb.f.

Pseuderia smithiana Schweinf. [E]

Spathoglottis pacifica Reichenb.f.

Spathoglottis plicata Bl.

PANDANACEAE

Freycinetia cf. *impavida* (Hombr. & Jacq.) Stone

Pandanus tectorius Warb.

POACEAE

**Arundo donax* L.

**Brachiaria mutica* (Forssk.) Stapf

Centosteca lappacea (L.) Desv.

**Dichanthium caricosm* (L.) A.Camus

Digitaria setigera Roth

Garnotia linearis Swallen [E]

Leptaspis angustifolia Summerh. & C.E.Hubb. [E]

Miscanthus floridulus (Labill.) Warb.

Oplismenus hirtellus (L.) P.Beauv.

**Paspalum conjugatum* Berg.

**Pennisetum polystachyon* (L.) Schult.

Saccharum edule L.

**Saccharum officinarum* L.

**Sporobolus* cf. *diander* (Retz.) Beauv.

Sporobolus virginicus (L.) Kunth

SMILACEAE

Smilax vitiensis (Seem.) A.DC.

TACCACEAE

Tacca leontopetaloides (L.) O.Ktze.

ZINGIBERACEAE

Alpinia boia Seem. [E]

Alpinia vitiensis Seem. [E]