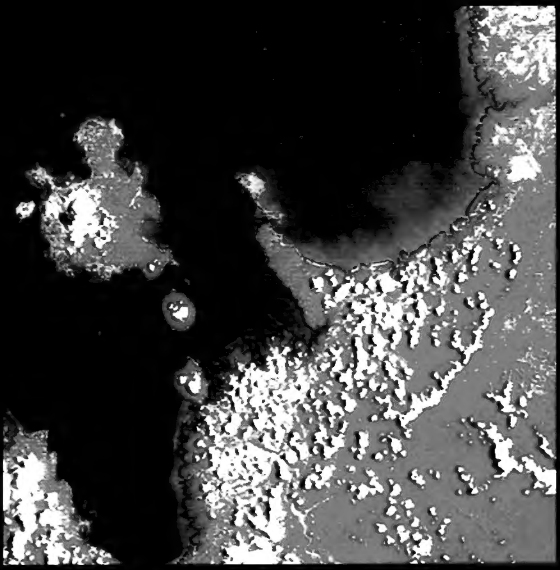
Madagascar
An environmental profile




Compiled by
IUCN Conservation Monitoring Centre

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MADAGASCAR
AN ENVIRONMENTAL PROFILE

WORLD CONSERVATION MONITORING CENTRE
219 Huntingdon Road, Cambridge CB3 0DL U.K.

IUCN UNEP WWF

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INTERNATIONAL UNION FOR CONSERVATION OF NATURE
AND NATURAL RESOURCES

UNITED NATIONS ENVIRONMENT PROGRAMME

MADAGASCAR
AN ENVIRONMENTAL PROFILE

Edited by M.D. Jenkins

Prepared by
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Rice paddies at Eminiminy, south-east Madagascar: S. O'Connor.
Indri *Indri indri*: WWF/J.J.Petter

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CONTENTS

INTRODUCTION

Madagascar, with its wide range of natural ecosystems, unique and varied fauna and flora, largely rural human population and often severe environmental problems, is universally recognized as a high priority for conservation action. This report aims to provide information on which decisions affecting the environment of the country can be made, and to give indications of areas in which further research is necessary. It is essentially bibliographic in nature and represents a distillation of available sources of information, both published and unpublished. Bibliographies and reference lists are provided for each section.

The principal subject areas covered are physical and human geography, vegetation, forest cover and loss, ethnobotany, marine and coastal ecosystems (in particular coral reefs), fauna, protected areas and sites of biological importance. With respect to fauna, emphasis has been laid on endemic and threatened taxa. All native vertebrate groups are discussed, but the sheer number and variety of invertebrates, particularly arthropods, has precluded their being treated in a similar fashion - it is evident that any attempt to cover all invertebrate groups in a single volume would result in extremely superficial treatment. Discussion has thus been confined to groups identified as of particular interest, notably crustaceans, molluscs and butterflies (Rhopalocera).

Work on the volume began in 1983 and has continued intermittently until the present (early 1987), with the most recent incorporation of new information being in January 1987.

The report was compiled and edited by Martin Jenkins and authored by the following:

Nigel Collar, Mark Collins, Tim Dee, Stephen Droop, Diana Evans, Brian Groombridge, Jerry Harrison, Martin Jenkins, Jane Thornback, Sue Wells, Lissie Wright.

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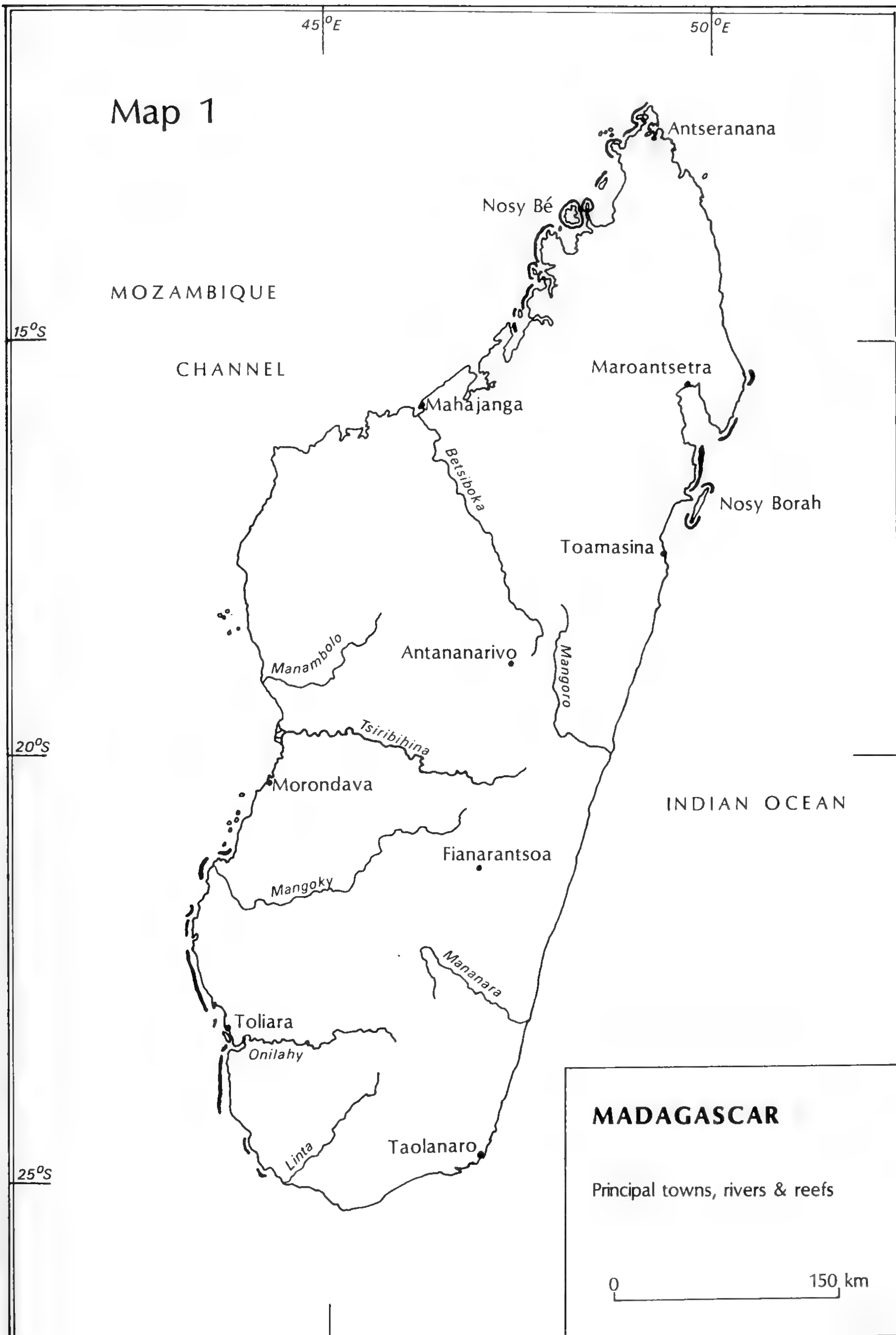
Errors and omissions remain the responsibility of the editor.

