The pteridophytes of Reunion Island

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THE PTERIDOPHYTES OF RÉUNION ISLAND *

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ABSTRACT

The pteridophytes of the island of Réunion and their habitats are described.

INTRODUCTION

The pteridophyte flora of Réunion Island is characterized by a high number of species (about 240) in relation to its small surface area. This holds true for the entire Mascarene archipelago where the total number of species is known to be about 265, or about one-half the number occurring in Madagascar and the Seychelles.

One of the authors (T.C.) has been actively investigating the botany of Réunion Island during the last ten years. His field observations, together with the results of many botanical missions carried out by the other author (F.B.) and those of J. Bosser and F. Friedmann have permitted a general outline of the island's present day pteridophyte vegetation to be established. The collections are housed at the Paris Herbarium and/or at Centre Universitaire de La Réunion.

In the past, ecological observations regarding the island's pteridophytes have been rare; Cordemoy (1895), Baker (1877) and Bory de Saint Vincent (1804) usually give only vague indications consisting of the localities without any mention of the biotope (habitat). The island's vegetation was studied by Rivals (1952) but he scarcely mentions the pteridophytes.

Until the last few years the study of tropical floras undertaken by large european institutions has been almost exclusively oriented towards a purely descriptive and systematic outlook.

Recently some ecological observations have been published for Africa by Tardieu-Blot, Nicklès & Jacques-Félix (1949), Tardieu-Blot, Jaeger & Adam (1971) & Adams (1954). Concerning the Mascarenes, most of the collections were made by Bory de Saint-Vincent, Boivin, Commerson, Sieber, Gaudichaud and Lepervanche-Mézière. These ancient collections are often very imprecise as to the locality and the biotope (which are generally not indicated), the collector merely stating "Mascarenes" or "Bourbon" (the island's previous name to 1848).

GEOGRAPHY AND RELIEF OF THE ISLAND

Réunion Island, Mauritius and Rodrigues form the Mascarene archipelago. Réunion (55°30'E, 21°00'S) lies 800 km east of Madagascar. Mauritius lies closest to Réunion at 170 km ENE. Rodrigues, on the other hand, is more isolated and is located 600 km ENE of Mauritius (fig. 1).

Réunion is oriented NW-SE and has a roughly elliptic contour, about 70 km long and 50 km wide, with a surface area of 2,500 km^2. A geologically young island (about 3 million years old) of volcanic origin, it was formed from two volcanic complexes, in the middle of which is a vast expanse occupied by the Plaine des Cafres and the Plaine

* English translation by D. Lorence, Mauritius Herbarium, MSIRI, Reduit, Mauritius. (Present address: Missouri Botanical Garden, 2345 Tower Grove Avenue, St. Louis No. 63110, U.S.A.).

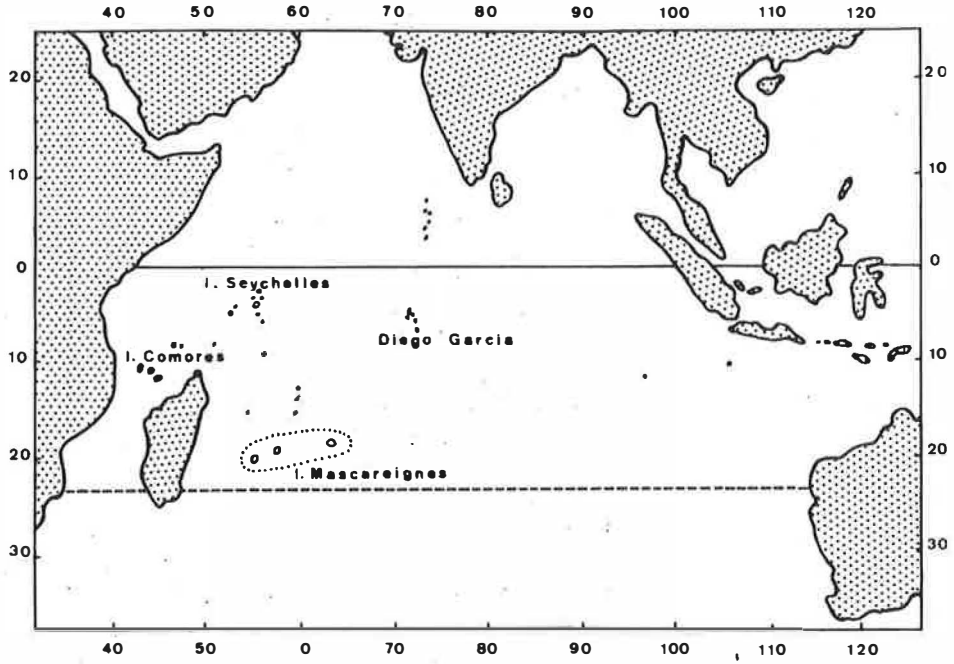

FIGURE 1. Position of the Mascarene Archipelago (Réunion Island, Mauritius, Rodrigues) in the Indian Ocean, with respect to other island groups.

des Palmistes (Fig. 2). The massif du Piton des Neiges, representing the NE two-thirds of the island, reaches 3,069 m. In the SE, the massif de la Fournaise has a crater which is still active, rising to 2,630 m. Each of these two massifs is the result of successive volcanic eruptions subsequently acted upon by erosion. As a result, the topography is extremely rugged and is characterised by "cirques" and radiating valleys with steep flanks bordering the remains of more or less extended expanses of somewhat regular slopes of about 10° inclination. The material detached by the still active erosion has formed several rather limited littoral plains extending from the mouths of some of the major rivers.

PHYSICAL AND CLIMATIC DATA

As a result of its geographical situation, the island enjoys a tropical climate with an insular character due to the influences of the trade winds and its accentuated relief which modify an otherwise truly tropical climate. Two more or less well marked seasons exist. The warm and rainy season (summer) lasts from December to April. It is marked by the passage of cyclonic disturbances over or near the island which bring very heavy rains. The cooler and relatively drier season (winter) extends from May to November.

