Coastal Vegetation of Taunovo Bay, Pacific Harbour, Viti Levu, Fiji – A Proposed Development Site

Gunnar Keppel
Biology Department, School of Pure and Applied Sciences, University of the South Pacific, Suva, FIJI
E-mail: keppel_g@usp.ac.fj

Abstract

Using four 100 × 10 m transects, the coastal vegetation types and their horizontal stratification at Taunovo Bay, Pacific Harbour, were investigated. The common stratification pattern of herb zone, shrub zone (dominated by the invasive species Chrysobalanus icaco*) and tree zone was observed. Littoral forest composed of species commonly associated with sandy beaches and species commonly associated lowland rainforest was observed. This vegetation type is here reported for the first time from Fiji and is probably caused by siliceous deposits from a nearby river. A detailed study of the extend, composition and distribution of this unique vegetation type should be conducted before the development project (planned at the study site) is approved.*

1 General Introduction

The paper mainly aims to describe the vegetation in an area (Taunovo Bay, Pacific Harbour, Viti Levu, Fiji) that is about to be converted into a tourism project. It also intends to describe the horizontal stratification of plant species in that particular area. The stratification pattern observed was very similar to that found on other sandy beaches. The major difference was that the littoral or beach forest had, in addition to plants expected on sandy beaches, had several species that are usually restricted to lowland rainforest. Such a mixed species composition of littoral forest has not previously been reported from Fiji and is possibly the result of the nutrient-rich sediment deposits from the adjacent Navua River. Invasive species, especially the coco plum (*Chrysobalanus icaco*) near the coast and the red bead tree (*Adenanthera pavonia*) in the littoral forest, were abundant in some places. The paper concludes that a thorough study of this vegetation type should be undertaken before the planned development project goes ahead.

2 Introduction

Coastal vegetation is strongly influenced by the adjacent sea. Therefore, plants in littoral areas must be adapted to salt spray, wind and wave action, and be able to recover from catastrophic disturbances. The conditions on sandy beaches due to the effects of drainage of these porous substrates may be even more limiting.

As a result, there is a distinct horizontal stratification on tropical sandy beaches, possibly reflecting different degrees of adaptation by the plants to their surroundings. The plants ability to colonize contributes to this stratification because sandy beaches are unstable as sands are shifted by wave and wind action. Coastal vegetation on sandy beaches is similar around the world, with a herbaceous outpost zone followed by a shrub zone that then grades into a littoral forest (Richards 1996). The herbaceous outpost zone consists of sprawlers of the genera *Ipomoea* and *Canavalia* (Convolvulaceae), and grasses and sedges. Many plants of this outpost zone, such as *Ipomoea pes-caprae* (Whistler 1992), are pantropical in distribution. This may be due to the efficient water-dispersal mechanisms that these species have evolved. However, the shrub and tree zone differ in species composition between two formations, one in the Pacific and the Indian Ocean, and other in the Atlantic Ocean (Richards 1996), although species, such as *Hibiscus tiliaceus*, are found in both.

Formations similar to those just described occur in Fiji and other Pacific islands. Generally, the herbaceous outpost zone is dominated by creepers, such as *Ipomoea pes-caprae*, *Canavalia rosea* and *Vigna marina*, but may also include abundant grasses, such as *Thuarea involuta*, *Lepturus repens* and *Sporobulus virginicus* and some sedges. A shrub zone where Scaevola taccada and Clerodendron inerme are generally dominant often follows this. There may be low growing, bushy-crowned trees, such as *Tournefourtia argentea, Acacia simplex, Thespesia populnea* and *Vitex trifoliata*, growing before, within or behind this zone. The herb- and shrub-vegetation grades gradually or abruptly into beach (coastal strand) forest. This forest contains *Barringtonia asiatica, Terminalia catappa, Calophyllum inophyllum, Pandanus tectorius, Cerbera manghas, Casurina equisetifolius,* and *Cocos nucifera* (Mueller-Dombois and Fosberg 1998).