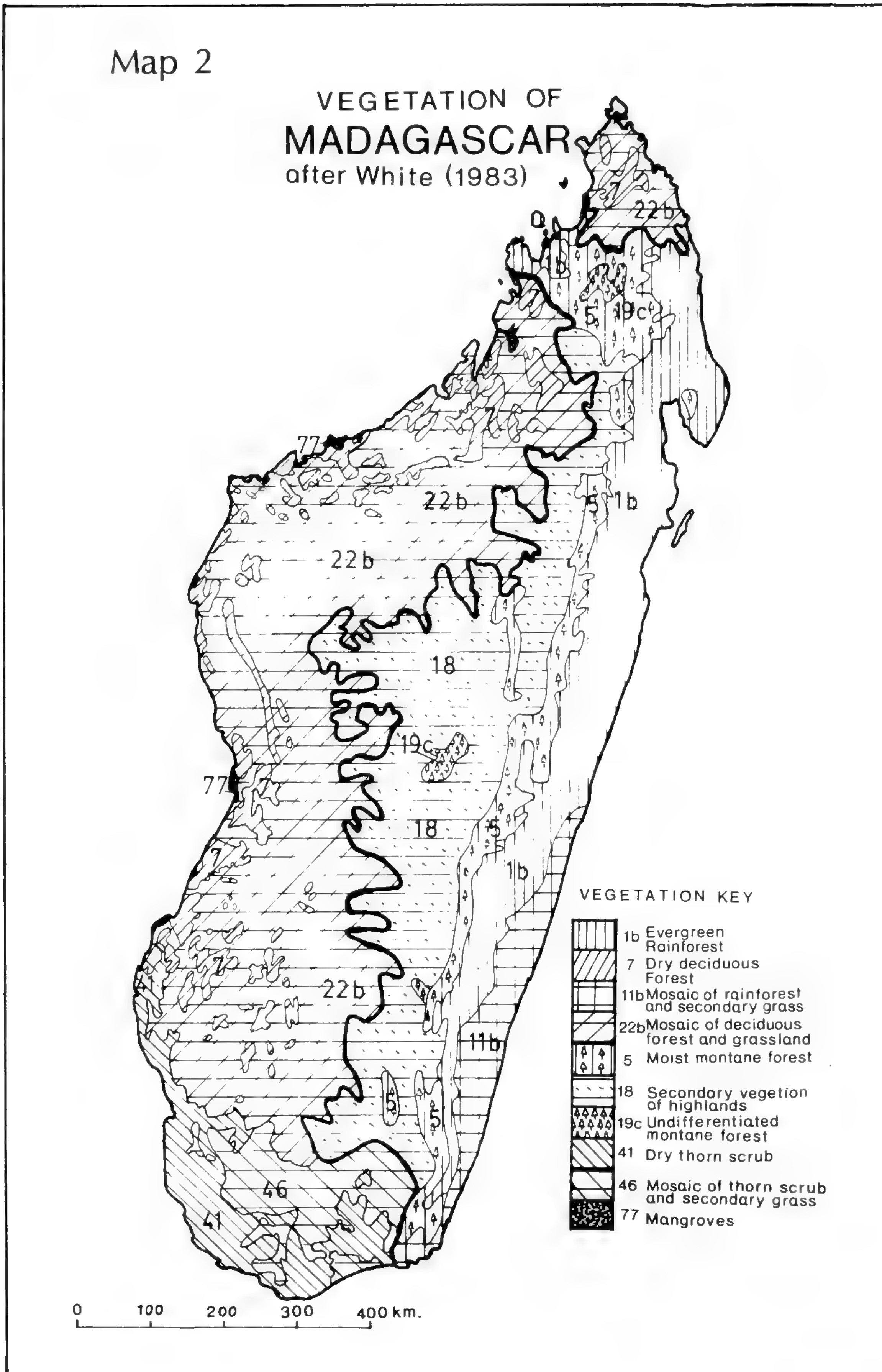
A NOTE ON PLACE NAMES

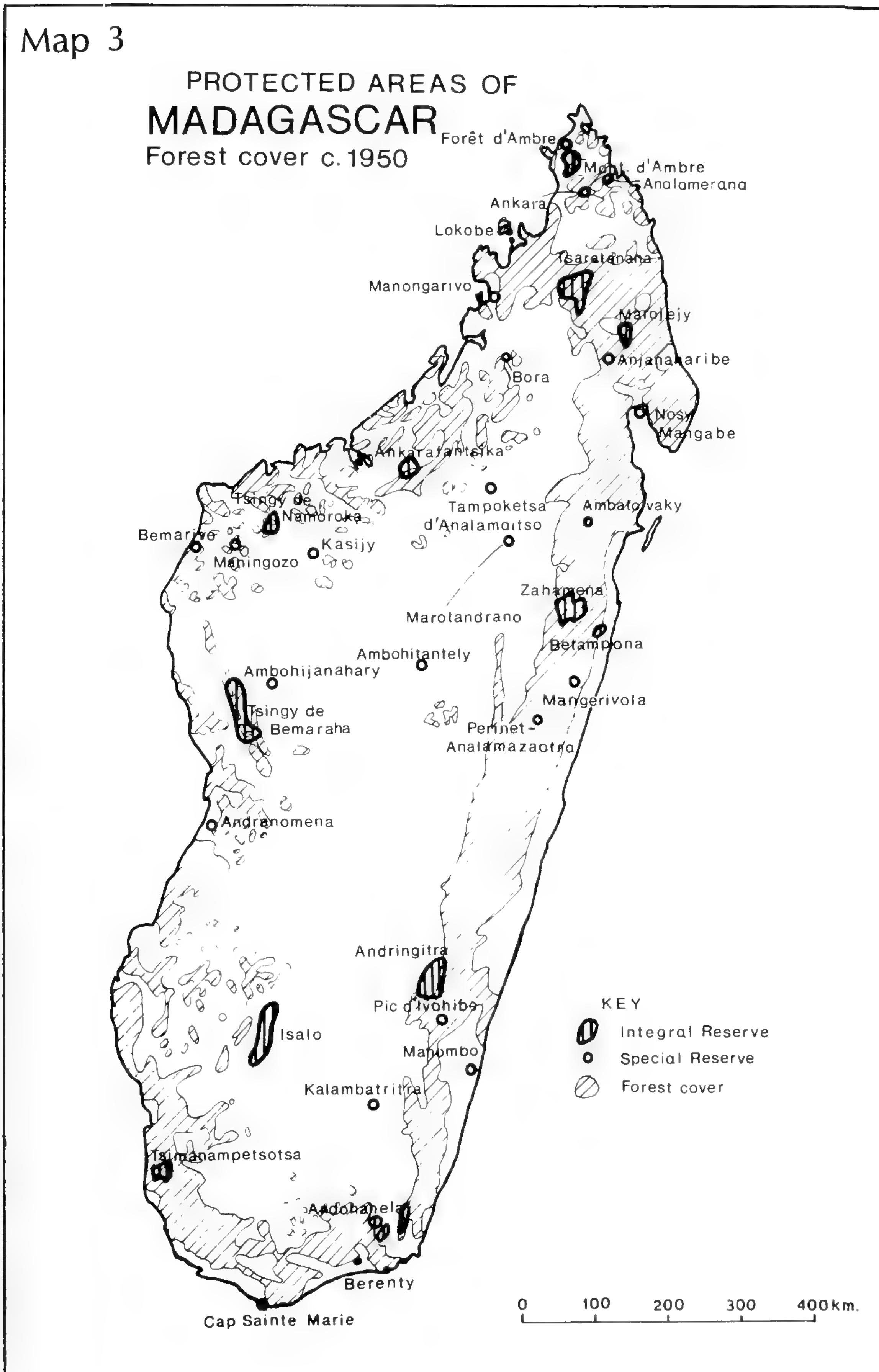
Seven of the principal port-towns of Madagascar, along with the capital and Ile Sainte-Marie, have recently changed their names; in almost all the available literature the old, French names are used. Every effort has been made in this report to use the current names, though some discrepancies may exist.

New	*Old*
Antananarivo	**Tananarive**
Antseranana	**Diégo-Suarez**
Fenoarivo Atsinanana	**Fénérive**
Mahajanga	**Majunga**
Nosy Borah	**Ile Sainte-Marie**
Taolanaro	**Fort Dauphin**
Toamasina	**Tamatave**
Toliara	**Tuléar**
Vohimarina	**Vohémar**

There is also some variation in the spelling of other place-names (e.g. Marojejy/Marojezy, Ihotry/Iotry, Sihanaka/Sianaka, Analamazoatra/Analamazaotra), though there should generally be no possibility of confusion. Finally, while the Malagasy term for 'island' has generally been spelt in the currently accepted form 'Nosy' (e.g. Nosy Bé, Nosy Mangabe), in some instances the alternative Nossi- or Nosi- has been used; again there should be no possibility of confusion.


