

Reprinted from the JAMAICA NATURALIST

CITATION:

Kelly, Daniel. The Threatened Flowing Plants of Jamaica.  
Jamaica Naturalist, Vol. 1, 19-26. 1991

Published by the

NATURAL HISTORY SOCIETY OF JAMAICA

<http://naturalhistorysocietyjamaica.org/>



# The Threatened Flowering Plants of Jamaica: *A Reappraisal*

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Jamaica is a small island with a rich flora: some 3000 species of flowering plants (native and naturalized). This richness reflects its tropical location, and its wide range of altitude - the Blue Mountains, rising to 2256 m, are very high for the size of the island. The mountainous topography results in a diversity of local climates, with wide variations in rainfall and temperature. Further diversity is added by the geological complexity of the island, giving contrasting landscapes of limestones, shales and other rock-types.

A striking feature of the flora is the large number of species found nowhere else in the world, *i.e.* endemic species. Jamaica has about 822 endemic flowering plant species - over a quarter of the total flora. Another substantial element in the flora consists of species that are found only in Jamaica and the immediately adjacent islands, *i.e.* are Greater Antillean endemics (e.g. the Dildo Cactus, *Stenocereus hystrix*). Of course, Cuba and Hispaniola each has a larger flora than Jamaica, and each has its own rich endemic flora.

In order to understand the constitution of the Jamaican flora, we must note the island's position, at a considerable distance from the mainlands of Central and South America. The geological history of the island is complex. The land of Jamaica was entirely submerged beneath the sea in late Oligocene and Eocene times (when the great thicknesses of White Limestone were laid down). Land began to re-

## I. The Uniqueness of the Jamaican flora

emerge in the mid-Miocene period, some 20 million years ago. Since its emergence, the island has apparently never had any land connection to the continents or to other islands.

This means that the flora had to come in by migration across a marine barrier that was probably never less than 100 km wide. The flora will have constituted itself gradually, but we have no record of the sequence involved. The first land plants to become established were probably species of lichens, mosses and ferns: small plants that are dispersed by spores, can eke out a living on bare rock. These 'pioneers' will have found an inhospitable land: no soil, no shade. For a prolonged period the flora must have been limited to a few highly tolerant species something like the flora of the offshore cays today. As vegetation cover developed, and the rocks weathered to form soil, conditions for plant growth will have gradually improved, and the flora will have become more diverse. Flowering plant species can immigrate by a variety of means. Many seeds must have arrived carried by birds, either adhering to their legs or plumage, or carried within their guts (many berry-bearing plants have achieved long-distance dispersal by means of their edible fruits). Many seeds will have been carried by wind: plumed seeds, or tiny dust-like seeds such as those of orchids. Yet other plants will have arrived floating on the sea, either as individual seeds or on "rafts" formed

by driftwood and other debris. (Such "rafting" must have been a major means of arrival for the terrestrial fauna).

With the passage of many generations, new traits appear, new mutations, new combinations of genes and may spread through a population. Other traits will diminish and disappear, because they are less well adapted to local conditions, or simply through random "genetic drift". Gradually, many members of the island flora became distinct from the continental species from which they were derived. In the same way, many forms on this island gradually became different from those on the other islands. A unique biological entity - an *endemic* - is formed: a plant (or animal) found nowhere else in the world.

This is the general way in which Jamaica's peculiar flora and fauna arose. On the other islands and on the mainland we find forms that are more or less similar, and yet distinct. To take a familiar example, the palm genus *Roystonea*: Jamaica has two native species, *R. princeps* (Swamp Cabbage) and *R. altissima* (Mountain Cabbage), both endemic; Cuba has several endemic species, including *R. regia* (Royal Palm); whilst another species, *R. oleracea* (Palmiste) is distributed over a wide area of northern South America (extending up as far as Barbados). The distinctions involved may be only slight, in which

# He's Jamaican Too

## **When we harm our environment, we harm ourselves.**

Like this Jamaican Owl  
(Pseudoscops Grammicus or Pato),  
every tree, river, fish and bird...every creature of  
Nature contributes to life on this planet and deserves  
our respect. In Jamaica we must take care to sustain the  
quality of our air, sea and land.