The temperatures are not excessive. Along the coast the mean maximum temperature for the warmest month (February) is 32.4°C at St. Leu and 30.2°C at St. Benoit. The mean minimum temperature for the coldest month (August) is 18°C at St. Leu and 16.4°C at St. Benoît. The temperature decreases with altitude and the higher parts of the island (above 1800-2000m) are subject to frequent frosts at night. The temperature may reach –5°C at soil level on the Massif de la Fournaise.

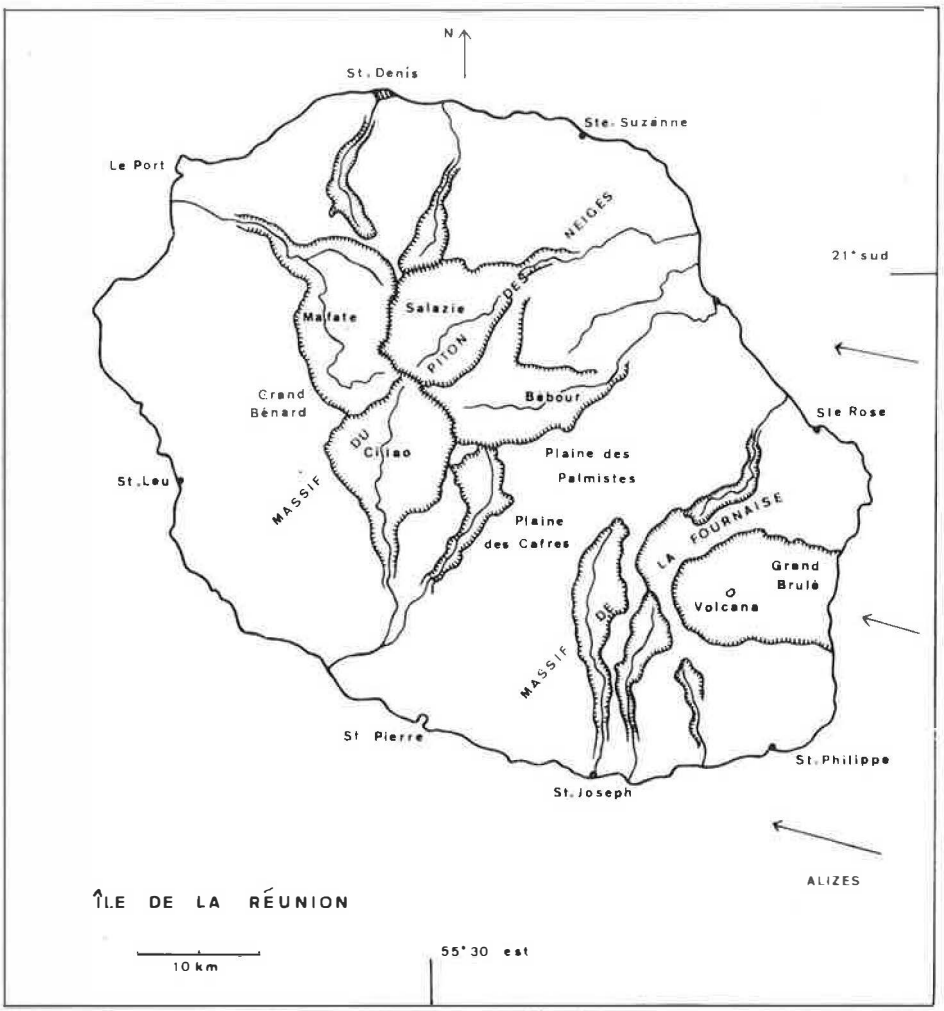

FIGURE 2. Map of Réunion Island showing chief volcanic areas, drainage and prevailing wind direction.

The mountain range results in markedly different climates between the windward and leeward regions. The ESE slopes, exposed to the direct force of the trade winds, experience a heavy rainfall (3m at St. Benoît) and have no ecologically dry season (the precipitation is more than 110 mm at St. Benoît for each of the months of August, September and October). In the leeward rain-shadow of the mountainous screen, a rather marked dry season prevails from May to November and the total yearly rainfall is much lower (less than 800 mm east of the port of St. Louis). In spite of this, most of the island receives more than 1500 mm of rain yearly, without any ecologically dry periods. The regions at low altitudes along the leeward zone are exceptional and the yearly total is frequently less than 1 m with a dry season that can be rather marked.

VEGETATION

As one goes from low to high altitude, the general aspect of the plant communities varies following more or less horizontal bands. This altitudinal succession of stages of vegetation depends on various factors among which are the decrease in temperature with altitude and the situation in relation to the ESE trade winds. The main zones of vegetation are as follows:

Littoral Vegetation

The original littoral vegetation has totally disappeared and has been replaced by secondary formations composed of numerous exotics with a few rare indigenous halophiles (*Scaevola taccada* (Gaertn.) Roxb., *Lysimachia mauritiana* Kam. and *Zoysia tenuifolia* Willd. ex Thiele).

Marsh Vegetation

Behind the littoral strands along certain coastal areas (St. André, St. Paul, Le Gol), marshes have developed which are flooded periodically. These have been colonized by large heliophytes among which the Cyperaceae are prevalent (*Cyperus papyrus* L. var. *madagascariensis* (Willd.) Kunth, *C. articulatus* L., *Eleocharis equisetina* Presl. and *Typha angustifolia* L.)