45°E
50°E
Map 1
Antseranana
Nosy Bé
MOZAMBIQUE
15°S
CHANNEL
Maroantsetra
Mahajanga
Betsiboka
Nosy Borah
Toamasina
Antananarivo
Manambolo
Mangoro
Tsiribihina
20°S
Morondava
INDIAN OCEAN
Fianarantsoa
Mangoky
Mananara
Toliara
Onilahy
MADAGASCAR
Linta
Taolanaro
25°S
Principal towns, rivers & reefs
0
150 km


Map 2
VEGETATION OF
MADAGASCAR
after White (1983)
22b
1b
5
19c
7
77
22b
5
1b
22b
18
19c
77
18
5
1b
7
7
41
22b
11b
5
5
46
41
VEGETATION KEY
1b Evergreen Rainforest
7 Dry deciduous Forest
11b Mosaic of rainforest and secondary grass
22b Mosaic of deciduous forest and grassland
5 Moist montane forest
18 Secondary vegetion of highlands
19c Undifferentiated montane forest
41 Dry thorn scrub
46 Mosaic of thorn scrub and secondary grass
77 Mangroves
0
100
200
300
400 km.



Map 3

PROTECTED AREAS OF MADAGASCAR

Forest cover c. 1950

PART I. PHYSICAL BACKGROUND

The island of Madagascar extends from 11°57'S to 25°35'S and 43°14'E to 50°27'E in the Indian Ocean; it is separated from the African continent by the Mozambique Channel, only some 300 km wide at its narrowest point. With a north-south length of 1600 km and a maximum width of 580 km, Madagascar has a surface area of 587 000 sq km and is the fourth largest island in the world, after Greenland, New Guinea and Borneo. Relief is complex and variable though nowhere rises higher than 3000 m and climate, though also highly variable, is predominantly tropical, despite the southern part of the island extending below the Tropic of Capricorn.

I.1. GEOLOGY

Four main geological features of Madagascar have combined to produce the island's relief; these are:

i. A Precambrian basement covering the eastern two-thirds of the island (excepting some small coastal areas which are sedimentary in origin).

ii. A sedimentary region along the west coast, dating from Permian to recent.

iii. Widespread volcanic intrusions, mainly Upper Cretaceous and secondarily late-Tertiary/Quaternary.

iv. An extensive lateritic mantle, principally overlying the Precambrian basement.

i. The Precambrian basement is much folded and entirely metamorphic; it outcrops over the eastern two-thirds of the island, an area of some 400 000 sq km. Knowledge of the mineralogy and petrography of the basement is generally reckoned good, though its stratigraphy and structure are still relatively poorly understood. The basement has been divided into three 'systems', or stratigraphic subdivisions, originally based primarily on the distribution of useful minerals:

a. The Androyan system, covering some 55 000 sq km in the extreme south, characterised by intense metamorphism, a prevalent sedimentary origin, a high frequency of magnesian and calcic rocks and the widespread presence of workable deposits of phlogopite mica and thorianite. The system apparently has a very rich assembly of highly metamorphic rocks and minerals.

b. The Graphite system, which overlies the Androyan. This extends for some 250 000 sq km, or most of the Precambrian basement and nearly half the land area of Madagascar. It is characterised by the widespread presence of graphite gneiss but is very complex and is regarded as the least well known of the systems, the category acting as something of a general repository. Metamorphism is average to strong, rarely intense, though almost the entire system has been migmatised which further hampers stratigraphic study. It outcrops from sea level to 2600 m.

c. The Vohibory system. This covers a total area of around 55 000 sq km, split into relatively small areas scattered over the Graphite system. It is characterised by moderate to slight metamorphism and by the marked importance of metamorphosed basic volcanic formations.

ii. The sedimentary region consists principally of slightly folded sedimentary formations along the west coast, west of the Precambrian basement. These form a continuous zone 30-200 km wide. The oldest strata are Permian and above these are Jurassic and Cretaceous sediments of very variable facies. Much of this belongs to the continental sedimentary system known as the Karroo system (essentially equivalent to the Karroo in southern Africa), starting in the Lower Permian and continuing to the Middle Jurassic, though with many marine incursions (often forming massive reef limestones and marls). The Upper Jurassic and Cretaceous formations are largely marine.

Tertiary marine deposits outcrop in the Antseranana region in the north and then along the coast in a discontinuous strip from the Ampasindava peninsular to the Menarandra in the south. Superficial recent continental or marine deposits, sometimes very extensive, overlie much of this.

The sedimentary region does not rise over 1300 m and is generally of gentler relief than the basement area.

iii. Volcanic formations. The two main periods of volcanic activity are Upper Cretaceous and late-Tertiary/Quaternary. The most extensive volcanic formations are Upper Cretaceous, found both in the Precambrian basement and the sedimentary areas where they can be dated by their relationships to identifiable sedimentary layers; they derive from extensive basaltic flows (from fissure-type volcanic activity) and locally from sheets of rhyolitic ignimbrites. The later volcanic intrusions are of much lesser extent and are often difficult to date precisely as they occur largely in the Precambrain basement area; however they play a locally important role in relief and are discussed in I.2.iv below.

iv. Weathering residues. Most of the Precambrian basement is mantled by a layer of lateritic clays or clayey laterites (produced by chemical weathering of plutonic, metamorphic or sometimes volcanic feldspars). Strictly speaking these are soils, but they are often so thick (10-15 m, sometimes up to 60-80 m) that they play an important geological and groundwater role. Laterisation has probably been going on since the Pliocene and is one of the principal causes of the accelerated erosion which is a major environmental problem in the country.

I.2 RELIEF

The island shows an extremely varied and often rugged topography, although it does not rise above 3000 m in elevation, (the highest point, Mt. Maromokotra in the Tsaratanana Massif, is 2876 m). The main axis of the island extends in a north-north-east to south-south-west direction, with the main lines of relief along this, though there is marked asymmetry about the central axis.

The eastern coastline, which is almost straight for a large part of its length (some 650 km), gives way to a narrow but continuous coastal plain. From this an escarpment (occasionally double) rises to a plateau of between 800 and 1500 m altitude which slopes down to the north and south and has many massifs of up to 2500 m altitude rising out of it. The westward slope is much gentler, though interrupted by cliffs, with the western regions consisting of plains and plateaux with extensive delta areas.

A division can be made between the relief of the Precambrian basement and that of the sedimentary region to the west.

i. The Precambrian basement has been considerably uplifted and faulted; this and the subsequent erosion explain the great variety of landscape forms. In general the gneiss outcrops have been profoundly affected by lateritic weathering and have formed a jumble of hills on which the characteristic 'lavakas'[1] form as a result of accelerated erosion. The granites and

[1] The term 'lavaka' is applied to the most prominent accelerated erosion forms which develop in the deep laterites of the Precambrian basin; these generally have the form of fan-shaped openings or cirques in hillsides. Individual lavaka may coalesce to form compound lavaka which may be several tens of metres deep and several hundred metres wide (for further discussion see Le Bourdiec, 1972).

quartzites which are much more resistant to erosion usually form the high points of the landscape, often as rounded massifs such as Andringitra, which contains the second highest summit on Madagascar. Also important in this region are the 'tampoketsa' which are the levelled off remains of ancient erosion surfaces at high elevation, generally forming plateaux bordered by steep escarpments. The most important of these are in the north-west: at Fenoarivo, Ankazobe, Kamoro, Beveromay and Analamahitsy; these are assumed to be late-Cretaceous in origin (see below).

ii. The sedimentary region in the west contains the two main sedimentary basins on the island - Mahajanga and Morondava, one south, the other north of Cap Saint André. The region consists mainly of alternating hard and soft beds dipping gently towards the sea (normally at an angle of some 3 to 5°, occasionally decreasing to 2° and rarely exceeding 10°). Erosion has led to the formation of a landscape of cuestas. In the sandstone cuestas such as the Isalo in the south-west, the reverse (steeper) slopes tend to be dissected by a labyrinth of deep canyons or to be cut into ruiniform relief. The limestone cuestas tend to be subjected to karst processes, often leading to a highly dissected, block-like topography (as in parts of the Bemaraha and Ankarana karsts) and the presence of dolines and extensive cavern systems. There are estimated to be some 33 000 sq km of karst, the most important of these being: Bemaraha; Kelifely plateau; Ankara plateau; Sitampiky; Ankarana; Mahafaly; Mahajanga and the Narinda peninsula.