Shell is helping the cause of environmental  
conservation in Jamaica. Shell helped found  
the Jamaica Junior Naturalists which teaches our  
children to value our country's  
plant and animal life.

Shell uses its calendar to encourage the protection of  
endangered marine life. Company representatives  
have discussed with community organizations  
the need to balance economic progress with  
environmental preservation. They also have urged  
business groups to "bring the environment into  
the boardroom." Within its own operations, Shell uses  
many opportunities to show its customers how to use  
its products safely...and in ways that won't hurt the  
environment. It was Shell's marketing initiative that  
brought unleaded gasoline to Jamaica.

But Shell knows it still has some way to go in its own  
operations. The company conducted an exhaustive  
environmental audit at all its installations, then  
hired a full time, in-house environmentalist to  
carry out the improvements.

Everyone of us ... children, professionals,  
the man & woman in the street... must help make  
sure we have a healthy environment.  
After all, we're all Jamaicans too!



The Shell Companies in Jamaica  
Rockfort, Kingston 2. Tel: 928-7301-9 / 928-7231-9



Table 1:

The flowering plant flora of the Greater Antilles: endemism and evaluation of threat.

All figures represent current estimates. Data for other islands extracted from Davis *et al.* (1986), Zanoni (1989)

	Jamaica	Cuba	Hispaniola (Dominican Republic + Haiti)
Area (km <sup>2</sup> )	11, 425	114, 524	76,191
Human population	2,290,000	9,966,000	12,520,000
Mean population density (people per km <sup>2</sup> )	200	87	164
Total number of species	3000	6140	5000
Number of endemic species	822	3150	1500-1650
Proportion of endemics in total flora	27%	51%	30-33%
Number of threatened species (Vulnerable, Endangered or apparently extinct)	256	322	>273 (figures for D.R. only)
Proportion of threatened species in total endemic flora.	31%	10%	>16%

case we treat each entity as a variety or a subspecies; or the distinction may be sufficiently marked to warrant treating each as a different species. (The "rank" accorded by taxonomists - variety, subspecies or species - is often a matter of debate).

The evolution of distinct species on different islands of the West Indies, through prolonged isolation, has also occurred in the fauna. Take some of the small non-migratory birds: among the Todies (*Todus* spp.), Jamaica, Cuba and Puerto Rico has each a single endemic species, and Hispaniola has two endemic species; among the Hummingbirds (Trochilidae), most species are confined to a single island or a small group of islands (Bond, 1974). Island endemism was also well-developed among rodents, e.g. the genus *Geocapromys* (which includes the

Jamaican Hutia or Coney, *G. brownii*). The evolution of the mammalian fauna of the West Indies has been ascribed to "rare immigration events followed by extensive adaptive radiations" (Morgan & Woods 1986).

Some plant families have shown a greater tendency to evolve endemics than others. Among the palms (Palmae), 9 out of 10 species native to Jamaica are endemic. Of the 15 native species of cacti (Cactaceae), 6 are endemic to Jamaica, 4 extend also to the Cayman Islands, and 2 extend to others of the Greater Antilles. Endemism is relatively low in the lower plants. For instance, there are only 67 endemic species out of the 579 species of pteridophytes (ferns and fern allies) in the Jamaican flora (Proctor 1985). In lower plants dispersal is by spores instead of seeds; the sea represents less of a barrier to migration, and species tend to have wider geographical ranges than do

species of flowering plants.