Megathermic Dry Sector Vegetation

This formerly occupied the zone occuring between the littoral and altitudes of 600 - 700 m in the leeward regions. Degraded remnants of this vegetation still exist along the vertical walls enclosing some of the large rivers (Riviére de St. Denis, Ravine de la Grande Chaloupe, Riviére des Galets, Bras de Cilaos and Bras de la Plaine). Species characteristic of this vegetation type may often be encountered in the form of a few isolated individuals. Some examples are : *Foetidia mauritiana* Lam., *Erythroxylum hypericifolium* Lam., *Olea chrysophylla* Lam., and *Cossignia pinnata* Lam. This formation probably occupied, at least in part, what today consists of lowland savanna of *Heteropogon contortus* Beauv. ex Roem. & Schult. and *Bothriochloa pertusa* (L.) Camus which have developed from the Massif de la Montagne (between 0 and 300 m) to the Plaine du Gol (near sea level at St. Louis).

Low Altitude Hygrothermic Forest or Lowland "Bois de Couleur" Forest

This formation formerly covered the lower slopes of the eastern region between 0 - 800 m, and in addition a narrow band in the west above the megathermic dry sector vegetation, between 700 and 1000-1100m. Today only more or less degraded vestiges remain at the Massif de la Montagne, the Plaine des Makes and above 600 m in the windward region. Some few remnants may also be seen in the region of St. Philippe and Grand Brulé below 400 m.

This type of vegetation consists of three characteristic strata : arborescent (average height of 10 - 15 m), understory shrubs, and herbs with the presence of numerous epiphytes (ferns and orchids). The most characteristic species are : *Sideroxylon majus* (Gaertn. f.) Baehni, *Mimusops maxima* (Lam.) Vaughan, *Labourdonnaisia callophylloides* Bojer, *Mallotus integrifolius* Mull. Arg., *Calophyllum inophyllum* L., *Hyophorbe indica* Gaertn., *Ochrosia borbonica* Gmel., *Eugenia cymosa,* Lam., *Eugenia paniculata* Lam., and *Diospyros melanida* Poir.

FIGURE 3. *Nephrolepis abrupta*, the first vascular plant on 1961 lava flow covered with the lichen *Stereocaulon vulcani*. Grand Brulé, 100 m.

High Altitude Hygrophylic Formations

These formations represent the best preserved stands of primary vegetation in Réunion today. The lower limits rise progressively from 700-800 m in the southeast and east to 1000 – 1100 m in the West and the upper limits extend from 1500 – 1600 m to about 2000 m. The floristic composition and physiognomy can be subdivided as follows:

1) The hygrophilic *Dombeya* or "Bois de couleur des Hauts" forest. In this type of forest the canopy trees rarely exceed ten metres. Epiphytes abound from ground level to the highest branches (e.g. at Plateau de Bébour and Plaine des Chicots). The most characteristic woody species are : *Dombeya reclinata* Cordem., *D. punctata* Cav., *Eugenia cotinifolia* Jacq., *Bertiera rufa* A. Rich and *Cladoxylon glandulosun* Baill.

2) The "Tamarin des hauts" forest (*Acacia heterophylla* (Lam.) Willd.). In the west at about 1300-1400 m the *Dombeya* forest passes progressively into a formation where *Acacia heterophylla* and *Nastus borbonicus* Gmel. are dominant. The latter species, a bamboo, forms an extremely dense but discontinuous lower stratum at Plaine des Chicots for example. The *Nastus borbonicus* stratum is inexistent on the east of Massif du Piton des Neiges (North of Plaines des Cafres, Bébour and Bélouve). Here it is replaced either by ericoid shrubs (*Philippia, Senecio, Stoebe* and *Phylica*) or by species found in the *Dombeya* forest.

3) Hygrophilous thickets of *Pandanus montanus* Bory. This formation type occurs on the eastern and northern slopes of the Massif de la Fournaise in a region receiving 5-6 m of rain yearly. Numerous tree ferns (*Cyathea* spp.) and *Acanthophoenix* palms impart a characteristic physiognomy to this formation.

High Altitude Ericoid Vegetation

This formation begins at 1600-1700 m in the windward and at 2000 m in the leeward

FIGURE 4. A group of *Dicranopteris linearis* (broad frond) and *Sticherus falgellaris* (narrow frond) in a pioneer shrubby vegetation along the road from St-Benoit to Plaine des Palmistes, 700 m.

FIGURE 5. A typical thermophilic and skiophilous species, the epiphytic fern *Antrophyum giganteum*. La Mare Longue forest near St-Philippe, 300 m.

FIGURE 6. Another typical fern species of the hygrophilous and thermophilic forest, the epiphytic *Asplenium nidus* with very large fronds attaining 2 m.

region. It consists of more or less dense thickets of ericoid shrubs (*Philippia montana* (Willd.) Klotzsch, *Stoebe passerinoides* (Lam.) Willd., *Senecio hubertia* Pers. and *Phylica leucocephala* (Bory) Cordem.) and also herbaceous or bushy montane species (*Faujasia pinifolia* (Bory) Cass., *Eriothrix lycopodioides* (Lam.) D.C., *Psiadia* spp. and *Heterochaenia rivalsii* Badré & Cadet).

Although the predominance of *Philippia montana* imparts a uniform appearance to this formation, variations in climatic and edaphic factors result in a number of subgroups; two of these are as follows:

1) Along its lower limits and in windward areas of very high rainfall the ericoid vegetation forms a very dense heath scrub of *Philippia* sheltering a herbaceous stratum rich in ferns. Beneath this primary vegetation, locally called "voune" or "avoune", there exists a thick cushion of raw humus which may exceed one metre in depth.

2) High mountain prairies. These are edaphic in origin, and develop over fine soil and débris which has accumulated in depressions. These prairies are rich in composites, *Cyperaceae* and *Graminae* (e.g. *Helichrysum arnieoides* (Lam.) Cordem., *Psiadia aspera* (Bory) Cordem., *Festuca borbonica* Spreng.) and also harbour two lycopods : *Lycopodiella affinis* (Bory) Pich.Serm. and *Huperzia saururus* (Lam.) Rothm.