Two other factors contribute to the landscape across both regions:

iii. Erosion surfaces. The earliest of these, attributed to the late-Cretaceous, affects the Precambrian basement and has been alluded to above. Two others of importance have been identified, corresponding to the mid- and late-Tertiary. The former, below the level of the late-Cretaceous surface, is believed responsible for many of the medium-sized hills in the landscape in the central plateau, particularly around Antananarivo; it has also levelled off parts of the sedimentary cover in the west: the summit plateaux between 900 and 1000 m in the sandstone Isalo massif are thought to result from it. The late-Tertiary erosion cycle has resulted in vast pediplains in both the basin and sedimentary areas, for example north of the Androy and Mahafaly massifs in the far south, the Zomandao plain and the reverse slope of the Isalo massif. It also appears at the base of the principal basins of the central highlands, where it has been dissected into a system of small hills of 50 to 100 m relative height.

iv. Volcanic forms. These constitute many of the major massifs on the island and occur principally in the following areas:

a. In the north the massifs of Ankaizina and Tsaratanana. The latter is the highest massif on Madagascar; both areas have necks of phonolite, with relief determined by differential erosion. The Ankaizina also has trachytes and two series of recent basalt eruptions, the first heavily eroded, the second well-preserved with many small volcanic cones, some with crater lakes.

b. The Itasy and Ankaratra massifs in the central highlands around Antananarivo; these are the most extensive volcanic regions. The Itasy is a 750 sq km assemblage of cones and domes with well preserved forms, produced by volcanic emissions in a gneissic depression; most of the domes are below 1600 m, though the gneiss is often higher than this. The Ankaratra is much larger (some 4000 sq km) and can be divided into three main regions: the first, in the north-east, consists of a strong line (running NNE-SSW) of volcanos dating from the end of the Pliocene or early quaternary with compact lava (ankaratrites); several summits exceed 2400 m (the Tsiafajavona is the third highest massif on island, reaching 2643 m). The second is in the western and central southern region of the massif, consisting of old rhyolitic and trachyitic Pliocene domes on which are superimposed huge, more recent, basalt flows which have resulted in barrage lakes and waterfalls on the watercourses. The third, situated in the south and south-west of Betafo and Antsirabe, represents the most recent volcanic activity, with numerous broken cones and crater lakes.

c. The Androy in the far south consists of a stack of superimposed flows, alternating basalt and rhyolite, dating from the end of the Cretaceous; relief results from differential erosion, with the basalt eroding easily, while the rhyolites have formed a large cuesta which encircles the massif (reaching 600 m). In the centre of the massif is a table of subhorizontal rhyolites of 700 m altitude.

I.3. SOILS

As with relief, there are marked differences between the soils of the Precambrian basement and the western sedimentary region.

i. The Precambrian Basement. Over the great part of the Precambrian basement, the soils are composed of lateritic clays; these are found in both forested and savanna regions and have virtually no surface humus. Hydroxides of aluminium and iron in them are mixed with a high proportion of clay and there is little surface concretion. Studies (cited in Guilcher and Battistini, 1967) have shown that although these soils are poor, they are not absolutely infertile, though leaching has led to impoverishment of alkaline and alkaline earth elements, and of silicates. Lateritic clays are the soils currently under formation in most areas. There are also far less widespread lateritic hardpans which are Pliocene or earlier in origin; these are considerably more prone to laterisation than the recent clays.

Above 2000 m, the clays are replaced by shallow grey arenaceous soils, or in the small basins of the quartzite crests by quartz sands. In the south and south-west of the Precambrian basin are found soils particular to the region: one is a soil of the calcareous crust, especially on gneiss, where cipolines and amphibolites provide calcareous elements for the soil (these can be cultivated if adequately irrigated); the others are variable red non-lateritic soils, sometimes skeletal and leached, sometimes deep and rich. There is a very sharp dividing line between these and the characteristic lateritic clays west of the principal Anosyenne chain in the south-west of the island.

The lateritic clays, which are essentially climatic soils, are found almost entirely over the crystalline and metamorphic rocks of the Precambrian basement; far fewer lateritic soils are found on most of the recent volcanic rocks. In the Itasy and Ankaratra massifs are found mostly black soils very rich in humus; these are analagous to the chernozems found in valley bottoms in the Androy in the western sedimentary region where they are derived from basalts (the rhyolites in the higher reaches do not produce them). These are relatively rich soils, whether they are forested or denuded.

Alluvions are also found in the Precambrian basement region; their fertility is a function of their consituent elements and their age. They are mainly developed on the high plains, and those of the Ankaizina, for example, are generally rich. However the older alluvions, which are usually found at higher levels in drainage basins, have normally undergone laterisation and are consequently impoverished; this is particularly notable in the region of the Alaotra basin. The recent alluvions of the lower regions are often degraded by massive influxes of sandy elements from leaching of the lateritic clays originating in lavakas in the surrounding areas (e.g. in the Antanetibe plain in the upper Betsiboka).

All in all the soils of the Precambrian basin are of average quality for tropical soils; they are often deficient in phosphoric acids but their nitrogen content is often good. However, all these soils except the lateritic and calcareous hard-pans are highly erodable, especially the lateritic clays.

ii. The sedimentary region. There is a wide variety of soils in the western sedimentary region, though the two most notable features are the virtual absence of true lateritic clays and the very wide surface cover of a 'sand-clay carapace' (carapace does not imply hardness, but simply an overlying of the bedrocks) - this latter is a collective term which covers a considerable variety of conditions.

Although there are no true lateritic clays, there are three types of red soils: decalcified clays on calcareous rocks (terra rossa), found widely on the limestone karsts; red soils on cretaceous basalts; reddish soils of the semi-arid regions, notably silicaceous sands coloured by iron hydrates, found in the Androy region (these are not necessarily infertile).

The marls and clays of the west never laterise. They form grey soils which have essentially the same composition as the bedrock, though with a higher organic content. In the recent volcanic massifs (Nosy Bé, Mt d'Ambre) are found the same humus-rich dark soils as in the recent volcanic regions of the Precambrian basement.

The sand-clay carapace, often very thick, can be a soil or a superficial geological formation according to circumstances; it covers large areas of a variety of rocks, especially sandstones or their surrounds. It is principally found in littoral or sublittoral zones, especially in the southern part of the island, though is also found in the interior, notably south of the Mangoky river.

There are also soils of the recent alluvial plains, notably in the large western deltas.

Overall, deforestation has led to somewhat less active erosion than in the Precambrian basement. This is doubtless because of the much higher frequency of flat or nearly flat areas (especially in the immense sub-littoral plains from Cap Saint André to the extreme south, but also elsewhere) and the permeability of the sand-clay carapace and of the karst plateaux (when the latter are not covered by terra rossa). However, although lavakas tend not to form, several erosive features which may have analagous effects are found in areas of deforestation - e.g. gully erosion on the reverse slope of the Isalo cuesta, between Ranohira and Sakaraha, and hemicyclic erosion in red soils on basalt, such as on the Radama peninsula - the latter implies that deforestation may have as drastic effects on red soil basalts as on the lateritic clays.

I.4. CLIMATE

Temperature

In the lowlands the mean annual temperature is fairly uniform, though decreases from north to south, ranging from ca 27°C (Antseranana) to 23°C (Taolanaro) with mean annual range increasing from around 3°C in the north to 7.5°C in the dry south-west region. In the west this is often masked by local conditions and moderated by the Mozambique channel, a warm sea with very little circulation, and the Föhn effects of the trade winds descending from the central plateau.

Altitude has a significant effect on temperatures, with an average lapse rate of around 0.6°C for every 100 m change in level. Generally lapse rate is below average on the eastern slopes, where the high humidity damps out the temperature variations, and above in the west.

On the central plateau, mean annual temperatures usually lie between 16° and 19°C. Frost sometimes occurs above 1500 m though snow is virtually (but not completely) unknown. The mean annual range is between 5° and 6°C in the north and 7°C in the south; diurnal range is greater, being for example between 6° and 16°C in Antananarivo (1381 m., latitude 18°56'S).

Rainfall

Rainfall in Madagascar is governed by a double gradient: the annual amount decreases from east to west and from north to south, while seasonality increases in the same directions. Thus travelling westward and southward the dry season becomes longer and more marked - in the extreme south-west the climate is sahelian or semi-desert while the eastern coastal area is a subequatorial region of high rainfall and humidity throughout the year. Where seasonality is marked the dry and cool seasons are coincident (roughly June - October), making the whole island characteristically tropical in climate despite the south being below the Tropic of Capricorn.

The major factor affecting rainfall is the interaction of the south-east trade wind (the predominant wind at all seasons), produced by the Indian Ocean anticyclone, with the direction of the principal lines of relief on the island (running NNE-SSW). North and north-west 'monsoon' air currents which are a continuation of the north-east trade wind exert an important secondary effect.

