

# The Vegetation of Lake Antoine, Levera Pond and Grand Étang, Grenada, W.I.

Paul L. Comeau and Yasmin S. Comeau

c/o National Herbarium, U.W.I., St. Augustine, Trinidad, W.I.

linusp47@hotmail.com

## ABSTRACT

Two former volcanic explosion craters now containing shallow fresh water lakes, and one former embayment now containing a shallow brackish water pond were surveyed over a four year period from 1992 to 1996 with attention being focused on their surrounding vegetation cover. The three sites, which are situated in central and north-east Grenada, display a harmonious balance between natural and cultivated land-use. Comparisons are made based on land ownership, the vegetation, climate, soil, ecology, and human disturbance.

## INTRODUCTION

Grenada is unique amongst the islands of the Lesser Antillean archipelago in possessing a number of volcanic explosion craters (Arculus 1976) that are located near a north-east/south-west trending fault line (Mann *et al.* 1990). Some of these craters and a former embayment (Fig. 1) are now filled with water and sediment, and surrounded by natural, semi-natural and cultivated vegetation. Only one of these sites, Grand Étang, has received attention regarding its natural history, with several studies being published or written on the geology and flora and fauna; notably Beard (1949) on the forest communities, Groome (1970) on the natural history, and Ramcharan and McAndrews (1992) on the palynology. The attention given to this area is attributable to the crater being the centre piece of the Grand Étang Forest Reserve which was established in 1897. The volcanic explosion crater of St. George's Harbour, which is surrounded by the urban development of Grenada's capital, fell outside the scope of this survey. The other prominent explosion crater, Lake Antoine, and the former embayment at Levera Pond (Sharman 1994; McAndrews 1996), have received little attention regarding their natural history; which is reflected in a dearth of studies on these sites. The present study aims to correct this imbalance.

The authors had the opportunity to do some vegetational sampling at Lake Antoine, Levera Pond, and Grand Étang, in conjunction with palynological studies being undertaken by the Royal Ontario

Museum from 1992-1996. Based on this extended survey, a number of interesting observations emerged regarding the vegetation dynamics of these three sites

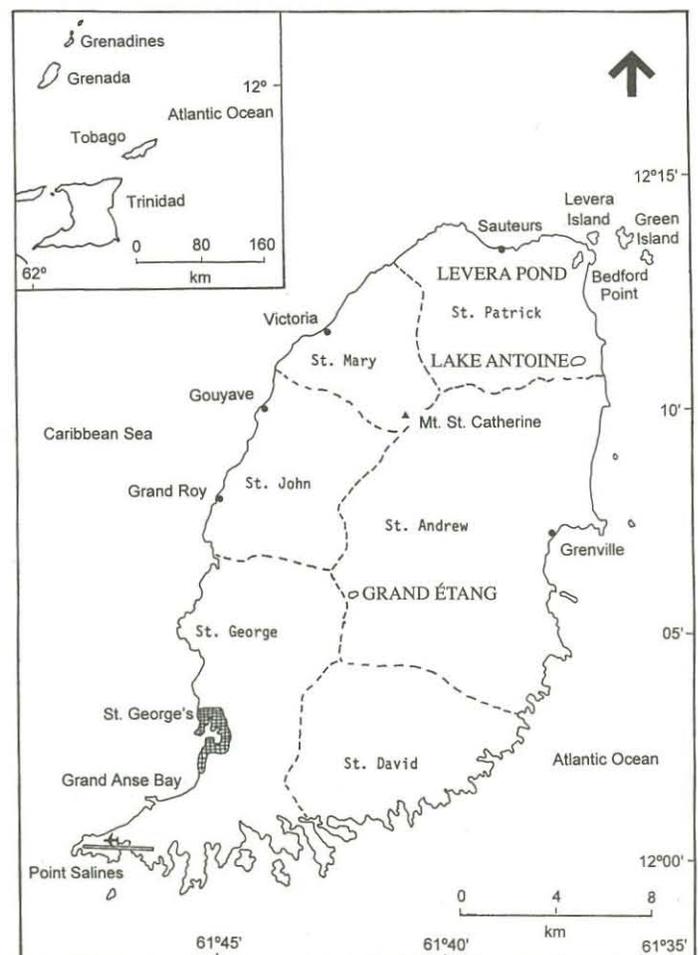


Fig. 1. The island of Grenada showing the location of the study sites.



**Plate 1a.** View of Lake Antoine looking southward.

where a stable balance exists between natural and human-made ecosystems that occur within the ambience of an aquatic environment. An understanding of this balance and diversity of vegetation types could provide the basis for land management plans and interpretive themes, especially for a national landmark at Lake Antoine and the recently established national park at Levera Pond.