DEFINITION OF THE PRINCIPAL ECOLOGICAL GROUPS

The distribution of pteridophytes on the island according to geography and station appears to depend upon three principal factors: temperature, light and humidity. The latter factor is the least decisive because of the high rainfall that most of the island receives.

The island's pteridophytes can be divided into two principal groups: those of forest formations including the pioneers (pioneer vegetation of *Nephrolepis abrupta* (Bory) St. John, pre-forest *Sideroxylon* association and *Philippia* scrub); and those which are associated with marsh vegetation, savanna, abandoned fields or have a more or less ruderal character.

Amongst the forest species, variation in temperature with altitude enable three categories of species to be defined:

- Thermophilic species of low to medium altitudes, 0 to 700-800 m, but extending to 1000-1100 m in the leeward zone, or even to 1200-1300 m in the cirque de Mafate and cirque de Cilaos where the altitude-temperature gradient differs from the usual one.
- Oligothermophilic species of extremely hygrophilic high altitude forests and ericoid vegetation of upper regions above 1000-1100 m.
- Eurythermophilic species occurring with the same frequency from sea level to the highest altitudes. Within the limits of the island, these species appear to be indifferent to temperature.

In each of the above three categories the light factor enables a further breakdown into:

- Heliophilic to hemi-skiophilous species. These are species of pioneer shrub formations, secondary scrubs occupying old abandoned fields or of forest clearings.
- Skiophilous terrestrial species growing beneath dense forests.
- Skiophilous epiphytes.

A group of species apparently restricted to remnants of forest in the warmer and drier regions of the west (the dry megathermic sector of RIVALS, 1952) is

FIGURE 7. *Blechnum tabulare*, anoligothermic and pioneer species of fern with a cycad-like habit. *Philippia* thicket on recent lava flow at Basse Vallée, St-Philippe, 900 m.

FIGURE 8. *Vittaria isoetifolia*, with its long and very narrow fronds in tuft on the lower face of bowed trunks. Hygrophilous forest of Bébour, 1350 m.

FIGURE 9. The very commun *Antrophyum boryanum*, an epiphytic, lithophytic or even terrestrial fern. Bébour, forest, 1350 m.

characterized equally by numerous species of phanerogams which, like certain pteridophytes, are no longer to be found on the island (thermophilic and more or less xerophilic species).

Amongst the non-forest species which are for the most part thermophilic heliophiles, there are:

- Saxicolic, more or less xerophilic species.
- Hygrophilic species of marshes, edges of water courses and seepage.
- Terrestrial species, some of which are more or less ruderal.

FOREST FERN SPECIES

These constitute the majority of the island's pteridophyte flora including more than 80% of the species.

Thermophilic forest species

The thermophilic species are associated with forests at the lower stage of vegetation occupying certain of the lower slopes of the island between 0 and 700-800 m altitude on the windward and 1000-1100 m on the leeward aspects.

These species are all more or less hygrophylic. More precisely, the humidity is quite sufficient here to assure their optimal development as a whole without much variation into sub-categories, except for those species of the "dry megathermic sector" as defined above.

Heliophilous or hemi-skiophilous species

These are essentially pioneer species colonizing lava flows. Some of these also occur in abandoned fields, others prefer forest clearings. *Nephrolepis abrupta* (Bory) Mett., *Sticherus flagellaris* (Bory) St. John, and *Dicranopteris linearis* (Burm. f.) Underwood are the three species which colonize recent volcanic flows (less than a century old) before the shrubs and trees have created a continuous canopy, at Grand Brule, for example. The latter two species are also encountered in considerable abundance in more or less degraded formations on mountain crests in all the low, humid regions of the island, particularly in the East (Hauts de St. Benoît and of St. André).

Sphaerostephanos elatus (Boj.) Holtt. (*Cyclosorus mauritianus* (Fée) Tard.) is a large, relatively hygrophilic fern very common in clearings, often along forest paths and roads, where it forms dense colonies. *Ochropteris pallens* (Sw.) J. Sm., *Lindsaea ensifolia* Sw. (*Schizoloma ensifolium* (Sw.) J. Sm.), and *Sphaerostephanos arbuscula* (Willd.) Holtt. (*Cyclosorus arbusculus* (Willd.) Ching), are less frequent, and the latter often grows in semi-shade, occupying rock fissures in stream beds. *Sphenomeris chinensis* (L.) Maxon is most frequently encountered in shrub formations occupying abandoned fields or along forest borders, paths and roads.

Skiophilous terrestrial species

The species in this category are not very numerous. The authors can cite *Angiopteris madagascariensis* De Vriese which had never before been recorded from Réunion, and is known only from the forest of Brûlé de Takamaka in the southeast. Also belonging to this group are species of *Ctenitis* (Nos. 3572 and 4371), *Selaginella obtusa* (Beauv.) Spring, of which there exists a form (or variety?) restricted to the rocky littoral of the southeast, and *Selaginella falcata* (Beauv.) Spring, which ranges up to 1100-1200 m altitude.

FIGURE 10. *Elaphoglossum splendens*, a typical epiphytic and skiophilous fern of the high altitude forest growing with the filmy fern *Hymenophyllum inaequale* on an horizontal trunk. Bébour forest, 1350 m.

Skiophilous epiphytic species

Certain of these can develop on rocks, at the bases of large tree trunks or on a substrate of still intact lava and constitute an essential part of the berbaceous stratum, but disappear where there is a true soil. Such is the case with *Nephrolepis biserrata* (Sw.) Schott and *Phymatodes scolopendria* (Burm. f.) Ching, both very abundant in forests occupying modern volcanic flows (100-200 years) in the southeast (St. Philippe region).