As we noted, the geology and terrain of Jamaica is highly diverse. There are significant barriers to the migration of plants from one part of the island to another. For example, the limestone block of the John Crow Mountains at the east end of the island is now cut off from the limestones of the middle and west of the island by the siliceous mass of the Blue Mountains. The complex rainfall pattern is a further limitation to plant distribution within the island. So we find the further feature of *localized* endemism within the island flora. In many of the larger genera, distinct species or subspecies have evolved in different parts of the island. This "evolutionary radiation" is very striking in a number of groups (Table 2). The figures given must not be taken as definitive: further study

Table 2:

## Genera of flowering plants showing remarkable evolutionary radiation within the island of Jamaica

The family to which the genus belongs is given in brackets. Extracted from data in Adams (1972) and Mabberley (1987).

	Total number of species (world)	Number of species native to Jamaica	Number of species endemic to Jamaica
<i>Portlandia</i> (Rubiaceae)	5	5	5
<i>Rondeletia</i> (Rubiaceae)	125	29	29
<i>Lisianthus</i> (Gentianaceae)	27	8	8
<i>Lepanthes</i> (Orchidaceae)	220	26	25
<i>Dendropanax</i> (Araliaceae)	30	11	10
<i>Hohenbergia</i> (Bromeliaceae) <sup>40</sup>	15	13	
<i>Pilea</i> (Urticaceae)	c. 250	49	37

some "species" are not truly distinct, and that others are present on neighbouring islands as well. Whatever fresh details may emerge, it is clear that we have an abundance of plants that are not only unique to Jamaica but highly localized in their distribution within the island. The factors involved in producing this multicentricity of forms are little understood, and provide a rich field of study.

Some parts of the island are much richer in local endemics than others. A parish-by-parish analysis is given in a recent publication (Kelly 1988). Forty-seven species are found only in the parish of Portland, in the north-east; this is the only part of the island with year-round high rainfall, and must once have supported rain forest right down to sea-level. The rugged limestone massif of the John Crow Mountains is the principal refuge of these rare species. The parish of Trelawny comes next, with 42 local endemics; 101 species are endemic to the Cockpit Country in its broadest sense (Proctor 1986). As Proctor remarks, "the majority have been collected only a few times or are

known only from a single locality". 23 species are known only from the parish of Hanover, of which most are known only from Dolphin Head, an isolated limestone hill. The high elevations of the Blue Mountains bring in many species found nowhere else in the island, of which many are, again, local endemics. The dry areas of southern Jamaica are relatively poor in endemic species. Few rare species are found close to sea-level. There are important exceptions: two genera unique to Jamaica, each with only a single species - *Acanthodesmos* (Compositae) and *Tetrasiphon* (Celastraceae) - are confined to restricted areas on the south coast.

There is a great deal still to be learned about the Jamaican flora. Only ten years after the publication of *Flowering Plants of Jamaica* (Adams, 1972), a further 115 species were added to the Jamaican flora, of which 44 were new to science (Proctor, 1982). Unquestionably, there are still species yet to be discovered. Of those that have been described, often very little is known about them. For instance, in 1975 G. R. Proctor discovered, in the heart of the Cockpit Country, a species that had never been re-found since it was first col-

lected in 1784-86, almost two centuries previously [*Antirhea tomentosa* (Rubiaceae)]. There are species from which fruits or even flowers have never been seen by botanists. A pleasing find during recent botanical work in the parish of Westmoreland was a female plant of the shrub *Wallenia clusioides* (Myrsinaceae), bearing flowers and young fruits (Oliver *et al* 1986). Although the species was first described in 1861, only plants bearing male flowers had hitherto been collected; the existence of the female of the species was only a surmise!

#### THE THREAT TO THE JAMAICAN FLORA

To reiterate, Jamaica is a small island, and many of its endemic species are restricted in their natural distributions to small portions of the island. Their vulnerability is self-evident.