Orographic ascent, along the eastern coast and escarpment, of unstable moisture-laden air carried by the south-east trade wind leads to extensive cloud formations and heavy rainfall in this region. In summer the trade wind is somewhat attenuated by the withdrawal of the Indian Ocean anticyclone to the south and east, the effect being much more marked in the north than in the south.

Above the moist convective trade wind layer there is a much drier stable air mass whose lower level is indicated by a subsidence inversion, also moving westwards. This inversion is most marked and at its lowest altitude in winter, from July to September, and at this time limits cumulus cloud formation and rainfall in areas away from the eastern coast. This combines with warming and drying Föhn effects of the trade wind descending the western slope of the plateau, to lead to generally dry and clear weather in western and southern parts in winter when the south-east trade wind dominates weather conditions.

In summer a zone of intertropical low pressure affects the island and brings with it north or north-westerly 'monsoon' air currents, which are a continuation of the north-east trade wind. These are also heavily moisture-laden and bring a large amount of rain, though their effect decreases markedly eastwards and southwards.

In winter the intensification of the Indian Ocean anticyclone and consequent south-east trade winds tends to drive the intertropical low pressure zone and monsoon air away to the north, considerably reducing the rainfall from this source.

Bioclimates

Rainfall and temperature variations combine to produce a number of 'bioclimatic regions' on the island. The boundaries between these are to some extent arbitrarily designated, though it is worth noting that in parts of the island (such as the south-east) the climate can change dramatically in character over the distance of a few kilometres.

a. On the east coast, the climate is subequatorial with rainfall exceeding 1500 mm and sometimes 3000 mm, with no ecologically dry month and high temperatures throughout the year.

b. On the eastern slopes of the plateau, the rainfall still exceeds 1500 mm with a dry season of 1 to 4 months and a mean temperature in the coldest months of between 10° and 15°C.

c. On the western slopes of the plateau the dry season is longer, up to 5 or 6 months, rainfall is likely to be less than 1500 mm, though humidity in the dry season is still high through the dominating effects of the trade wind at this time of year.

d. On the western plains, the dry season lasts 7 or 8 months in southern regions, somewhat less further north. Rainfall is around 1500 mm in the north, 500 to 1500 mm in the south.

e. In the extreme south, rainfall is sparse and highly irregular in occurrence, being stormy and very localised. Some areas may not have any precipitation for 12 to 18 months. There is an absence of detailed climatic data for this region, making characterisation particularly difficult.

These divisions correspond well with Humbert's phytogeographical divisions of the island based largely on the concept of a natural climatic plant climax community.

Cyclones

A factor of some considerable environmental importance in Madagascar is the prevalence of cyclones. Donque noted in 1972 that since 1848, 155 cyclones had hit the island, representing just under one quarter of all cyclones in that time in the south-western Indian Ocean. They occur in summer only, with the great majority between mid-January and mid-March; most hit the island along the north-eastern coast, travelling south-west and curving south-east across the island, though others hit the island from the Mozambique channel. They can cause great devastation, with winds of up to 300 km/hr and rainfall of 600 to 700 mm in four or five days, often resulting in large-scale flooding and massive destruction of crops and forests.

I.5. HYDROGRAPHY

River systems

Following Aldegheri (1972), Madagascar is divided into five hydrographic regions of very unequal size:

a. The slopes of the Montagne d'Ambre in the extreme north;
b. The slopes of the Tsaratanana Massif;
c. The eastern slopes which run into the Indian Ocean;
d. The western and north-western slopes whose waters run into the Mozambique channel;
e. The southern slopes.

a. The Montagne d'Ambre region covers only some 11 200 sq km or barely 1.8% of the land area of the island, in the extreme north. The volcanic massif is drained by narrow torrents with few tributaries running in beds littered with blocks of basalt. The major rivers are the Irodo, the Saharenana and Besokatra; the waters of the last are used to the supply the town of Antseranana.

b. The drainage area of the Tsaratanana Massif covers around 20 000 sq km; rivers are characterized by having very steep gradients (30 or 40 m/km) in the upper reaches, levelling off to only a few m/km on the coastal plains, both on the western and eastern slopes. There are four major rivers: the Mahavary (160 km long), the Sambirano (124 km) and the Maevarano (203 km) all flow into the Mozambique Channel, while the Bemarivo (140 km) flows east into the Indian Ocean.

c. The eastern slopes cover around a quarter of the land area, or ca 150 000 sq km, extending in a strip some 1200 km long and averaging 100 km wide (ranging from 50 km along Beampingaratra north of Taolanaro to 190 km at the latitude of the Ankaratra Massif).

Watercourses are comparatively short, with steep profiles. Because of the prevalence of secondary hill chains running parallel to the coast, linked by faults perpendicular to the coast, the watercourses are often many times longer than the direct distance from source to coast. The rivers meander in the narrow coastal plain and feed a chain of lagoons separated from the sea by sand dunes. These lagoons have been artificially joined along the central part of the coast to form the 400 km Canal des Pangalanes.

There are five main rivers in this region: the Mananara, Mangoro, Rianila, Maningory and Mananjary. The Mananara is the longest of these at 418 km (though the source is only 50 km from the coast) while the Mangoro is the largest in terms of size of drainage basin (17 175 sq km) and volume of water carried. The Alaotra basin (discussed in more detail below) feeds into the Maningory.

d. The western slopes cover almost 365 000 sq km or over 60% of the land area; watercourses here are divided by Aldegheri into two groups: large rivers which flood widely over the Hauts Plateaux, having roughly triangular drainage basins with the apex towards the coast; and coastal streams located between these whose sources are on the western edge of the Hauts Plateaux.

In the first group seven major basins are identified including the five largest basins in Madagascar. From north to south they are: the Sofia with a drainage basin of 27 315 sq km and major tributaries the Anjobony and the Bemarivo; the Betsiboka-Mahajamba system which covers 63 450 sq km, making it the largest basin in Madagascar; the Mahavavy, covering an area of 16 475 sq km; the Manambolo at 13 970 sq km; the Tsiribihina at 49 800 sq km; the Mangoky, the longest river on the island (821 km) with a basin of 55 750 sq km; and the Onilahy at 32 000 sq km.

The numerous small coastal rivers all have basins of less than 8000 sq km.

e. The southern slopes are divided into three parts:
- The Mandrare basin in the east, which covers some 12 570 sq km. The Mandrare River rises in the Beampingaratra Massif, running for some 270 km; it is the only Madagascan river with a longitudinal profile very close to the equilibrium profile.
- Three rivers, the Manamboro, Menarandra and Linta make up most of the Androy region in the extreme south, although here there are also several closed basins with no outlet to the sea, the largest of these being the Ampamabora bowl north of Amborombe.
- The Mahafaly plateau in the west which has virtually no surface water or rivers.

Lakes

Keiner (1963) has provided an inventory of waterbodies (lakes, lagoons and large ponds) in Madagascar of over 20 ha in extent, listing over 530. The majority of these are small (less than 100 ha), and only 18 exceed 1000 ha in area.

Of the five largest lakes, two are in the Hauts Plateaux region (Alaotra and Itasy) and three in the west (Kinkony, Tsimanampetsotsa and Ihotry).

a. Lake Alaotra is the largest lake on Madagascar; its minimum extent (i.e. during the dry season) is some 22 000 ha, though during the height of the flood an additional 35 000 ha of marsh to the south and west are entirely under water. The lake is very shallow, having a maximum depth of around 2 m during the dry season and 4 m at highest water. The lake is at 750 m altitude and is in an area which has suffered considerable deforestation and subsequent erosion; soil run-off results in the lake waters being highly turbid and brown in colour.

b. Lake Kinkony (17°09'-18°04'S, 48°15'-48°40'E), the second largest lake, covers an area of ca 10 000 ha at low water and 14 900 ha at high water; maximum recorded depth at high water is 4 m. The lake lies in the basin of the lower Mahavavy and is formed from a natural alluvial impoundment.

c. Lake Ihotry (21°50'S, 43°30'E) is a closed lake in the region of the lower Mangoky; it shows great variations in surface area, ranging from a minimum of 865 ha to around 9 400 ha. Salinity varies accordingly, being higher than that of sea water at lowest water but over ten times less than this at high water. Maximum depth is 3.8 m.

d. Lake Itasy (19°07'S, 46°45'E) is a 3500 ha lake situated in the volcanic Itasy Massif in the centre of the island; it is not strictly a crater lake, but rather a lake blocked by a lava outflow. It lies at a mean altitude of 1221 m and has a maximum depth of 6.5 m.

e. Lake Tsimanampetsotsa, situated on the edge of the Mahafaly Plateau, is a shallow, saline lake of ca 20 by 3 km (its surface area ranges from ca 1600 to 2900 ha), saturated with calcium and magnesium sulphates; in areas on the east shore freshwater rises to the surface. The lake forms part of the Reserve Naturelle Intégrale de Tsiminampetsotsa (R.N.I. No 10) (see Part VI).