The true epiphytes in this group are numerous, certain of them are frequent and abundant: *Hymenophyllum sibthorpioides* (Bory ex Willd.) Mett. ex Kuhn, *Hymenophyllum hirsutum* (L.) Sw., *Trichomanes bipunctatum* Poir., *Trichomanes giganteum* Bory, *Ophioglossum pendulum* L., *Humata repens* (L.f.) Diels, *Vittaria ensiformis* Sw., *Asplenium pellucidum* Lam. (3404, 3388, 3595), *Asplenium nidus* L, (with immense fronds attaining 2m), *Microsorium punctatum* (L.) Copel, *Belvisia spicata* (L.f.) Mirb., *Arthropteris boutoniana* (Hook.) Pich. Serm., and *A. giganteum* Bory (fig. 5).

The remaining species are not particularly rare, but are represented by fewer individuals: *Antrophyum immersum* (Bory ex Willd.) Mett., *Elaphoglossum lepervanchei* (Fée) Moore, *Lomariopsis pollicina* (Willem.) Mett. ex Kuhn., *Vittaria scolopendrina* (Bory) Thwait., *Vittaria elongata* Sw., *Xiphopteris serrulata* (Sw.) Kaulf., *Trichomanes bonapartei* C. Chr. (Cadet 3333 and 3764).

Forest species within the dry megathermic sector

These tend to be more or less xerophilic. They can sustain a dry period sometimes exceeding two months (August-September). Their leaves are able to remain in a shrivelled state or tolerate the dryness because of their coriaceous lamina.

The more characteristic terrestrial species are: *Schizaea dichotoma* Sm., *Tectaria puberula* (Desv.) C. Chr. (3711 and 4117), *Asplenium adiantoides* (L.) C. Chr., *Asplenium viviparum* (L.F.) Presl., *Asplenium pellucidum* Lam. var. *dareaefolium* (Bory) Tard., *Adiantum reniforme* L. var. *asarifolium* (Willd.) Sim, and *Adiantum hispidulum* Sw. The latter two species have never been observed by the authors on the more humid side of the island (with the exception of a single station for *Adiantum hispidulum*) and apparently cannot tolerate a high and constant humidity.

Epiphytes are rare in this group. *Arthropteris orientalis* (J.F. Gmel.) Posth. thrives at the base of trunks and on rocks in open understories. It can also tolerate exposure to full sun and its fronds shrivel completely during the dry season. *Trichomanes pyxidiferum* L. var. *melanotrichum* (Schlechttend.) Schelpe is of rare occurrence. The commonest epiphytes are in fact those species with a large ecological amplitude for water. Abundant principally in the humid region, they persist equally in the dry sector, but develop less copiously .This is the case with *Nephrolepis biserrata* (Sw.) Schott and *Phymatodes* scolopendria (Burm. f.) Ching.

Oligothermic forest species

These may be encountered beginning at 800-900 m altitude in the east and about 1000 m in the west. Strongly hygrophilic, they are restricted to humid *Dombeya* forests and ericoid vegetation of high altitudes.

Heliophilic to hemi-skiophilous species

Certain of these demand a fairly high light intensity and grow in rather open tree formations along forest borders, ravines and roads, or in natural clearings. *Blechnum tabulare* (Thunb.) Kuhn, a large fern with a cycad-like habit, prefers *Philippia* thickets over intact lava flows for its habitat and occurs principally on the Massif de la Fournaise around the active volcano. Bory de Saint-Vincent named the Plaine des Osmondes after this impressive fern. *Blechnum montbrisonis* C. Chr. has more or less the same biotope and abounds beneath *Philippia* thickets covering intact lava flows between about 1500-2000 m altitude. This species also commonly grows inside ravines in dense rain forests. Certain other species are restricted to clearings, particularly in the "Tamarin des Hauts" forests: *Hypolepis villoso-viscida* (Thouars) Tard., *Histiopteris incisa* (Thunb.) J. Smith, *Athyrium scandicinum* (Willd.) C. Presl, *Pseudophegopteris aubertii* (Desv.) Holtt. (*Thelypteris cruciata* (Willd.) Tard.), *Ophioglossum ovatum* Bory and *O. reticulatum* L. may even grow in clearings within *Casuarina, Eucalyptus* or *Acacia* plantations.

The remaining species tend to occupy the lower stratum of pioneer ericoid formations: *Lycopodium clavatum* L. var. *borbonicum* Bory, *Mohria caffrorum* (L.) Desv., *Gleichenia boryi* Kze., *Amauropelta salazica* (Holtt.) Holtt., *Huperzia saururus* (Lam.) Rothm., *Lycopodiella affinis* (Bory) Pichi Sermolli. The latter two species are characteristic of high mountain prairies. *Huperzia selago* (L.) Bernh. ex Schrank & Mart. is known only from a single station at Petit Matarum in the Cirque de Cilaos. *Cyathea glauca* Bory is a component of the upper stratum in pre-forest formations and imparts a characteristic physiognomy to these.

Skiophilous terrestrial, more or less humilolous species

There are many species which are constant and highly characteristic components of the ground flora of high altitude rain forest : *Blotiella pubescens* (Kaulf.) Tryon, *Athyrium arborescens* (Bory) Milde, *Polystichum ammifolium* (Poir.) C. Chr.,

FIGURES 11 and 12. The obligothermic tree fern *Cyathea glauca*. Hygrophilous forest on the ridge between Cirque de Mafate and Cirque de Salazie, 1600 m.

FIGURE 13: An eurythermic terrestrial and skiophilous fern : *Marattia fraxinea*. La Mare Longue forest near St-Philippe 300 m.

Amauropelta heteroptera (Desv.) Holtt. (*Thelypteris heteroptera* (Desv.) Tard.), *Amaurolpelta strigosa* (Willd.) Holtt. (*Thelypteris tomentosa* (Thouars) Ching), *Dryopteris aquilinoides* (Desv.) C. Chr., *Ctenitis subglandulosa* (Mett.) Tard., *Ctenitis crinita* (Poir.) Tard., *Ctenitis mascarhenarum — lanuginosa* group, and *Ctenitis* sp. (Cadet 4154 and 4360). Other less abundant species include: *Selaginella cataphracta* (Willd.) Spring, *Ctenitis* sp. (Cadet 4155) and *Pteris croesus* Bory.