The mammalian fauna of the West Indies is already unnaturally depleted; fossil remains show the existence of a diverse endemic fauna prior to the impact of humans. "Since the arrival of man in the West Indies some 4500 years

ago, 37 species of non-volant mammals have disappeared" (Morgan & Woods, 1986). The authors ascribe the decimation of this forgotten fauna to direct human predation, habitat alteration, and the introduction of exotic species (rats, mongoose, cats and dogs). In the past century Jamaica has lost the Cane Rat *Oryzomys antillarum*, not seen since it was described in 1898 (Morgan & Woods, *op. cit.*). Turning to birds, Jamaica has lost the endemic Pauraque (*Siphonorhis americanus*), last recorded in 1859, and a species of Macaw of which not even a museum specimen survives (Lack, 1976).

The principal threat to Jamaica's flora is without doubt, *deforestation*: the destruction of the natural forest cover. Prior to the first human settlement, nearly all of Jamaica was thickly forested from coast to mountain-top. The principal exceptions would have been areas of herbaceous swamp such as are found in parts of the Black River morass; also areas of open savanna-type vegetation, which however must have been very restricted in extent. (The best surviving area of natural savanna is at Mason River Reserve). The vast majority of Jamaica's endemic plants are forest-dwellers. The lowlands of Jamaica were largely cleared of forest in the 17th and 18th centuries; in the 19th and 20th centuries clearance has spread higher and higher up the hillsides. As the forest flora retreated, rare species became rarer, and often their areas of distribution must have become fragmented.

To date, the flora appears to have survived to a remarkable degree. Its protection has lain primarily in the extraordinarily rugged terrain of much of the island, with its innumerable craggy hills. In spite of minimal soil, and unpredictable periods of

intense drought, the limestone hills, in particular, provide refuge for an amazing wealth of plant life. However, the forest is now shrinking fast. From satellite information, it is estimated that the forest cover of the Cockpit Country was reduced by 15.9% during the period 1981 to 1987, making an annual deforestation rate of about 2.8% (Eyre 1989). Pressure on land drives people to clear and plant even in little patches of soil between the rocks. Fear of praedial larceny, and fear of the discovery of illegal crops, drive cultivators into the hills. Even the supposedly protected Forest Reserve continues to be selectively logged for good hardwood timber (*cf.* Fairbairn 1986). There is also enormous demand for wood regardless of quality. The Cockpit Country is



*Pilea crassifolia* - after Brenda Sutton in *Wildflowers of Jamaica*, Collins 1974

the source of scores of thousands of yam poles every year, and hundreds of tons of charcoal (Eyre, 1989). The enormous increase in charcoal production in the past decade is taking an immense toll of the forest cover, especially in the drier parts of the island. The native forest trees, in general, can survive a certain level of exploitation; most species 'spring back' after cutting, often with impressive speed. However, they have to be given a chance to regrow: a minimum of time, a minimum of protection from grazing and from fire.

There is also danger of over-collecting: a special threat to the

orchids, of which Jamaica has many beautiful and unique species. A plant here and there may be insignificant, so long as one collector is not followed by another, and another. The stripping by commercial collectors of whole trees, and even whole hillsides, is another matter. Orchids are slow-growing plants and their populations may never recover. Government records provide some indication of the scale of the export trade. During 12 months in 1982-83, the export of 9,897 orchids was recorded; many more probably left unnoticed (Fairbairn 1986). Even so widespread a species as *Broughtonia sanguinea* must now be regarded as Vulnerable, given the international demand.

There is little doubt that some endemic plant species have already disappeared. G.R. Proctor wrote to me in 1985, chronicling certain members of the Myrtaceae (Rodwood family) that he had described as new to science, and had since been keeping a fatherly eye on. *Myrcia skeldingii*, a tree discovered in the 1950s on the Clarendon-St. Ann border near Mason River, has apparently been extirpated within 2-3 decades of its discovery; all known individuals are gone. *Psidium dumentorum*, a kind of Guava - and hence a species of possible hor-

gricultural significance - was discovered in the same district in 1956. However, its potential is probably lost for ever: again, within 2-3 decades its habitat had been completely cleared.