Coastal vegetation on sandy beaches may differ in species composition even in geographically close areas. For example, *Barringtonia asiatica* is common on beaches in eastern Viti Levu and Eastern Vanua Levu but seemingly rare on or absent from sandy beaches in low rainfall areas, such as the northern Kadavu Group (Ghazanfar *et al.* in prep.) and Yadua Taba island off the western coast of Vanua Levu (Olson *et al.* 2002). Considering such local differences, species composition on smaller islands may differ from that of larger islands with rivers and additional vegetation types. While sandy beaches of small islands have been much investigated, the latter have received comparatively little attention. In this study the coastal vegetation and zonation patterns of Taunovo Bay, Deuba, near the mouth of the

Navua River are described. The study site is of interest as it is to be cleared for a proposed tourism development project.

3 Materials and Methods

The study site was at Taunovo Bay, near Deuba, Pacific Harbour, Serua Province on Viti Levu. Here four transects of 100 × 10m that started form the mean high water mark (MHWM) to the north (perpendicular to the coast). Transects were placed 50m apart. Within each transects the abundance (in terms of contribution to the total vegetation cover) of all species was estimated at 10 m intervals using a modified Braun-Blanquet Scale (Table 1). The abundance estimates were averaged for each vegetation zone over the 4 transects and a "species-changeover graph" constructed using MS Excel. Within the species-changeover graph abundance of various species were indicated using cones of different height, representing average values of a modified Braun-Blanquet (Table 1) for the four transects. A preliminary species list was also collated (see Appendix).

Table 1: Modified Braun-Blanquet vegetation cover scale used in this study.

Value	Corresponding Cover
0	rare/ isolated individuals with little cover
1	less than 5% cover
2	5-25% cover
3	25-50% cover
4	50-75% cover
5	75-100% cover

4 Results

4.1 Slope and Substrate

From the MHWM the beach initially rises gently for 10m to about 1m above the MHWM. Then there is a slight drop to a plane that is about 50m in width. Some 60m from the coastline there is another drop and swamps are formed. The substrate was beach sand, turning darker in colour (and presumably richer in nutrients) about 20m above the MHWM.

4.2 Stratification

The common stratification of herb, shrub and tree zone was observed. *Ipomoea littoralis*, *Ipomoea pes-caprae,* and typical beach grasses, such as *Lepturus repens* and *Sporobolus virginicus*, dominate the herbaceous zone. A single plant, the introduced *Chrysobalanus icaco*, dominated the shrub zone, which in some places began close to the MHWM and such places lacked a herbaceous zone. Both zones tended to be very narrow, together being less than 10 m in depth (Figure 1, see Appendix). Tree species with high salt tolerance, such as *Calophyllum inophyllyum, Pandanus tectorius* and *Barringtonia asiatica*, extend into or border the shrub zone and form a transition zone to the adjacent littoral forest (described below), where they intermingle with plants usually associated with lowland rainforest. This littoral forest ended 60m from the MHWM, being terminated either by *Pandanus tectorius*-dominated (with some *Metroxylon vitiense*) swamps or cassava (*Manihot esculenta*) plantations.

4.3 Composition of Littoral Forest

The littoral forest consisted of a unique mixture of typical littoral and lowland rainforest plants. Examples of the latter plants include the conifers *Podocarpus neriifolius* and *Gnetum gnemon*, the palm *Balaka* sp., the angiosperm trees *Buchanania attenuata, Myristica castaneifolia* and *Garcinia myrtifolia.* Figure 1 shows the species variations associated with distance from MHWM. Some 60m from MHWM and behind this littoral forest were plantations of *Manihot esculenta* (cassava). Beside *Chrysobalanus icaco*, *Adenanthera pavonia* is the other common adventive but is restricted to the littoral forest.

5 Discussion

The observed zonation (Fig 1, see Appendix) is similar to that on other tropical beaches in the Pacific (Mueller-Dombois and Fosberg 1998), consisting of herbaceous, shrub and tree zones. The plantations found 60m from the MHWM are an anthropogenic intrusion into the natural vegetation and may partially explain the presence of some weedy species.