## BACKGROUND

Lake Antoine, at an altitude of eight metres above sea-level, is situated, at  $61^{\circ} 37' W$  and  $12^{\circ} 11' N$ , near the east coast of Grenada approximately 500 m from the sea (Plate 1a). It is surrounded by low volcanic hills of tuffaceous material which on the west side of the catchment forms a rocky escarpment up to six metres in height. Large boulders, some well-rounded, are scattered around the lake. The lowest ridge elevations, up to 30 metres, surrounding Lake Antoine occur on the south-east side; while on the west side, at



**Plate 1b.** Vegetation zones on the north side of Lake Antoine. Note the sedge (*Cladium jamaicense*) community forming part of the 'aquatic zone' along the lake's margin. On the landward side of this zone is the cultivated area (coconuts, pasture, bananas). Further inland on higher elevation there is a secondary forest community.



**Plate 2.** View of Levera Pond looking eastward from the summit of Levera Hill. The pond's margins are surrounded by red mangrove (*Rhizophora mangle*).

higher elevations up to 90 m, the vegetation shows signs of wind trim. The lake itself is almost circular, approximately 17 hectares in area and 8 metres deep. There are no inflow or outflow channels. The climate in the vicinity of the lake is dry-mesic, with approximately 1600 mm of rain per annum. The soils on the lower slopes near the lake are rich in nutrients and have been extensively cultivated and used as pasture. The steeper slopes at higher elevations are covered with second growth forest trees (Plate 1b). Due to the drier climatic conditions, fires frequently damage the natural vegetation on these slopes.

Levera Pond, situated at the north-east corner of Grenada (lat.  $61^{\circ} 37' W$ , long.  $12^{\circ} 13' N$ ), is the remnant of a former bay that has been isolated from the sea (Plate 2). The pond, which is 3 metres deep (Sharman 1994) and approximately 11 hectares in area, is surrounded on three sides by elevated terrain. Bedford Point on the east and low-lying hills on the



**Plate 3a.** View of Grand Étang looking southward from near the summit of Mt. Qua Qua. Montane Thicket occurs in the foreground. The sedge (*Cladium jamaicense*) community is clearly visible around the lake's margin.



**Plate 3b.** A portion of the forest bordering Grand Étang displays a sharp zonation boundary between Lower Montane Rain Forest on the left and the Blue Mahoe (*Hibiscus pernambucensis*) Plantation Forest on the right. The blue mahoe was planted following forest devastation caused by Hurricane Janet in 1955.

south have elevations of 45 m while Levera Hill on the west reaches an elevation of 254 metres. On the north side, between the pond and the sea, is a mangrove-filled depression with a sandy beach along the shore. Organic muck and clay, the latter having eroded from the surrounding hills (McAndrews 1996), form thick deposits in the low-lying areas around the pond while large igneous boulders are a common feature on Levera Hill. Marine limestone overlies reworked volcanics at Bedford Point. The local climate is dry with approximately 1200 mm of rain per annum. The natural vegetation on the hills is strongly xerophytic reflecting the drier conditions. Around the pond patches of cultivated land intersperse with the natural vegetation.

Grand Étang (Plate 3a) occurs inside a forest reserve of the same name and has national park status. It is located at 61° 42' W and 12° 06' N in the southern massif of Grenada, which includes the summits of Qua Qua (elev. 724 m) and Feldon's Camp (elev. 754 m) both of which are north of the lake. The shallow lake, depth 4.5 m and approximately 8 hectares in area, is surrounded by mountain ridges and occurs at an elevation of 510 metres. At these elevations, the climate is cool, mean temp. 22° C, and wet with approximately 3880 mm of rain per annum (Caribbean Conservation Association 1991). The presence of ferns around the lake margin is a reflection of the wetter climate, these plants being absent at Lake Antoine and Levera Pond. Grand Étang has two large and two small inflow channels, and one large outflow brook where a concrete spillway has been

constructed 150 m downstream from the lake. Most of the vegetation in the vicinity of the lake is natural except for some pockets of plantation forestry (Plate 3b).

## METHODS

Vegetation surveys, covering approximately 80 percent of the terrain at each of the three study sites, were made by walking around each area. These surveys were conducted in November 1992 and June 1993 around Levera Pond and Grand Étang, and in June 1993 at Lake Antoine. All the sites were revisited in April 1995 and February 1996. Vegetation zonation was noted and species lists were compiled for each zone at each site. For most plant species information was recorded on habitat, abundance, distribution, habit, economic value and disturbance factors. Species not identified in the field were collected and keyed out using the *Flora of the Lesser Antilles* (Howard 1974-1989).