In the latter category we can also include *Asplenium unilaterale* Lam., an extremely hygrophilic species which thrives on humid soil and is particularly fond of humid rocks in shady stream beds and *Pityrogramma argentea* (Willd.) Domin. which favors old fallen trunks or humus tussocks especially in old *Acacia heterophylla* forests.

Skiophilous epiphytes

These species occur on tree trunks at various levels but always in the shade of the canopy. Certain of them are particularly common : *Pleopeltis excavata* (Bory ex Willd.) Schelpe, *Vittaria isoetifolia* Bory (with long and narrow pendant fronds), *Asplenium aethiopicum* (Burm.f.) Bech. (Cadet 3187, 3512 and 4114), *Asplenium boltonii* Hook. ex Schelpe, *Elaphoglossum aubertii* (Desv.) Tard., *Elaphoglossum splendens* (Bory ex Willd.) Brack., and *Elaphoglossum hybridum* (Bory) Brack. Others are less common and include: *Huperzia verticillata* (L.f.) Rothm., *Huperzia obtusifolia* (Sw.) Rothm., *Hymenophyllum peltatum* Desv., *Asplenium protensum* Schrad., *Asplenium rutifolium* (Berg.) Kze., *Asplenium theciferum* (Kunth) Mett., *Ctenopteris leucosora* (Boj.) Tard., and *Ctenopteris parvula* (Bory ex Willd.) J. Smith.

Some species, although consistently found growing on the lower and middle levels of trunks, tolerate increased light and may also become established on high and exposed branches. They may even be encountered within dense *Philippia* thickets at bases of shrubs or rooting in carpets of moss. They include the following species: *Blotiella glabra* (Bory) Tryon, *Elaphoglossum angulatum* (Bl.) Moore (*E. alstonii* Tard.), *Elaphoglossum* sp., *Ctenopteris rigescens* (Bory ex Willd.) J. Sm., *Ctenopteris torulosa* (Bak.) Tard., , *Pleopeltis macrocarpa* (Bory ex Willd.). The latter species is particularly abundant on the trunks and branches of *Acacia heterophylla*.

Cavernicolous species

A certain number of species favour rocky walls of grottos, fissures in cliffs, or rock concavities at high altitudes. These include : *Asplenium kassneri* Hieron., *Asplenium erectum* Bory ex Willd., *Asplenium stoloniferum* Bory, *Cystopteris fragilis* (L.) Bernh., *Ctenitis* sp. (1942, 1974, 2047, 1532, 1553), *Elaphoglossum deckenii* (Kuhn) C. Chr. var.rufidulum (Willd.) Tard., *Elaphoglossum hybridum* (Bory) Brack.var. *vulcanii* Lepervanche ex Fée, and *Elaphoglossum stipitatum* (Bory ex Fée) Moore. *Grammitis barbatula* (Bak.) Copel. is consistently found in this biotope, but may also occur in forests in extremely sheltered sites, e.g. on the lower surface of inclined trunks. *Cheilanthes farinosa* (Forsk.) Kaulf. is more or less heliophilic and occurs at the mouths of caverns or on the edges of cliffs.

Eurythermic forest species

In view of their geographic distribution over the island, these species have a wide tolerance for temperature. They are just as common in forests of low altitude as they are in those of the uplands.

In terms of biomass they are without equal amongst the pteridophyte flora.

The tree ferns

The tree ferns have a special appearance which imparts a characterised physiognomy to much of the island's forested expanses, so we shall give it special consideration. Two of the component species are truly polyaltitudinal. The first, *Cyathea borbonica* Desv. (*C. canaliculata* Willd.), has a fairly slender stem which often becomes ramified at higher altitudes. It is generally a component of the canopy where the trees exceed 7-8 m. *Cyathea excelsa* Sw. is, on the other hand, a large tree fern attaining 10-12 m. Its fronds are a component of and often transcend the canopy. The base, which is thickened by a dense network of adventitious roots, is used for the construction of planters ("fanjans ') or support plaques well suited for orchid culture.

Cyathea glauca Bory is much more oligothermic and is never found below 1000-1100 m altitude. A pioneer species in ericoid formations, it dominates the upper stratum of preforest shrub vegetation for quite some time. During the hot and humid period its leaves dry up, after which new growth is initiated. The base of the stem of this species is used in the same way as that of *Cyathea excelsa*.

A fourth species of *Cyathea*, probably introduced, is cultivated in humid regions of low altitudes (Ste. Rose, St. Benoit, Plaine des Palmistes), where it now appears to be naturalized.

Heliophilic species

These species are not very numerous and three can be cited. *Lycopodiella cernua* (L.) Pich. Serm. is common within pioneer shrub formations and also in fallow land, particularly those of very humid regions. *Pteridium aquilinum* (L.) Kuhn is almost ubiquitous in fields on poor soil, fallow land, gravelly areas, secondary scrub and even more or less degraded forests. This incredible fern sometimes exceeds four metres in height. *Elaphoglossum spatulatum* (Bory) Moore is a tiny fern which grows exclusively on exposed and humid boulders in sheltered streambed. This species could be considered to be a heliophilic saxicole.

Skiophilous terrestrial species

At times these constitute the greater part of the forest ground flora. Examples include: *Selaginella sinuosa* (Desv.) Alston, *Selaginella surculosa* Spring, *Marattia fraxinea* Sm, ex J.F. Gmel., *Pteris scabra* Bory ex Willd., *Asplenium viviparum* (L.f.) Pr. var. *lineatum* (Sw.) Tard. and *Ctenitis* sp. (Cadet 1674 3399, 3472, 3378, 3544, 3555). The remaining species are much less frequent : *Trichomanes meifolium* Bory, *Trichomanes parviflorum* Poir., *Nephrolepis tuberosa* Bory, *Pteris cretica* L., *Pteris woodwardioides* Bory ex Willd., and *Blechnum australe* L.