Many sites for rare species have been ravaged within the past decade (*cf.* the brief survey of Kelly & Burke, unpub.). Take Quaco Rock, near Ritchies (Upper Clarendon), visited by the Natural History Society of Jamaica in 1978. The site of several very rare species, at that date it was still well-wooded right to the top. Passing by in 1989, the hill appeared sadly denuded,

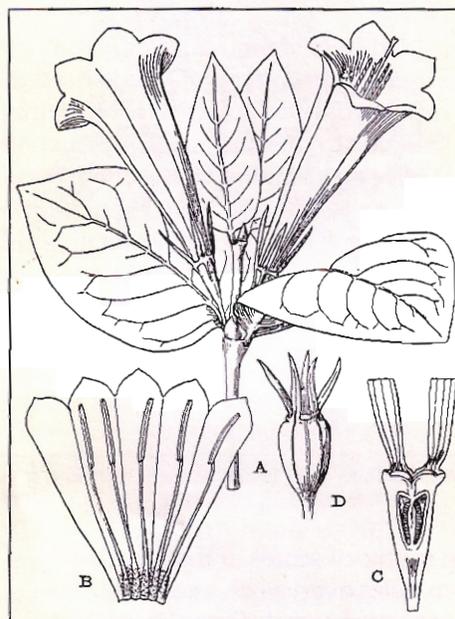
apparently through the activities of charcoal-burners. The rare shrubs *Sebastiania lesteri* and *Vernonia rigida* have either been extirpated or are in extreme danger. Miss Laura's Hill, Warsop (Trelawny), another site of several very rare species, was one that G.R. Proctor frequently put forward in the 1970s as a priority for conservation. Revisited in 1989, the vegetation was found to be highly disturbed right up to the bases of the cliff faces (with crops planted wherever possible); the cliffy sides were still more or less wooded, but everywhere with signs of cutting; the summit had been burned repeatedly, reducing the vegetation to low open scrub, with some areas completely bare. The hill was explored by Daniel Burke and myself, from bottom to top and down the other side, in search of two rare species, *Lobelia harrisii* and *Dendropanax filipes*, but we failed to re-find either of them.

Broom Hall (Upper Clarendon), near Cave Valley, was in the 1970s the site of a fine stand of evergreen seasonal forest over limestone probably as good as any outside the Cockpit Country (Kelly *et al.* 1988). A species of *Jacaima* (Asclepiadaceae) new to science was collected there in 1978 (Proctor 1982). A parasitic flowering plant, of a family never previously reported from the West Indies, was discovered there in 1976 by a zoologist, Glenn Goodfriend. In 1983 I found a woody climber (or 'withe') at Broom Hall that neither I nor Dennis Adams could identify; he suggested that it belonged to a genus of the Malpighiaceae not hitherto known from Jamaica. I went back in 1985 to look for flowers on my withe; it was gone. It had been cut down, along with most of the forest.

Returning in 1989, in the forlorn hope that my withe had been allowed to re-sprout, we found the hillside now almost completely deforested. Another piece of forest is now history; three

more species may have gone from Jamaica.

To obtain an overall picture of the state of Jamaica's endemic flora, I have worked through the information available on each species, trying to assess the degree to which it is at risk. I have used the categories employed by the International Union for the Conservation of Nature and Natural Resources (Davis *et al.* 1986). A first analysis is already published (Kelly 1988); Table 3 presents a revised set of figures, in the light of fresh fieldwork and herbarium work, and additional information from other botanists and from publications. However you look at it, the numbers of Vulnerable, Endangered and Indeterminate (i.e. apparently extinct) species are large. The gravity of the situation is highlighted when you compare these



*Portlandia coccinea* Sw.