## RECENT ENVIRONMENTAL CHANGES

The shoreline of northern Grenada indicates recent uplift. The offshore island of Sugar Loaf (Levera Island) influences wave and sand deposition on Levera Beach. On the south side of Sugar Loaf Island there is a remnant of an elevated beach just to the west of a beach house. A sand-bar extends offshore indicating a possible connection with the mainland in recent times, circa the 1970's. At the last glacial maximum sea-levels were 120 m lower

(Williams *et al.* 1993). Based on a topographic map survey, the washed-out bridge and road at the mouth of the Levera outflow channel indicate approximately 10 m of shoreline retreat over the past 30 years. A sea-level rise of one centimetre corresponds to a shoreline retreat of one metre (J. McAndrews personal communication). Along the south-east side of Levera Pond there is evidence of a former shoreline where shells and rounded beach rocks were found. Elevated markings, i.e. painted tree trunks, along the trails around Levera Pond indicate periodic flooding which occurs whenever the sea breaches the beach or heavy rainfall causes increased runoff from the landward side.

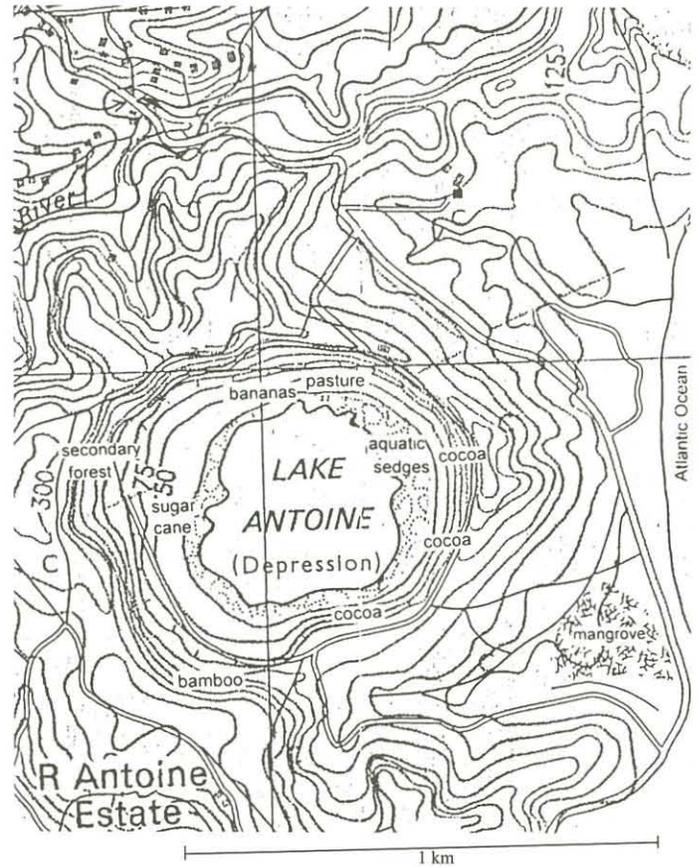
## VEGETATION ZONATIONS

The vegetation at Lake Antoine, Levera Pond, and Grand Étang shows clear zonation patterns that are based on environmental gradients, topography and land-use. The zonations at all three sites start at the water's edge, i.e. the fresh water basin at Lake Antoine and Grand Étang, and the brackish water pond and salt water beach at Levera.

### Lake Antoine

Surrounding the margin of Lake Antoine is an 'aquatic zone' of natural vegetation where, because of moisture extremes, a few plant species form almost pure stands. *Cladium jamaicense*, a tall sedge over two metres, grows in an almost continuous belt around the lake margin (Plate 1b) usually away from the shore where it propagates vegetatively via thick horizontal rhizomes producing a floating vegetation mat. Closer to the shore, the aroid *Montrichardia arborescens* also forms an almost continuous belt where it is grazed by cattle. Both these plants also feature prominently at Grand Étang, where the sedge surrounds the lake (Plate 3a), but the aroid is mainly confined to the north-east side. Neither species occurs around the more brackish Levera Pond.

Other plants in the aquatic zone around Lake Antoine that form sporadic colonies include: the water lily *Nymphaea ampla*, which also occurs at Levera Pond; *Acrostichum danaeifolium*, a large aquatic fern; the sedges *Eleocharis flavescens*, small and caespitose at the lake edge, and *E. mutata*, tall in standing water; *Bacopa monnieri* (Scrophulariaceae) which forms mats at the water's edge; and



**Fig. 2.** Some of the vegetation zones around Lake Antoine. (contours in feet)

*Sarcostemma clausum* (Asclepiadaceae), a climbing epiphyte on *Montrichardia*.

Between the natural vegetation of the aquatic zone and the second growth forest on the upper slopes at Lake Antoine there occurs the 'cultivated zone', a broad continuous belt of pasture, plantation and arable land (Plate 1b). Grand Étang, which is the least disturbed site, has nothing corresponding to this zone while Levera Pond has small isolated patches of pasture and plantation. The vegetation of this zone at Lake Antoine reflects the agricultural history of the site. The native species that occur here are those that take advantage of the disturbance and compete successfully with the cultivated plants. These include aggressive herbaceous weeds, such as *Paspalum conjugatum*, *Vernonia cinerea* and *Ruellia tuberosa* that invade pastureland, and woody species, like *Sida acuta*, *Cordia collococca*, *Croton balsamifera* and *Rauvolfia viridis* that are common throughout this zone.