Eurythermic, skiophilous epiphytes

Most species of this group are generally quite frequent. Certain are strict skiophile: *Huperzia squarrosa* (G. Forst.) Trev., *Huperzia gnidioides* (L.f.) Rothm., *Huperzia ophioglossoides* (Lam.) Rothm., *Asplenium petiolulatum* Mett., *Hymenophyllum hygrometricum* Desv., *Hymenophyllum inaequale* Desv., and *Hymenophyllum capillare* Desv. which is very exacting as far as shade is concerned, and is always found on the lower surfaces of inclined trunks or at base of trees.

Trichomanes erosum Willd. (probably synonymous with *T. cuspidatum* Willd.) is also extremely hygrophilic and has the same habitat as the preceding species but also grows closer to or even on the soil. The tiny fronds shrivel readily with the slightest decrease in humidity. *Trichomanes tamarisciforme* Poir. and *Elaphoglossum*

tomentosum (Bory ex Willd) Christ are also present. *Antrophyum boryanum* (Willd) Kaulf. is often lithophytic or even terrestrial. *Blechnum attenuatum* (Sw.) Mett. occasionally forms a complete collar around trunks, especially those of Cyathea. At middle altitudes the species may acquire a terrestrial habitat and even constitute a dominant part of the herbaceous stratum. *Loxogramma lanceolata* (Sw.) C. Presl. quite often lithophytic, can withstand short periods of dessication. It also occurs in the Eastern dry zone inside ravines.

Certain other species are encounted less frequently : *Psilotum nudum* (L.) Beauv. (in crevices of more or less shaded rocks), *Trichomanes borbonicum* Bory, *Trichomanes digitatum* Sw., *Cheiroglossa malagassica* (C. Chr.) Pich. Serm. (*C. palmata* Presl var. *madagascariensis* C. Chr.), *Elaphoglossum richardii* (Bory) Christ, and *Monogramma graminea* (Poir.) Schkuhr.

Although indeed very abundant on trunks in the shade, another group of species is equally at home on high branches exposed to full sun. These include : *Rumohra adiantiformis* (Forst.) Ching, *Oleandra distenta* Kunze, *Elaphoglossum macropodium* (Fee) Moore, *Elaphoglossum petiolatum* (Sw.) Urban ssp. *salicifolium* (Willd. ex Kaulf.) Schelpe, *Ctenopteris argyrata* (Bory) Tard., and *Grammitis obtusa* Willd.

NON FOREST FERN SPECIES

The pteridophyte flora outside of the forest is poorly represented, probably because the biotopes are not very diverse. All thermophilic, these species can be divided into three ecologic categories.

Saxicolious, heliophilous more or less xerophilic species

Not very numerous, these species are highly characteristic of the "dry megathermic sector". They live in small cracks and fissures of the most exposed rocks and their fronds dehydrate completely during the dry season. *Actiniopteris australis* (L.f.) Link and *Actiniopteris radiata* (Sw.) L. are characteristic. The latter species can also be found between rocks of walls along roads. *Adiantum rhizophorum* Sw. prefers a more protected habitat and retains its leaves year round. We can add to this group *Pyrrosia lanceolata* (L.) Farw. which is found equally in the very humid eastern zone. It grows on isolated tree trunks and can withstand fairly prolonged dessication during the dry season.

Terrestrial, heliophilous, more or less ruderal species

A number of species have an ecology sometimes difficult to define. They commonly occur along roads, in fields at the base of dry stone walls, in gravel and sometimes in fallow land.

Plants of such situations include : *Pellaea viridis* (Forsk.) Prant. var. *viridis* and *Asplenium adiantum-nigrum* L. *Equisetum ramosissimum* Desf. is almost always encountered on the moist alluvium deposited in torrent beds or on their banks but also occurs on impermeable soil within the "cirques", where it attains 1600-1700 m altitude. *Ophioglossum lancifolium* C. Presl and *O. nudicaule* L.f. are diminutive ferns allied encountered in *Heteropogon* savannahs in the west. Their fronds appear just after the first rains marking the end of the dry season. This species has the same ecology in Madagascar. *Pteris linearis* Poir. occurs at the foot of walls in the dry western region. *Pityrogramma calomelanos* (L.) Link. var. *calomelanos* grows between rocks in stream beds that are almost always dry and also along roadsides. *Pityrogramma calemelanos* var. *aureoflava* (Hook.) Weath. ex. Bailey is commonly

situated along roadsides. *Sphaerostephanos unitus* (L.) Holtt. (*Cyclosorus unitus* (L.) Ching) is extremely frequent in abandoned fields and along roads. *Macrothelypteris torresiana* (Gaud.) Ching (*Thelypteris uliginosa* (Kunze) Ching) may occur between rocks of torrent beds which are for the most part dry.

Certain species are extremely localized, being restricted to one or two "cirques". *Cheilanthes hirta* Sw., *Pellaea calomelanos* (Sw.) Link. var. *calomelanos* and *Pellaea dura* (Willd.) Hook. are known only from the Cirque de Cilaos and Cirque de Mafate. Two other species are known exclusively from the Cirque de Cilaos : *Doryopteris pedatoides* (Desv.) Kuhn. and *Doryopteris pilosa* (Poir.) Kuhn. All of these species are absent from the Cirque de Salazie, which is much more humid. They can be considered as species which are thermophilic but scarcely hygrophilic.

Hygrophilic and heliophilic species of marshes, water courses and seepage

Not many species grow in this biotope. *Cyclosorus interruptus* (Willd.) H.Ito (*Thelypteris totta* (Thunb.) Schelpe) is abundant around marshes at low to medium altitudes. *Osmunda regalis* L. grows in areas of marshy prairie below the village of Plaine des Palmistes, the only known station. *Athyrium accedens* (Bl.) Milde (*Diplazium proliferum* (Lam.) Kaulf.) and *Pteris pseudolonchitis* Bory are most frequently encountered amongst rocks along permanent streams or springs, or on talus slopes along irrigation canals at low altitudes.