The sandy beach studied supports a unique vegetation type composed of a mixture of species commonly associated with coastal strand vegetation and those found in lowland rainforests. This may be due to siliceous deposits received from the Navua River. Although vegetation on siliceous river sands differs from that of sandy beaches (pg. 50, Mueller-Dombois and Fosberg 1998), it has not been studied in detail. Sediment and seeds of rainforest plants washed down by the adjacent river could cause this unique type of coastal forest, as similar coastal formations are found near other rivers in Fiji (M. Tuiwawa pers. com.). The nutrient-rich sediment may provide the conditions needed for germination and growth of some rainforest species. However, some or many of the populations of rainforest species may not be self-sustaining and would vanish in time, should the seed source disappear. The existence of populations of lowland rainforest species on presumably sub-optimal substrate poses a question regarding their viability. At least some of these populations may actually be "sink-populations" that are only maintained through the continuous input of numerous seeds through the river system. An investigation into the self-sustenance of such populations may provide further information regarding the existence of "sink-populations".

The abundance of the introduced *Chrysobalanus icaco* and *Adenanthera pavonia* is of concern. The former appears to be an aggressive weed that seems to have out-competed most native vegetation of the shrub zone and possibly the herbaceous vegetation in some places. Only few individuals of *Scaevola taccada* and *Clerodendron inerme*, which usually dominate the shrub zone, were seen. Likewise the presence of the rapidly spreading weeds *Schefflera actinophylla* and *Wedelia trilobata*, although in low abundance, show the disturbed nature of the study site.

Besides highlighting the uniqueness of the littoral forest at Taunovo Bay, the present study shows the vulnerability of this vegetation type. The major threats identified in this study were conversion for human development projects, agriculture and displacement of certain native species by introduced ones. Deforestation of nearby lowland rainforest may also endanger this vegetation type, if many of the forest species indeed constitute sink populations. Therefore, the conversion of this particular type of littoral forest, enriched with siliceous river deposits will be another step towards the expiration of this forest type in Fiji. A thorough study of Fiji's coastal vegetation types and protection of representative sections should be carried out before any development projects in areas covered by this vegetation type are approved.

6 Acknowledgments

I would like to express my sincere gratitude to the students of BI 207 (Semester I, 2002) at the University of the South Pacific, who assisted me in collecting the data as part of their practical studies. "Vinaka vaka levu" also to Dr. Craig Morley and Prof. Robin H. Meakins for the helpful comments on the manuscript of this paper.

References

Ghazanfar, S.A., G. Keppel and S. Khan. In prep. *The coastal vegetation of islands in the Astrolabe Group, Kadavu, Fiji*.

Mueller-Dombois, D. and R.F. Fosberg. 1998. *Vegetation of the Tropical Pacific Islands*. Springer Verlag, Berlin, Germany.

Olson, D.M., M.V. Tuiwawa, J. Niukula, P. Bicoloa, G. Keppel, A. Naikatini, B. Thaman and L. Vakausausa. 2002. *Conservation of Fijian Dry Forest and Fijian Crested Iguana on Yadua Taba Island*. Unpublished report submitted to The National Trust for Fiji, July 17, 2002.

Richards, P.W. 1996. *The Topical Rainforest. An Ecological Study*. Cambridge University Press, Cambridge, UK.

Whistler, W.A. 1992. *Flowers of the Pacific Island Shore*. Isle Botanica, Honolulu, Hawaii.

Appendix

List of plants within the transects (preliminary species list)

PTERIDOPHYTA

Adiantaceae
Stenochalena palustris (Burm.) Bedd.

Aspidiaceae
Tectaria latifolia (Forst.) Copel.

Aspleniaceae
Asplenium austalasicum

Davvalliaceae
Davallia solida (Forst. f.) Swartz
Nephrolepis biserrata/ Nephrolepis hirsutula (Forst.) Presl.

Polypodiaceae
Drynaria rigidula (Sw.) Bedd.
Phymatosorus grossus (Langsd. & Fisch.) Brownlie

Schizaeceae
Schizaea dichotoma (L.) J. Sm.

Vittariaceae
Haplopteris elongata (Sw.) H.E. Crane
Vaginularia angustissima (Brack.) Mett.