Cultivated species at Lake Antoine (Fig. 2)

include the legumes, *Leucaena leucocephala*, a fast-growing shrub that is a source of high-protein foliage-forage for cattle and goats, provided it is coppiced, and *Gliricidia sepium*, planted along roadsides on the east side of the lake. *Bambusa vulgaris*, bamboo, is spreading from its use as a slope stabilizer. The most common plantation species are *Theobroma cacao*, concentrated on the south-east side of the lake, *Cocos nucifera*, coconut, *Saccharum officinarum*, sugarcane, occurring on the north-west side of the lake and *Musa sp.*, banana. Scattered amongst the cacao trees is *Artocarpus altilis*, breadfruit, with *Solanum hazenii* in the under-storey, while *Psidium guajava*, guava, *Tamarindus indica*, tamarind, and *Mangifera indica*, mango, are scattered throughout the cultivated zone. Two other plantation species, *Myristica fragrans*, nutmeg, and *Manilkara zapota*, sapodilla, are found only occasionally. *Swietenia mahagoni*, West Indian mahogany, is the only tree planted for its timber value, a small immature stand occurring on the north side high above the lake.

On the upper slopes around Lake Antoine occurs the 'second-growth Forest zone' where very large trees predominate. *Albizia niopoides*, *Spondias mombin* and *Tabebuia heterophylla* are common to abundant throughout this zone, with the former two also being scattered in the cultivated zone, while *Bursera simaruba* is concentrated on the upper east slopes. Smaller trees and shrubs common in this zone include, *Pisonia fragrans*, *Randia aculeata*, *Cordia curassavica*, *Melochia nodiflora* and *Croton sp.* In the under-storey and along roadsides, *Cereus margaritensis*, a cactus, *Wedelia calycina*, a composite, *Hymenocallis caribaea*, an amaryllis, and *Solanum hazenii* can be found.

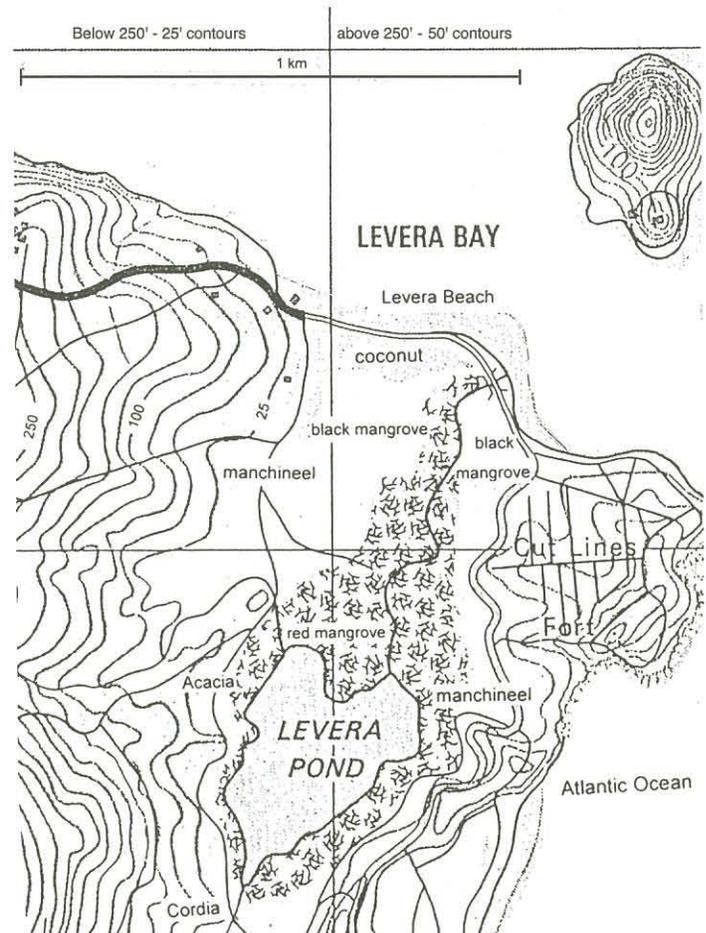
### Levera Pond

Levera Pond is approximately 600 m inland from Levera Beach where a 'littoral zone' separates the mangrove from the sea. The upper beach sand is covered in places by dense vegetation mats composed of prostrate vines, like the legume *Canavalia rosea* and two species belonging to the Aizoaceae, *Sesuvium portulacastrum*, seaside purslane, and *Trianthema portulacastrum*. Grasses in this zone include *Eleusine indica*, a weedy species, *Sporobolus virginicus* and *Brachiaria distachya*. Other herbs found growing on



**Plate 4.** Manchineel (*Hippomane mancinella*) woodland north-west of Levera Pond. Lack of under-storey vegetation is owing to periodic flooding.