The flora of waterfalls and seepage at low altitudes is characterised by *Adiantum capillus-veneris* L., and *Pteris vittata* L. the latter of which is not exclusively found in this habitat and occasionaly occurs along streams on humid alluvials. *Christella hilsenbergii* (Presl) Holtt. is a sun loving species which is not very particular in its water requirements. It is also found on seepage areas as well as on the almost permanently dry silty banks of streams and in the undergrowth of forests of the hot dry parts of the island.

CONCLUSIONS

Most of the 240 or so species of native pteridophytes are still abundant in Réunion because they occupy habitats which are presently quite extensive and they do not have ecological requirements that are highly exacting. Many hygroskiophilous species of low altitudes, for example, may thrive in secondary formations (*Eugenia jambos* L. forests) which have taken the place of the indigenous forests. Other species, notably those belonging to the genera *Hymenophyllum, Trichomanes* and *Humata,* even grow on old fruit trees in orchards. On the other hand, as a consequence of the reduction of the areas once occupied by the forests in the dry megathermic sector, certain species restricted to this formation have become rare, for example *Asplenium adiantoides* (L.) C. Chr., *Actiniopteris radiata* (Sw.) Link, and especially *Actiniopteris australis* (L.f.) Link which is confined to emergent rock faces in the *Heteropogon* savanna of the leeward region. These species are infrequent and more importantly, are menaced by fires. *Pellaea calomelanos* (L.) Link var. *calomelanos, Doryopteris pedatoides* (Desv.) Kuhn, and *D. pilosa* (Poir) Kuhn are only encountered at rare stations, principally in the Cirque de Cilaos, in areas alternatively cultivated and left fallow. *Asplenium nidus* L. is also in danger because it is often collected for its attractive fronds.

Various other species such as *Vittaria scolopendrina* (Bory) Thwait. and *Angiopteris madagascariensis* De Vriese are limited to areas of low altitude humid forest which have become established on lava flows about 200 years old. Their restricted distribution can only be explained by man's destruction of this type of

formation. These species are thus threatened by extinction.

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REVIEWS

FERNS OF HONG KONG by Harry H. Edie XVIII + 285 pp., 15 pl. Hong Kong University Press, 1978. 214 x 140 mm. Price not quoted.

This is a flora of the island of Hong Kong and that part of the China mainland and offshore islands that make up the New Territories. Harry Edie has written this book "out of necessity" for his undergraduate students and the first 23 pages therefore are devoted to notes on life-cycle, ecology, classification morphology and evolution. These are clear and concise and will be easily understood by amateurs and sixth-form students alike. That on classification is weakest and I feel the higher taxa could have been discussed more fully or, at least, references given to up to date work on the subject. In that on morphology, the variation of spore shape and wall structure and ornamentation is not mentioned nor is its importance as a taxonomic character. I would have liked a paragraph on geographical affinities to emphasise that some 50% of the species are south-east Asian ranging from India to S.E. China and often to Philippines and Malesia; 12% are Chinese reaching Formosa and Japan, and only 17% are confined to SE China. Two or three species are doubtfully endemic.

There is a checklist to the 180 or so species covered, arranged according to R.E. Holttum's account of genera for *Flora Malesiana*. One new combination (*Lunathyrium zeylanicum* (Hook.) H. Edie) is made there. Keys and descriptions are good, illustrated with clear thumbnail sketches by the author. Standard of binding (soft but durable) and printing are good. I detected only one printing error *Arachnoides* instead of *Arachniodes* and perhaps 'deltoid' (p.18) should be 'deltate' but these are minor points. This is a nice book to possess as an introduction to the fern flora of mainland east Asia and will, I feel sure, encourage the study of ferns generally in that part of the world.

A.C. JERMY

THE PTERIDOPHYTE FLORA OF FIJI by G. Brownlie. 397 pp. 44 plates. 175 x 250 mm. (Beihefte 55 zur Nova Hedwigia). J. Cramer, Vaduz, 1977. Price DM 200 (about £51.00) Subscription price DM 160 (about £41.25).

The main body of this work is given over to description of families (25), genera (89) and species (296) of the pteridophytes found on the Fiji island Group. Full place of publication is given for each taxon but few details are given on types. The author, Garth Brownlie, on the staff of the University of Christchurch, Canterbury, NZ, has already one other fern Flora to his credit, namely that of New Caledonia. This reviewer would have wished for a biogeographical discussion on the flora of Fiji and more about the environment of those islands; only seven pages are given over to introductory matter.

Eighteen of the species are described here for the first time (in *Belvisia, Bolbitis, Ctenitis, Ctenopteris, Elaphoglossum, Grammitis, Hypolepis, Lycopodium, Microlepia, Pteris, Tectaria* and *Trichomanes*). The following new combinations are also made: *Dicksonia moluccana* Bl. var. inermis Baker is transferred to *Dennstaedtia; Microlepia* tenuis Brack. to *Orthiopteris; Ctenitis* gordonii (Baker) Copel. and *Athyrium* gillespiei to *Lunathyrium; Dryopteris* maxima (Baker) C.Chr. to *Arachnoides; D.* waiwaiensis C.Chr. to *Ctenitis; Lomaria* coriacea Brack., *L.* doodioides Brack. and *L.* pilosa Brack. to *Blechnum;* and *Microsorium* parksii Copel. to *Phymatosorus.*

The book is of the technical standard we have come to expect from J. Cramer; clear typography and the plates by Hélène Mulder are exceptionally good and show useful diagnostic features. However, one must ask the question: "For whom do we write such Floras?" For the professional botanist, the student or keen amateur who wishes to identify ferns of Fiji the meat of this book could have been produced for one quarter the price.

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