GYMNOSPERMAE

Araucariaceae
Agathis macrophylla (Lindl.) Masters

Podocarpaceae
Podocarpus nerifolius D. Don

Gnetaceae
Gnetum gnemon L.

ANGIOSPERMAE

MONOCOTYLEDONAE

Agavaceae
Cordyline fruticosa (L.) Kunth

Araceae
Epipremnum pinnatum (L.) Engl.

Arecaceae
Cocos nucifera L.
Metroxylon vitiense (Wendl.) Wendl. ex Hook.
Balaka sp.

Cyperaceae
Cyperus stoloniferus Retz.
Pycreus polystachyos (Rottb.) Beauv.
Scleria polycarpa Boeck.
Flagellariaceae
Flagellaria gigantea Hook. f.

Orchidaceae
Taeniophyllum fasicola

Pandanaceae
Pandanus tectorius Warb. var.

Poaceae
Centosteca lappacea (L.) Desv.
Lepturus repens (G. Forst.) R. Br.
Panicum maximum
Paspalum distichum L.
Sporobolus jacquemontii Kunth

Thuarea involuta (Forst. f.) R. Br. ex R. & S.

Taccaceae
Tacca leontopetaloides (L.) Ktze.

DICOTYLEDONAE

Anacardiaceae
Buchanania attenuata A.C. Sm.
Mangifera indica L.

Annonaceae
Cyathocalyx sp.

Apiaceae
Centella asiatica (L.) Urban

Apocynaceae
Alstonia vitiensis Seem. f. *glabra* A.C. Sm.
Cerbera manghas L.
Neisosperma oppositifolium (Lam.) Fosb. & Sachet
Araliaceae
Schefflera actinophylla

Asclepiadaceae
**Hoya australis* R. Br.

Asteraceae
Wedelia trilobata (L.) Hitchc.
Caesalpiniaceae
Intsia bijuga (Colebr.) Ktze.

Chrysobalanaceae
Atuna racemosa Raf.
Chrysobalanus icaco

Clusiaceae
Calophyllum inophyllum L.
Garcinia myrtifolia (A.Gray) Seem.
Garcinia pseudoguttifera Seem.

Combretaceae
Terminalia catappa L.

Connaraceae
Connarus pickeringii A. Gray

Convolvulaceae
Ipomoea littoralis Bl.
Ipomoea pes-caprae (R. Br.) Sweet ssp. *brasiliense* (L.) v. Ooststr.
Merremia peltata (L.) Merr.

Dilleniaceae
Dillenia biflora (A. Gray) Mart. ex Dur. & Jacks

Euphorbiaceae
Guettarda speciosa
Macaranga seemannii (Muell. Arg.) Muell. Arg.
Manihot esculenta Crantz

Fabaceae
Derris trifoliata Lour.
Desmodium incanum DC.
Inocarpus fagifer (Parkinson) Fosb.
Vigna marina (Burm.) Merr.

Goodeniaceae
Scaevola taccada (Gaertn.) Roxb.

Lauraceae
Cassytha filiformis L.

Lecythidaceae
Barringtonia asiatica (L.) Kurz.

Malvaceae
Hibiscus tiliaceus L.

Melastomataceae
Clidemia hirta (L.) Don

Meliaceae
Dysoxylum richii (A. Gray) C. DC.
Xylocarpus granatum Koenig
Xylocarpus moluccensis (Lam.) M. Roemer

Mimosaceae
Acacia simplex (Sparrman) Pedley
Adenanthera pavonina L.
Entada phaseoloides (L.) Merr.

Moraceae
Ficus barclayana (Miq.) Summerhayes

Myristicaceae
Myristica castaneifolia A. Gray

Myrtaceae
Eugenia reinwardtiana DC.

Polygalaceae
Polygala paniculata L.
Rubiaceae
Ixora sp.
Psychotria sp.

Sapotaceae
Planchonella grayana St. John

Sterculiaceae
Heritiera littoralis Dryand.

Verbenaceae
Clerodendrum inerme L.