A, Branch with leaves  
and flowers  
B, Corolla cut open

C, Ovary with calyx cut  
lengthwise  
D, Capsule

figures to the total numbers of endemic species (Table 1). My current estimate is that almost one-third of all species endemic to Jamaica are threatened (Vulnerable, Endangered or already extinct). This ratio is far worse than for Cuba, and probably as bad as, or worse than for the island of Hispaniola.

## Why it matters, and what can be done

What possible use are Jamaica's endemic plants? In most cases we can only speculate. Wild relatives of crop species are of particular significance, as possible resources to widen the genetic base of the crop: here we may point to the endemic Jamaican Pawpaw, *Carica jamaicensis*. Many Jamaican plants besides orchids have horticultural potential. An example is the endemic genus *Portlandia* (Rubiaceae), a group of shrubs bearing trumpet-shaped flowers with a range of tints, and some with exquisite perfume. *Portlandia grandiflora*, Bell Flower, is grown in gardens in East Africa, but several species remain almost unknown. Other plants may have value as the sources of medicinal drugs. (It was the folk medicine of Jamaica that first brought the Madagascar Periwinkle, *Catharanthus roseus*, to the attention of the pharmacologists. This herb is now the commercial source of several anti-cancer drugs and the basis of a multi-million dollar industry).

Even if no specific use can be ascribed to a plant, it forms a part of the forest cover that clothes, or clothed, the Jamaican hillsides, making this the 'Land of Wood and Water'. Deforestation of hillsides is a serious matter. The maintenance of reliable supplies of water, to the villages and to the cities, is dependent on the maintenance of forest cover in the catchment areas. The idea is far from new: over a century ago, forest conservation in Jamaica was being urged as a "necessity for regulating the water supply in the eastern district; for protecting the lowlands from the torrential flow of the rivers" (Hooper 1886). There is now an accumulation of evidence from many parts of the world, including Jamaica (Cunningham 1986). Soil erosion, silting up of reservoirs, landslides, flash floods and water shortages: all are symptoms of the cancer of deforestation.

Table 3:

## ANALYSIS OF THE CURRENT CONSERVATION STATUS OF THE FLOWERING PLANTS OF JAMAICA

The categories used are those of the International Union for Conservation of Nature and Natural Resources (Davis *et al.* 1986):

**'Endangered (E)** - Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating'. Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.

**Vulnerable (V)** - Taxa believed likely to move into the Endangered category in the near future if the causal factors continue operating. Included are taxa of which most or all of the populations are *decreasing* because of over-exploitation, extensive destruction of habitat or other environmental disturbance; taxa with populations that have been seriously *depleted* and whose ultimate security is not yet assured; and taxa with populations that are still abundant but are *under threat* from serious adverse factors throughout their range.

**Rare (R)** - Taxa with small world populations that are not at present endangered or vulnerable, but are at risk. These taxa are usually localized within restricted geographical areas or habitats or are thinly scattered over a more extensive range.

**Indeterminate (I)** - Taxa *known* to be Extinct, Endangered, Vulnerable or Rare but where there is not enough information to say which of the four categories is appropriate'.

For Jamaica, taxa in this category are to be considered as extinct until proved otherwise.

	Rare	Vulnerable	Endangered	Indeterminate	Total
Species endemic to Jamaica	142	135	71	50	398
Varieties and subspecies endemic to Jamaica	9	11	7	4	31
Species endemic to Greater Antilles (status in Jamaica)	4	10	8	1	23
<b>TOTAL</b>	155	156	86	55	452

Protection of the forest cover is clearly in the national interest. There *have* to be effective measures to limit clearance. Where wood on hill slopes must be cut, the cut-over areas must be protected to allow re-growth. It seems timely to promote the idea of felling on a rotational basis, as in traditional coppicing systems. At least one Jamaican hillside is successfully managed by coppicing on a seven-year rotation (Alan Eyre, speaking to the Jamaican Broadcasting Corporation in July 1989). Planting of fast-growing fuel-wood trees is another way to relieve the pressure on the native woodlands.