the upper beach are *Chamaesyce serpens* (Euphorbiaceae) and *Spigelia anthelmia* (Loganiaceae), a medicinal plant that is very toxic (Howard 1974-1989). Shrubs present in this zone include *Capparis odoratissima* (Capparaceae), *Jacquinia armillaris* (Theophrastaceae), which



**Fig. 3.** Some of the vegetation zones around Levera Pond (contours in feet).

prefers drier habitats, and *Clerodendrum aculeatum* (Verbenaceae). Common tree species are *Hippomane mancinella* (Euphorbiaceae), all parts of which are caustic, and *Coccoloba uvifera* (Polygonaceae), the sea grape, while *Conocarpus erectus* (Combretaceae), buttonwood, is scattered.

In the 'aquatic zone' around Levera Pond, *Rhizophora mangle*, red mangrove, forms a dense continuous belt of trees (Plate 2) with its tangled mass of stilt and aerial roots. Floating in the water near the mangrove are sporadic colonies of *Nymphaea ampla*, water lily, while rooted in the muck at or near the edge of the pond are the tall guinea grass, *Panicum maximum*, the sedge, *Fimbristylis spadicea*, and the vines *Evolvulus convolvuloides* (Convolvulaceae) and *Rhabdadenia biflora* (Apocynaceae).

Moving away from the pond but still forming part of the low-lying depression, several distinct natural vegetation zones can be recognized (Fig. 3). The 'Black Mangrove zone' occupies a large area between the pond and the littoral zone. Black mangrove trees, *Avicennia germinans*, form young, immature stands on the north-west side of Levera Pond where they are being cut continuously for charcoal. Beneath these stands, numerous pneumatophores extrude from the muck. Very large mature black mangrove trees, with dark fissured bark, are not found in this area but are concentrated on the north-east side of the pond where their population density is smaller in comparison with the trees in the immature stands. Scattered amongst the black mangrove are manchineel, *Hippomane mancinella*, which in places occur in almost pure stands (Plate 4), coconut, *Cocos nucifera*, and hog plum trees, *Spondias mombin*, plus one other mangrove species, *Laguncularia racemosa*, white, and *Conocarpus erectus*, buttonwood.

Under-storey species in the Black Mangrove zone include: the weedy grass *Cynodon dactylon*;; two sedges, *Fimbristylis cymosa* and *Abildgaardia ovata*, the latter growing in sandy-organic soil; several vine-like species; *Blutaparion vermiculare*, a prostrate herb, and *Alternanthera flavescens*, a weedy scandent herb, both belonging to the family Amaranthaceae plus *Jacquemontia pentantha* (Convolvulaceae); the shrubs, *Malachra fasciata* and *M. alceifolia* (Malvaceae); and the legumes *Senna obtusifolia*, a weedy species and *Acacia nilotica*, a

naturalized small tree, which also is found on the adjacent hillside in pure stands or mixed with other acacias. Also growing in the Black Mangrove zone are the herb *Capraria biflora* (Scrophulariaceae) and the shrub *Jacquinia armillaris* which occurs in the littoral zone as well.

At the south or landward end of Levera Pond, the 'Cordia zone' is found (Fig. 3), dominated by the small tree *Cordia obliqua*, sticky cherry, belonging to the family Boraginaceae. Two other members of this family also occur here, the shrub *Bourreria succulenta* and the scrambling shrub *Tournefortia caribaea*. Other species in the under-storey include the shrubs, *Psychotria microdon* (Rubiaceae), *Erythroxylum havanense* (Erythroxylaceae), and the herb *Fimbristylis ferruginea* (Cyperaceae). Large trees in or near this zone include *Bursera simaruba* (Burseraceae), *Crateva tapia* (Capparaceae), *Diospyros inconstans* (Ebenaceae), *Albizia niopoides* and *Samanea saman* (Leguminosae), while smaller trees found here are the calabash, *Crescentia cujete*, having large oblong or almost spherical fruit, belonging to the family Bignoniaceae, and buttonwood which is scattered in this zone.

On the eastern side of Levera Pond, along the forest edge and mangrove, the following trees are found: *Genipa americana* (Rubiaceae), *Pisonia fragrans* (Nyctaginaceae), *Coccoloba* sp. (Polygonaceae), and *Casearia sylvestris* (Flacourtiaceae) while vines growing here include *Phryganocydia corymbosa* (Bigoniaceae) and *Paullinia pinnata* (Sapindaceae). On the western side of the pond, near the red mangrove, there is a small stand of the legume tree *Acacia macracantha*, which also occurs on the adjacent slopes.