Hydrology

All rivers show high discharge, often in the form of sudden violent spates during the rainy season (November to March-April) and particularly after cyclones (mostly mid-January to mid-March). Response to rainfall is usually almost instantaneous and in many areas there are daily flood peaks during the rainy season, usually at night.

In the north and east rainfall is high throughout the year and low water dishcarge is correspondingly high; water flow is thus generally abundant throughout the year. Flood waters are violent, especially on the east coast, because of the rugged relief and the direct exposure to cyclones from the Indian Ocean.

In the west a distinction can be drawn between large and small watercourses. There is very little rain in the dry season and at this time of year the volume of water in small watercourses usually decreases downstream, being gradually lost by seepage to the water table; most of these streams are thus dry in their lower reaches from April/May to November. Spate waters generally appear very suddenly and are of short duration (often only a few hours). The larger rivers, however, have catchment areas which extend over the Hauts Plateaux region; here there is usually some rain during the dry season which, combined with the relatively high retention of the predominant lateritic soils, ensures that low waters are generally well sustained, though still considerably lower than on the east coast. This effect carries over into the western region and these rivers thus continue flowing throughout the year. Dry season discharge rates are still much lower than those in the wet season, with a relative decrease from north to south as the extent and severity of the dry season increases - thus the Mangoky has specific low water discharge values about 10 times less than those of the Betsiboka some 600 km further north.

In the south, with a very marked dry season and erratic rainfall in the wet season, rivers can show very rapid spate and extreme variations in water level - Aldegheri reports a case on the Menarandra of a rise of almost 3 m in water level in under 20 minutes. During the dry season flows decrease to such an extent that few rivers carry water as far as the sea throughout the year. However there is usually an underground supply in the riverbed sand which is used by local people.

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PART II. HUMAN GEOGRAPHY

II.1. POPULATION ESTIMATES AND GROWTH RATES

The most recent population census, in 1974/75, gave a figure of 7 603 790 (Thompson, 1982). UN mid-year population estimate for 1985 is 10 012 000.

Growth rates are extremely high: the UN estimate for average growth rate over 1980-85 is 2.8% per annum, giving a population doubling time of 25 years. In 1974/75 over half the population was under 20 years old (Thompson, 1982).

In 1972 registered birth rate was 37.4/1000 and death rate 11.1/1000, though birth registration was estimated to be only 70% complete, death registration 50%, this giving real figures of 53.4/1000 and 22.2/1000 respectively.

II.2. DISTRIBUTION OF POPULATION

Regional breakdown of population is given in Table 1. The population is very largely rural; Battistini and Verin noted in 1972 that 86% of people lived in villages of fewer than 2000, only 14% of the population living in agglomerations of 2000 or over, and 8% in towns of over 20 000.

The population is very unevenly distributed over the island with population growth rates also varying regionally. Average density in 1981 was around 15 per sq km. Regions of higher population density are mainly in the central highlands and eastern coastal plain. Battistini and Verin (1972) noted that high local densities of over 50 per sq km (with patches of over 150 per sq km) (presumably outside towns), were coincident with regions of intensive rice cultivation, mainly in the central highlands: around Antananarivo (Betsimitatatra region), Antsirabe (Vakinankaratra) and in the Betsileo country around Ambositra, Ambohimahasoa and Fianarantsoa, but also on the eastern coastal plain, notably in the Farafangana, Manakara, Mananjary and Fenoarivo Atsinanana regions.

In large areas of the west and south, population densities are very low, from 2 to 5 per sq km., with the inhabitants largely pastoralists. Areas of shifting cultivation, such as much of the eastern escarpment slopes, and some rice growing areas (e.g. the Tsimihety highlands) have intermediate densities (5 to 15 per sq km).

These variations and the widely differing land-use patterns in different parts of the island lead to marked regional differences in environmental impacts and problems.

II.3. ETHNIC DIVISIONS

The origins of the Madagscan people are complex and incompletely understood, though appear to be based on successive waves of migration from both Indonesia and Africa (most importantly the former), with Arab influences from the twelfth century onwards and contact with Europeans dating from the sixteenth century. There is no evidence for human occupation earlier than 2500 years ago. There is now essentially a single, though diverse, culture and a predominantly Indonesian language of which several mutually understandable dialects exist. At present, around 20 tribes are generally recognized, though these are based more on old kingdoms than on genuine ethnic groupings. Continuous migration and increased communication in the present century, along with a marked cultural unity, has tended to break down many geographic and ethnic barriers. However strong fidelity to traditional homelands persists, and the custom of endogamy remains widespread, militating against intertribal marriage. Historical tensions still manifest themselves, in particular between the peoples of the Hauts Plateaux, especially the traditionally elite Merina, and the coastal tribes, collectively known as 'côtiers'.

TABLE 1. REGIONAL BREAKDOWN OF POPULATION (1978)

Province	Area Sq km	Population	Mean density	Chief Town	Population
Antseranana	42 725	620 228	14.5	Antseranana	48 000
Mahajanga	152 165	857 610	5.6	Mahajanga	57 500
Toamasina	72 212	1 254 639	17.4	Toamasina	59 100
Antananarivo	57 775	2 322 109	40.2 (33.3)#	Antananarivo	400 000
Fianarantsoa	100 326	1 908 465	19.0	Fianarantsoa	55 500
Toliara	162 283	1 084 083	6.7	Toliara	34 500

Figure in parentheses excludes Antananarivo.

Source: *Bulletin mensuel de Madagascar* (from 1971) continuation of the trimestrial *Bulletin de statsitique générale de Madagascar (1949-71)*, Service de Statistique Générale, Antananarivo.

TABLE 2. ETHNIC GROUPS IN MADAGASCAR (1972)

Ethnic group	Number
Merina	1 934 765
Betsimisaraka	1 106 991
Betsileo	892 352
Tsimihety	533 289
Sakalava	434 315
Antandroy	396 820
Antaisaka	377 110
Tanala	283 908
Antaimoro	255 161
Bara	250 261
Sihanaka	182 948
Antanosy	172 797
Mahafaly	120 620
Antaifasy	88 899
Makoa	80 069
Bezanozano	56 588
Antakarana	44 852
Antambahoaka	29 481
Other Madagascans	80 245

Source: Area Handbook for the Malagasy Republic (1973).

Merina Inhabit the central highlands around Antananarivo, the city being 95% Merina; the region itself is called Imerina. The tribe is divided into three castes: Andriana (Nobles), Hova (Free-men), Andevo (descendants of former slaves). There is much rice cultivation by irrigation. The Merina formed the last and most powerful of the Madagascan kingdoms, which by the nineteenth century controlled most of the island; they were the first tribe to develop any skill in architecture and metallurgy and were the first to use a metal bladed 'angady', the long-handled Malagasy spade which is still the principal agricultural tool.

Betsimisaraka The second largest tribe, living on the east coast in the Toamasina - Antalaha region. Some practice slash-and-burn cultivation on hillsides, growing mountain rice and maize, others practice irrigated high-density rice cultivation in scattered patches, often at the mouths of the principal rivers; there is also large scale production of cash crops, in particular coffee. The inhabitants of Nosy Borah (Ile Ste Marie) are sometimes considered Betsimisaraka.

Betsileo Centred in the south of the Hauts Plateaux around Fianarantsoa but about 150 000 live in the Betsiboka in the north-west (Mahajanga province). Much rice growing, often on hillside terraces, and some scanty pastureland.