Stachytarpheta urticaefolia (Salisb.) Sim

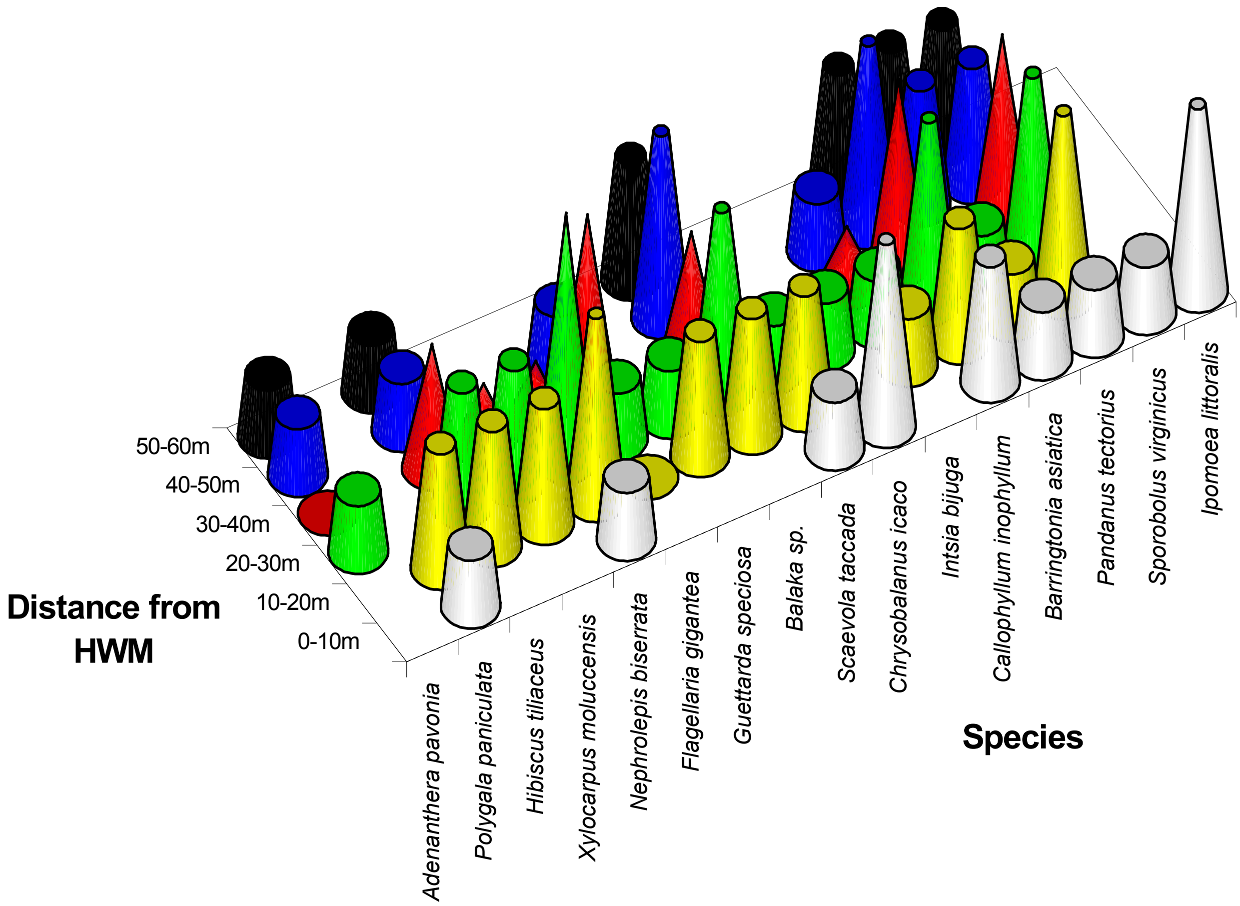

Figure 1 Changes in the abundance of common species with increasing distance from the mean high-water mark (MHWM). Cones of the same colour are found within the same zone. Cone heights represent average Braun-Blanquet abundance values (Table 1). Values range from 0 (coloured flat circle) to 4 (coloured entire cones).