All the zones described so far for Levera Pond are composed mainly of natural vegetation. The cultivated areas around the pond are not as extensive as those found at Lake Antoine. Coconut plantation covers the western portion of Levera Beach (Fig. 3) and extends inland a short distance in the north-west section of the low-lying depression. In addition to *Cocos nucifera*, a few guava trees, *Psidium guajava*, belonging to the Myrtaceae family are found here. Under the coconuts are the legumes *Desmodium triflorum*, *Crotalaria retusa* and *C. falcata* plus the grass *Paspalum vaginatum*. Pastureland is found on the east-

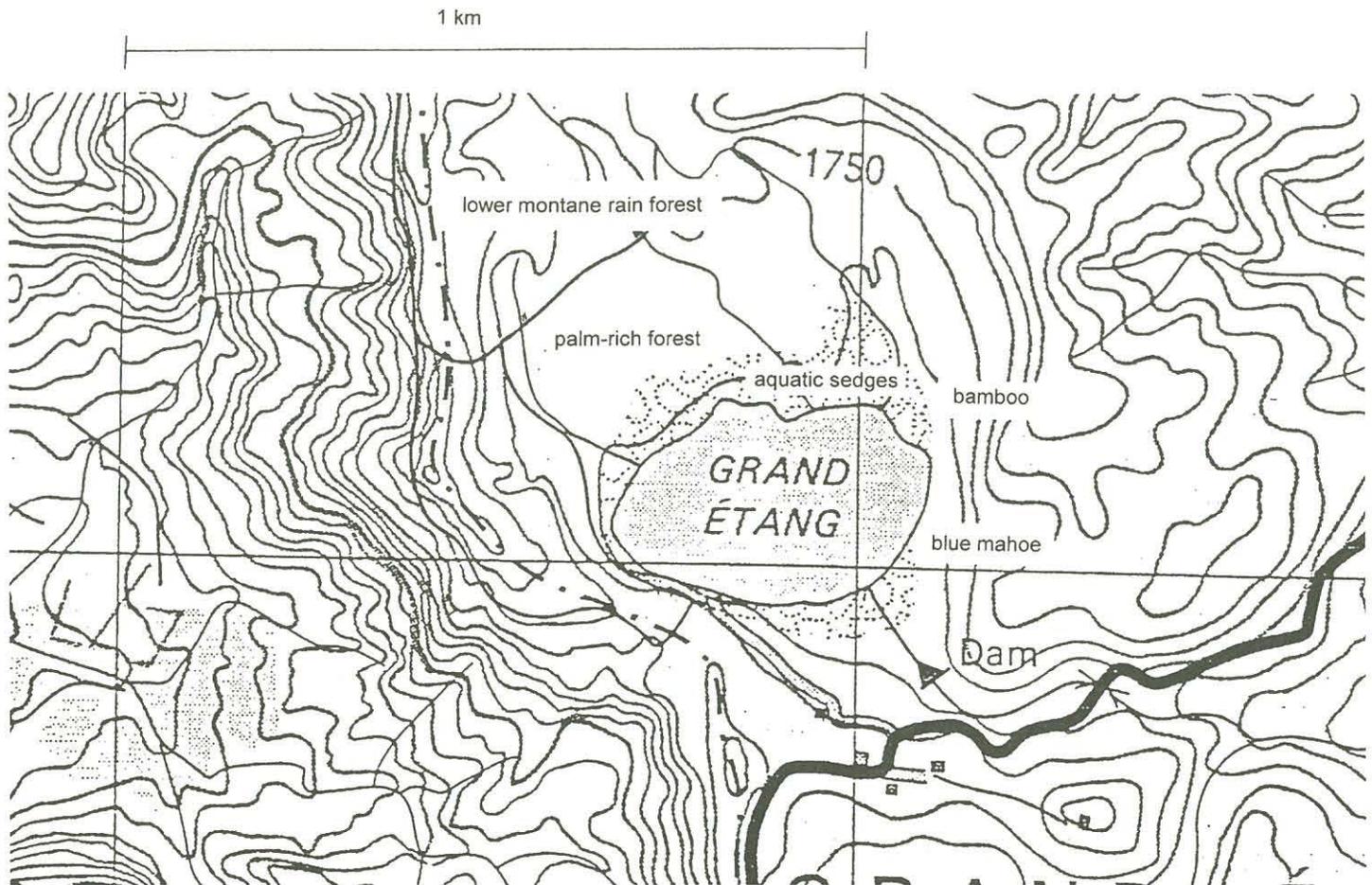


Fig. 4. Some of the vegetation zones around Grand Étang. (contours in feet)

ern side of the pond and in the south-east corner of the depression. Forage herbs and grasses are the dominant vegetation cover in these areas. Large patches of *Sesuvium portulacastrum*, a species of the littoral zone, are growing in pastureland on the eastern side of the pond near the edge of the mangrove. Also found here are the legumes *Desmanthus virgatus* and *Coursetia caribaea*, a forage shrub, plus the composite *Vernonia cinerea*. In the pasture at the south-east corner of the depression, several scattered fruit trees are present: sapodilla, *Manilkara zapota*, coconut, guava and mango, *Mangifera indica*.