Tsimihety Descendants of the Sihanaka, inhabiting the north-central area, spreading west. Generally rice-growers, though they live in a region of low population density, with extensive thinly populated grazing lands between rice growing areas. Cattle are of very great social importance.

Sakalava Occur in the west between Toliara and Mahajanga. The Sakalava were the first important Madagascan kingdom, founded at the end of the sixteenth century, but were largely conquered by the Merina in the nineteenth century. Essentially cattle raisers, with large herds grazing over enormous areas. Dry crops occupy a small amount of land around the villages. Near some of the rivers through the area there are considerable rice-growing areas, though these are apparently mainly the work of the Betsileo and Antaisaka immigrants south of Cap Saint-André, and the Betsileo and Merina on the lower Betsiboka. 60 000 inhabitants of the Mangoky delta, sometimes called 'Masikoro' are generally included in the Sakalava; the Veza fishermen (qv) are also sometimes considered Sakalava.

Antandroy Nomadic, living in the arid south around Ambovombe. Dark skinned, different from other tribes. Primarily pastoral. Very little rice is grown, mostly millet, maize, cassava and beans.

Antaisaka An offshoot of the Sakalava tribe, though now largely of mixed descent (e.g. with Bara and Tanala elements), centred south of Farafangana on the south-east coast. The poverty of the region and the high population growth rate has led to much migration, both seasonal and permanent. By 1970 nearly 40% of Antaisaka lived outside their homeland. They principally cultivate coffee, bananas and rice.

Antaimoro Live in the south-east around Vohipeno and Manakara. They are of Islamic extraction and, unusually, have written records dating back to 1335, when they arrived on the island, they being one of the most recent peoples to arrive. Principally rice-growers.

Bara Nomadic cattle-raisers, originating in the south-west near Toliara, they now live in the south-central area around Ihosy and Betroka.

Tanala Forest people living inland from Manakara, occupying about half of the eastern mountain escarpment. They practice slash-and-burn but are also skilled hunters, gatherers and woodsmen. Increasingly, improved cultivation methods have been adopted, especially in the growing of coffee and the irrigation of rice.

Sihanaka Inhabit the central plateau region north-east of the Merina, in the region around Lake Alaotra. They have much in common with the Merina and live principally by fishing, growing rice and raising poultry; they inhabit one of the best regions for agricultural development, with large scale rice growing projects taking place around Lake Alaotra.

Antanosy Live around Taolanaro in the south-east and are principally rice-cultivators.

Mahafaly Inhabit the extreme south-west. Here, along the coastal strip, there are densely populated rural regions where almost all the land, especially that on the Karimolian dune sands, is occupied by contiguous plots of land ('vala') enclosed by aloe hedges; in these dry land crops such as manioc, sorghum, sweet potato and beans are grown. No rice is cultivated. Cattle raising is of secondary importance and is carried out inland on the crystalline pediplain in the north of the Mahafaly region.

Antaifasy Live in the south-east around Farafangana; they cultivate rice and also practice fishing in lakes and rivers.

Makoa Originally spread along the north-west coast, many have now moved south to the area of the Onilahy River. They are believed to be descended from African slaves and are the only true negroid peoples on the island.

Antankarana An offshoot of the Sakalava dynasty, now a heterogenous group of mixed Sakalava, Betsimisaraka and Arab ancestry living in the north-west around Antseranana; mainly cattle raisers, they also grow dryland crops such as maize, rice and cassava.

Bazanozano One of the first tribes to arrive, these live between the Betsimisaraka lowlands and the Merina highlands. They are predominantly herders and woodsmen, though they also grow some rice.

Antambahoaka The smallest tribe, they are rice cultivators who live around Mananjary on the south-east coast. These are of the same Islamic descent as the Antaimora.

Also recognized are:

> **Vezo** A clan of the Sakalava living in the west from Morondava to Faux Cap; they live by fishing and do not cultivate rice.
>
> **Zafimaniry** Live in ca 100 villages between the Betsileo and Tanala, are descended from high plateau people who migrated to the region early in the nineteenth century.
>
> **Mikea** These are hunter-gatherers whose existence as a separate ethnic entity has been questioned. They are found in the south-west, in the Mikea forest between Manombo and Morombe north of Toliary where they live in very tight groups of up to 15, having no contact with other tribes. Battistini and Verin aver that these people are Sakalava-Masikoro, also stating that on the Mahafaly plateau south of the Onilahy river there are Mahafaly with a 'Mikea' lifestyle.
>
> **'St Marians'** Live on Nosy Borah (formerly the Ile Sainte Marie) off the east coast; the population is mixed though originally Indonesian, later influenced by Arabs and pirates. The island was ceded to the French in 1750 and became the first enduring French settlement.

II.4. AGRICULTURE

Agriculture is by far the most important activity on the island and the great majority (over 80%) of the population are either pastoralists or farmers. Agriculture supplies most of the raw materials for industry, ca 80% of revenues, and 34% of G.N.P. In common with almost all other countries, however, the proportion of the population engaged in agriculture is declining - FAO quote estimates of 89.4% in 1970, 83.7% in 1980 and 80.1% in 1984.

Cultivation is the dominant form of agriculture and provides most of the national diet as well as the bulk of exports; stockraising is the chief activity in parts of the southern and western regions but is of more limited economic importance because of its low productivity.

In 1972 it was estimated that 56.6% of crop production and 73% of livestock production was for subsistence consumption, with some 80% of the nation's farmers engaged primarily in subsistence production, though most sold some portion of their crop for cash.

Agriculture on the island is characterized by a high diversity of production, made possible by the wide range of climatic and edaphic conditions. It is however beset with problems at present, brought about partly by this very diversity of conditions, and also by the fragmentation and dispersal of arable land, the distance between producing areas and internal and external markets, low monetary return to farmers, lack of modern techniques and capital, and the vagaries of a tropical climate, prone to cyclones and drought.

Rural communications are a severe problem, with only some 6300 km of road motorable throughout the year out of a total of around 40 000 km, much of which is dry-season tracks and trails. Food output has increased to some extent since the mid 1970s, but has been outstripped by the population increase, and with general stagnation of agricultural production in the 1970s, farmers have given more attention to feeding their families than to export crops or agro-industry. Rapid population growth, particularly in the Hauts Plateaux region, coupled with lack of adequate fertilizers has led to unsustainable crop rotation and soil degradation. Irrigation networks have not been maintained. Information is lacking and responsibility for agriculture is dispersed between various ministries and para-statal organizations.

The 1978-79 development plan allocated 55 400 million F.M.G. to agricultural development. This had limited success for a variety of reasons, including delay in redistribution of requisitioned land, insecurity of rural regions (increase in cattle thefts), failure to eradicate share-cropping, and the relatively disappointing performance of the rural Fokonolona co-operative societies as vehicles for participation in and promotion of rural revival. Climatic conditions were also particularly difficult in the early 1980s, with four cyclones in January 1982, following a long period of drought which had itself depressed agricultural production, and a further four cyclones in early 1984 which destroyed an estimated 40 000 ha of rice-fields, mainly in the provinces of Toliara and Fianarantsoa.

A document on agricultural policy circulated in February 1983 outlined many of the prevailing difficulties and proposed solutions, emphasising particularly the ironing out of structural and organizational problems and aiming in the short term at the rehabilitation of the existing farm economy. Agrarian reform, an essentially political issue complicated by centuries of tradition, will aim at settling under-used land, ensuring a minimum of viability on small farms (average holding is 1-1.5 ha) and usefully channelling internal emigration. Mechanization was to take second place to the encouragement of artisanal techniques and the better use of traditional hand-tools.

Consequent on this, a three-year plan for the agricultural sector announced in June 1984 laid most emphasis on restoring and developing the island's rice production with the aim of restoring self-sufficiency in rice by 1988. Other areas emphasised were livestock, tree-planting and fisheries.

Land use and farm structure

In 1972, some 5 000 000 ha or 9% of the total land area was considered to be suitable for cultivation without extensive reclamation measures, though other estimates put the extent of arable land at as much as 15% of the land area. FAO estimates for 1982 gave some 3 011 000 ha as under cultivation or fallow, a small increase over a 1968 estimate of 3 000 000 ha.

In 1965 land use (of cultivable land) was estimated as: 35% fallow; 25% under irrigated crops (mainly rice, also sugar and cotton); 10% under tree crops (e.g. coffee, cloves); 30% planted to dryland crops (e.g. mountain-rice, cassava, maize, groundnuts, sisal and tobacco).