Endangered species need to be brought into cultivation. Then, even if they do become

extinct in the wild, their lineage will survive. Increasingly, this is being seen as a major role of botanic gardens worldwide. Why not for the Botanic Gardens of Jamaica? Jamaica has a range of splendidly-located Public Gardens (Hope, Castleton, Cinchona, also Bath), each in a different climatic zone: between them, they could provide suitable growing conditions for the great majority of native species. There would seem to be ample space and labour-force for such a project.

Education, and the heightening of public awareness, are vital to successful conservation. People of the towns tend to have little knowledge of the flora of their own country. Here again, Botanic Gardens could play a significant role. Country people often

have considerable knowledge of the local plants, especially plants used for medicinal purposes. However, this knowledge is not held in great esteem nationally, and is tending to diminish with the passing of the generations [I wonder if there is any 'tree-spotter' left of the calibre of the late Mr. Daniel Brown of Sherwood Forest, some of whose knowledge I had the privilege of helping to record (Kelly & Dickinson 1985)].

It is vital that special protected areas are established and maintained: places where the native flora (and fauna) are safeguarded in a determined way. I see the urgency of this even in areas where ten years ago protection seemed unnecessary. The Blue

Mountain/John Crow Mountain National Park, currently being set up, is an exciting and timely development. However, it is very important that conservationists learn from both failures and successes in the past. It is salutary to recall the 'permanent' study plots set up in 1976 in the Canoe Valley area (Anon. 1981); in spite of barbed wire and Government notices, trees were being cut inside them almost from their inception. On the success side, the longest-running Nature Reserve in Jamaica is Mason River Station, near Clarendon-St. Ann border, in the very heart of the island. A remarkable place: mainly savanna vegetation, with some peat bog, it contains many species unknown elsewhere in Jamaica, and a few known from nowhere else in the world. The land for the Reserve was acquired for conservation in 1963 (Proctor 1970); a far-sighted act, as otherwise this unique ecosystem would undoubtedly have been destroyed by now. The Station is run by the Institute of Jamaica, under the wardenship of Mr. P. Gilzene, who continues to keep fires and trespassing animals at bay. However, the place does suffer through a lack of public interest. Conserved areas have to be actively monitored and protected; they need public support at local, national and international levels.

The tourist potential of conserved areas is enormous. The new 'swamp safari' trail in the Negril Royal Palm reserve is an example of what can be done. More and more people, especially those from colder countries, want to find out what it is like to be in a rain forest. The John Crow Mountains and the Blue Mountains can amply satisfy this desire, with the bonus of being free of venomous snakes! The forests of the Cockpit Country are a unique experience, within easy reach of Montego Bay or Ocho Rios.

The whittling away of Jamaica's forests and their flora reflects, in microcosm, what is hap-

pening today all over the tropics. The destruction of the tropical forests is a matter of concern to people everywhere. We have only one Earth: the challenge is to leave some part of it as green as we found it, and not greyer.

#### ACKNOWLEDGEMENTS

This article is based on a lecture given to the Natural History Society of Jamaica in July 1989. I am grateful to the Society, and especially to Dr. E. Garraway, Dr. P Vogel and Dr. S. Iremonger. This visit to Jamaica was supported financially by the Fauna and Flora Preservation Society, the Royal Irish Academy, Trinity College Dublin Association & Trust, and the Botany Department of Trinity College Dublin. Logistic support was provided by the Botany Department of the University of the West Indies (Mona), for which I thank Professor G. Sidrak and Dr. S. Iremonger. For much assistance in field work I thank Mr. D. Burke; for other assistance, I thank Dr. C.D. Adams, Mr. J. Dalling, Mr. P. Gilzene, Mrs. I. Greene, Mr. S. Terry, Mr. M. Williams and Mr. P. Williams.