On elevated embankments near Levera Pond the spiny shrub *Randia aculeata* (Rubiaceae) occurs while at even higher elevations near Bedford Point on exposed headlands species belonging to the Cactaceae family are a prominent aspect of the under-storey vegetation. Cacti include *Opuntia dillenii*, forming prostrate clumps, and the erect *Pilosocereus royeri* and *Acanthocereus tetragonus*. Other plants in the under-storey are the shrubs *Justicia sphaerosperma*

(Acanthaceae) and *Guettarda odorata* (Rubiaceae). A prominent tree in elevated areas on the eastern side of the pond and near exposed headlands is *Bursera simaruba*. Most of the vegetation in the elevated zones around the pond is xerophytic reflecting low rainfall and the drying onshore winds. On the south-west side of the pond on the lower slopes of Levera Hill, an occasional cultivated tree, such as tamarind, *Tamarindus indica*, is found in the natural forest cover.

### Grand Étang

Like the other sites, the vegetation zonation at Grand Étang (Fig. 4) start at the water's edge with an 'aquatic zone' up to 50 m wide. The dominant species here, is the sedge *Cladium jamaicense*, which grows in an almost continuous belt around the margin. Other sedges growing in standing water and found around the lake are *Fuirena umbellata* and *Eleocharis interstincta*, together with the grass *Paspalum conjugatum*. Also growing around the lake margin are ferns belonging to the genus *Thelypteris* (for example *T. reticulata*).

*Montrichardia arborescens* (Araceae) is concentrated mainly on the north-east side of the lake while a colony of *Hydrilla verticillata*, a submerged aquatic, is found at the boat launch site on the south side of Grand Étang. Overlapping the margin between the aquatic zone and the adjacent landward zone are *Cyclanthus bipartitus* (Cyclanthaceae) and *Ischnosiphon arouma* (Marantaceae).

Moving inland from the lake edge, on slightly elevated but level terrain that is periodically flooded, there occurs the 'lake margin forest zone'. Trees observed in this zone include the palms *Prestoea acuminata* and *Euterpe broadwayi* that proliferate in poorly drained areas on the north-west side of the lake. On slightly higher ground in this region large *Sloanea caribaea* trees (Elaeocarpaceae) are common. Other trees growing in this zone include *Dacryodes excelsa* (Burseraceae), *Ficus guianensis* (Moraceae) and *Micropholis guyanensis* (Sapotaceae), which is common. Under-storey trees found here are *Miconia tetrandra* (Melastomataceae) and *Palicourea crocea* (Rubiaceae). Epiphytes include *Anthurium hookeri* (Araceae), *Alloplectus cristatus*, *Columnnea scandens* (Gesneriaceae), *Asplundia rigida* (Cyclanthaceae) which also grows on the ground, and the orchids *Epidendrum secundum* and *E. lechleri*.

Small sections of plantation forest have been established near Grand Étang. Bamboo occurs along the north side of the lake, while blue mahoe, *Hibiscus pernambucensis*, is common on the north-east side, having been planted to rehabilitate sections of the forest damaged by Hurricane Janet in 1955.

Beyond the lake margin forest zone, the terrain rises steeply on all sides covered with Lower Montane Rain Forest, which grades at higher elevations into Montane Thicket, then Palm Brake and Elfin woodland at the highest summits (Beard 1949).

## ECOLOGICAL ASSESSMENT

### Lake Antoine

This is the most disturbed site with respect to human activities and probably has had a long history of agricultural development through cultivation and grazing. This is reflected in the type of vegetation cover now surrounding the lake. There is little historical documentation of the natural plant communities around

Lake Antoine. Beard (1949) does not even mention the lake in his paper on "Natural Vegetation of the Windward and Leeward Islands". Based on the native trees present, he would have included the area in his Dry Scrub Woodlands "near the sea-coast". Groome (1970), in discussing the geology of the island, only mentions the lake briefly as an example of an extinct explosion crater. In addition to the plants found in the aquatic zone, probably the least disturbed area, some of the natural trees surrounding the lake that reflect the original vegetation include: *Tabebuia heterophylla*, *Bursera simaruba*, *Spondias mombin*, *Albizia niopoides* and *Pisonia fragrans*, which are now more abundant on the upper slopes.

The cultivation history of the area seems to have undergone many changes, with the dominant crop reflecting the economic climate of the time. It would seem from existing evidence that sugar cane and coconuts were more widely planted in the past. The same might be said of the cacao plantations, while bananas represent a crop currently in demand. Recent plantings of *Leucaena leucocephala*, as a forage crop, plus the planting of a samaan tree for shade indicate the extensive use of the land around the lake as pasture. Short-term vegetable crops are presently being planted in tilled areas

### Levera Pond

The natural vegetation around the pond has not been disturbed to the same extent as the native plants around Lake Antoine. The former site is situated in a low-lying, flat depression that is frequently inundated with brackish water thus preventing extensive use of the area for agricultural crops, although some grazing takes place. The only plantation crop is a stand of coconut palms along the beach west of the outflow channel. At the back of the pond on slightly elevated terrain there occurs open pastureland surrounded by scattered plantation species such as: *Manilkara zapota*, *Cocos nucifera*, *Psidium guajava* and *Mangifera indica*.