#### REFERENCES

- Adams, C. D. 1972. Flowering plants of Jamaica. University of the West Indies, Mona, Jamaica.
- Anon. 1981, unpublished. Final Report: Ecological Preaudit Study of an Alumina Plant, Jamaica, W. I. Natural Resources Conservation Department, Kingston, Jamaica.
- Bond, J. 1974. *Birds of the West Indies* (4th edn.). Collins, London.
- Cunningham, C. G. 1986. Forests and water management. In *Forests of Jamaica*, ed. by D. A. Thompson, P.K. Bretting & M. Humphreys. Jamaican Society of Scientists & Technologists, Kingston, Jamaica.
- Davis S.D., S.J.M. Droops, P. Gregerson, L. Henson, C.J. Leon, J.L. Villa-Lobos & J. Zantovska. (1986). Plants in danger: what do we know? *International Union for Conservation of Nature and Natural Resources*, Gland, Switzerland and Cambridge, UK.
- Eyre, L.A. 1989. Slow death of a tropical rainforest: the Cockpit Country of Jamaica, West Indies. In *Environmental Quality and Ecosystem Stability: Vol IV-A, Environmental Quality*, ed. by M. Luria, Y. Steinberger and E. Spanier. Jerusalem, Israel.
- Fairbairn, P. W. 1986. Conservation of Jamaican Forests with particular reference to Wildlife. In *Forests of Jamaica*, ed. by D. A. Thompson, P.K. Bretting & M. Humphreys, 111-119. The Jamaican Society of Scientists and Technologists, Kingston, Jamaica.
- Hooper, E.B.M. 1886. Report upon the forests of Jamaica. (Pamphlet X SD152 J3H6, Special Section, General Library, UWI, Mona)
- Kelly, D. L. 1988. The threatened flowering plants of Jamaica. *Biological Conservation*, 46, 201-216.
- Kelly, D. L. & T.A. Dickinson (1985). Local names for vascular plants in the John Crow Mountains, Jamaica. *Economic Botany*, 39, 346-362.
- Kelly, D.L. & D. Burke (completed ms.) Endemic flowering plants of Jamaica under threat: a fresh report. Submitted to *Oryx*, July 1990.
- Kelly, D. L., E. V. J. Tanner, V. Kapos, T.A. Dickinson, G. Goodfriend & P. Fairbairn 1988. Jamaican limestone forests: floristics, structure and environment of three examples along a rainfall gradient. *Jour. Trop. Ecol.*, 4, 121-156.
- Lack, D. 1976. *Island Biology: illustrated by the land birds of Jamaica*. Blackwell Scientific Publications, Oxford.
- Morgan, G.S. & C.A. Woods (1986). Extinction and the zoogeography of West Indian land mammals. *Biol. Jour. Linn. Soc.*, 28, 167-203.
- Mabberley, D.J. 1987. *The plant-book: a portable dictionary of the higher plants*. Cambridge University press.
- Oliver, W. L. R., L. Wilkins, R.H. Kerr & D.L. Kelly 1986. The Jamaican Hutia *Geocapromys brownii* captive breeding and reintroduction programme history and progress. *Dodo, J. Jersey Wildl. Presero. Trust*, 23, 32-58.
- Proctor, G. R. 1970. Mason River Field Station. *Jamaica Journal*, 42: 29-33.
- Proctor, G. R. 1982. More additions to the flora of Jamaica. *Jour. Arnold Arb.*, 63, 199-315.
- Proctor, G. R. 1985. *Ferns of Jamaica* British Museum (Natural History), London.
- Proctor, G. R. 1986. Cockpit Country Forests. In *Forests of Jamaica*, ed. by D. A. Thompson, P. K. Bretting & M. Humphreys, 43-48. The Jamaican Society of Scientists and Technologists, Kingston Jamaica.
- Zanoni, T. 1989. Hispaniola. In *Floristic Inventory of Tropical Countries: The Status of Plant Systematics, Collections, and Vegetation, plus Recommendations for the Future*, 337-340. New York Botanical Garden, U.S.A.