Beard (1949) and Groome (1970) only make brief references to Levera Pond, the former classifying it as swamp and listing the various mangrove species present, while the latter describes the pond as "a Hydrophytic community associated with mangrove swamps." The various mangrove species, especially *Rhizophora* and *Avicennia*, tend to form pure stands

with their distribution controlled by their salt tolerance. *Rhizophora mangle* forms a continuous belt around the pond while young *Avicennia* occurs in almost pure stands north of the pond.

### Grand Étang

Grand Étang is the most natural of the three sites but still shows signs of human disturbance around parts of the lake margin, where some bamboo, *Bambusa vulgaris*, and blue mahoe, *Hibiscus pernambucensis*, have been established. The former as a soil stabilizer and the latter as a replacement tree for hurricane-damaged forest. Because the area has been set aside as a forest reserve much of the native vegetation remains intact and has been well documented by Beard (1949) in his "Natural Vegetation of the Windward and Leeward Islands". He recognizes the following forest types in the Grand Étang area: Lower Montane Rain Forest around the lake margin and the lower slopes of the surrounding hills; Montane Thicket at higher elevations; Palm Brake on steep windward slopes near the summits; and Elfin Woodland at the summits. Groome (1970) uses Beard's vegetation types in describing high elevation areas such as Grand Étang.

### COMPARING SITES

An examination of the plant species found at the three sites reveals very little overlap in the flora. None of the species were present at all three sites, six were present at both Levera Pond and Lake Antoine, three at both Lake Antoine and Grand Étang, while none were common to Grand Étang and Levera Pond. This lack of similarity in the flora between the sites is to be expected in light of the contrasts regarding elevation above sea level, degree of salinity, moisture levels, prevailing wind, and amount of cultivation. The two sites near sea level, Levera Pond and Lake Antoine, have the most overlap but this has more to do with elevation, low rainfall and/or cultivation than salinity. The absence of overlap at two sites, Grand Étang and Levera Pond, is owing to large contrasts between elevation, amount of rainfall and salinity.

There is much stronger affinity between the 122 plant species recorded in the survey area and the species that are found on Trinidad and Tobago. Seventy-six or 62% of the species in the survey are found on the three

islands, with 93 species (76%) being shared with Trinidad and 81 (66%) with Tobago. This is a reflection of similar habitats found on these islands.

### ACKNOWLEDGEMENTS

The authors wish to thank the following people for their kind support: Winston Johnson of Trinidad & Tobago's National Herbarium for field assistance and plant identifications; Eugene Ramcharan, John McAndrews and Ken Barbour of the Royal Ontario Museum for organizing and financing the trips to Grenada; and Dennis Adams for critical comments.

### REFERENCES

- Arculus, R.J.** 1976. Geology and geochemistry of the alkali-andesite association of Grenada, Lesser Antilles island arc. *Bull. Geol. Soc. Amer.*, 87: 612-624.
- Beard, J.S.** 1949. Natural vegetation of the Windward and Leeward Islands. *Oxford Forestry Memoirs*, 21: 1-192.
- Caribbean Conservation Association.** 1991. Grenada environmental profile. St. Michael, Barbados.
- Groome, J.R.** 1970. A natural history of the island of Grenada, West Indies. Caribbean Printers Ltd., Trinidad.
- Howard, R.A.** 1974-1989. Flora of the Lesser Antilles. Arnold Arboretum, Harvard University, Cambridge, Mass. (6 volumes).
- Mann, P., Schubert, C. and K. Burke.** 1990. Review of Caribbean neotectonics. In Dengo, G. and Case, J.E. (eds) *Geology of North America: the Caribbean Region*. Geological Society, Boulder, Colo. pp. 307-338.
- McAndrews, J.H.** 1996. Habitat history at Levera National Park, Grenada. *Rotunda*, 42: 2-3.
- Ramcharan, E.K. and J. H. McAndrews.** 1992. Late Quaternary Pollen Analysis from Grand Étang, Grenada, West Indies. *Department of Botany, ROM*. C:\EKR\GRENADA.TX2
- Sharman, M.Y.** 1994. Vegetation and sea-level history of a mangrove swamp at Levera Pond, Grenada. *M.Sc. Thesis, University of Toronto*.
- Williams, M.A.J., Dunkerley, D.L., De Deckker, P., Kershaw, A.P. and T. Stokes.** 1993. Quaternary Environments. Edward Arnold, London.