Trees were grown primarily in the east and north, irrigated crops in the Hauts Plateaux and river basins of the west; dryland crops were more evenly distributed, accounting for around 37% of cultivated areas in the east, 46% in the Hauts Plateaux, 53% in the north and 58% in the west.

In 1971 there were estimated to be around 940 000 farms on the island. The great majority of these were small private (family) holdings, the average size having been estimated at from 1 ha, excluding forest and right of way, to 1.7 ha in all. This size does not appear to vary much from region to region. Only 3% of holdings exceed 4 ha.

Most family holdings were divided into a number of separate fields or plots (e.g. rice paddy, kitchen garden and field for dryland crops). Pastureland is usually communal.

Crop Production

Crop production, derived from FAO figures, is given in Table 3. Crops grown principally as cash crops include: coffee, cloves, vanilla, sugar, groundnuts, cotton, soya, coconut (for copra), sisal, tobacco, and cocoa; the remainder are apparently mainly grown for subsistence consumption.. Of cash crops, coffee accounted for 35% (in value) of all exports in 1981, cloves 23% and vanilla 8.8%.

a. Rice is the single most important crop and is the dietary mainstay of the Madagascan people. Average yearly consumption per head was put at ca 135 kg in 1972 (thus ranking as the world's fifth largest per capita consumer). Rice was originally a prestige food, its use has now spread throughout the island, replacing in most areas the traditional diet of cassava and other tubers. Only the people of the south (e.g. Antanosy, Antandroy) still feed mainly on these, and in 1972 it was noted that rice was increasing in popularity even here.

Rice is grown on around 1 million ha and accounts for 40 to 50% of the total annual value of the island's agricultural produce. Annual production up to 1982 (when severe flooding had a disastrous effect) was more or less static at just over 2 million tonnes despite the considerable governmental efforts to improve rice production in the 'fight for rice'; moreover a decreasing proportion of the crop was reaching the open market: normally some 88% is retained by the growers for domestic consumption, but this had increased to perhaps 96%, as a result of increasing population pressure and the deterioration of both irrigation systems and trade and transportation networks in most areas. A 27% price rise imposed by the government in 1982 appears to have helped alleviate this. Up to 1972 Madagascar was a net exporter of rice, by 1982 the country had to import 15% of its needs. The 1981 import of 170 000 tonnes absorbed 8.5% of the country's revenues.

In 1965 an estimated 85% of riceland was in irrigated paddies ('tanim-bary'), the remaining 15% was rain fed ('horaka') or cultivated by the 'tavy' method of slash-and-burn. About half of the country's irrigated rice production was in the Hauts Plateaux including the Alaotra basin, this last area is the site of a massive agricultural development project for rice cultivation.

In the early 1960s four sub-prefectures produced a substantial amount of rice surplus to their needs. Three of these were in the Hauts Plateaux: two in the Alaotra basin and one on the Antananarivo plain. The fourth was on the swampy Marovoay plain along the Betsiboka River on the western coast, an area where a modern agricultural station and a large-scale French private firm had been promoting the cultivation of high quality rice varieties for export to France and Mauritius. At this time the densely populated Imerina and Betsileo regions of the highlands tended to be in overall balance of rice production and consumption, though by the early 1970s the situation had already started to deteriorate. Other areas roughly in balance were largely those with a relatively low population density or a strong production of export crops, such as the north-central region and the sedimentary riverain areas of the western coast.

Yields are generally very low compared with other countries - the average for the country in 1970 was a mere 1.7 tonnes per ha, with rain-fed rice producing around 1.2 tonnes and tavy

TABLE 3. PRINCIPAL CROPS ('000 tonnes)

Year	1974-76	1982	1983	1984
Rice	2009	1970	2147	2132
Cassava	1321	1898	1992	2047
Sugar cane	1412	1409	1621	1660
Sweet Potatoes	340	356	463	463
Potatoes	124	201	253	264
Bananas	423	281	286	224
Mangoes	194	160 F	160 F	170 F
Maize	125	113	132	141
Taro	82	78	85	93
Coconuts	32	80	80	82
Oranges	77	80	81	81
Green coffee	81	81	81	81
Pulses	71	55	58	57
Pineapple	56	50	50	50
Beans (dry)	62	41	45	44 F
Ground nuts (+ shell)	45	32	31	32
Cottonseed	22	16	16	20
Sisal	29	18	19	20
Avocados	18	13 F	13 F	14 F
Cotton (lint)	11	10	10	12
Copra	4	11	10	10
Cocoa	4	6	6	6 F
Palm kernels	+	5	5	5
Cashew	3	4	4	4
Tobacco	4	3	2	3
Palm oil	2 F	3 F	3 F	3 F
Castor beans	1	1 F	1 F	1 F

Figures for cloves, vanilla and pepper have not been located for these years.

F = FAO estimates

Source: FAO Production Yearbook 1984.

method 1.5 tonnes. Even irrigated paddies produced results far below those obtained elsewhere - in the Antananarivo district in 1970, the average yield was 4.2 tonnes per ha, though some producers were obtaining 5-7 tonnes per ha in fields of 1 to 2 has, while in the large-scale mechanized Alaotra project up to 7.4 tonnes per ha had been obtained by the mid-1960s. This compares with Japanese yields at that time of 50 to 60 tonnes per ha on 1 to 2 ha fields.

Attempts to increase rice production have been a major thrust of the government's agricultural policy for many years and have centred on both increasing production (through increasing yields and the area under cultivation) and improving net distribution, especially to town dwellers; these have however met with only limited success.

Official measures include forming state companies (SINPA) to collect rice for milling and marketing (1973), issuing ration cards for rice and controlling sale and price to consumers (1975), inducing change from rice to wheat in diet (1976), creating more farmer's co-operatives (1977), improving irrigation over 20 000 ha by building 1500 small dams (1978), decreasing consumption with one riceless day per week (1979-1980) and increasing price to paddy producers by 17% (1981), and again by 27% in 1982.

The effectiveness of these measures has been variable, though in general the campaign has had limited success. This has been ascribed to a number of causes, including drought, especially in the south, problems in the running of SINPA, and changing food habits of the Malagasy, with rice becoming ever more popular. Efforts to eliminate middle-men and usurers have reportedly been relatively successful, though the effects of this do not appear to have been completely beneficial - in large measure the state companies which have replaced them (SINPA) have run into serious financial and managerial problems. Although farmers may have previously been exploited by the traditional middlemen, these people also brought goods into the villages, maintaining internal trade circuits. There are now virtually no consumer goods, and incentive to sell produce and increase output beyond the needs of the producer's family is correspondingly low.

From 1975 to around 1982, only 25 000 ha of new rice fields were under cultivation, the goal of the government for one million new hectares between 1978 and 2040 was already falling behind. However the 1983 and 1984 harvests were considerably higher than the 1982, being 2147 and 2132 million tonnes respectively, compared with 1723 million tonnes in 1982; improvements such as the construction of dozens of small dams each year are thus having an effect. Increasing yield has been gained by increasing the area under cultivation rather than yield per hectare, which decreased from 1983 to 1984 and is still below that achieved in the period 1974-76. A Swiss backed campaign against pests (grain borers) has begun in the important rice-growing area of Lake Alaotra which could increase yields there by about 500 kilos per ha.

b. Cassava (manioc). In 1972 this was stated to be the second food crop after rice in terms of area planted and probably in quantity consumed, though it rated low in consumer preference. FAO production figures for 1980 note an unofficial yield estimate of 1 450 000 tonnes, placing it third after rice and sugar cane. This represents around a fourfold increase over estimated total production in 1962 of 327 000 tonnes, though this may be accounted for by a change in type of estimate i.e. from consumption to production (see below). However Thompson and Adloff quoted a figure of 800 000 tonnes harvested in 1961 from 202 600 ha.

In the 1960s it was grown in every part of the island except the interior grazing lands of the west and the uncultivable mountain ranges of the east. Production was greatest in the far south, where it was a staple of subsistence consumption, and around Lake Alaotra and the Sambirano River, where it was grown for industrial processing into tapioca, starch and flour at the chief processing centres in the provinces of Antananarivo, Mahajanga and Toamasina. Exports were declining and not considered to have much potential, and were apparently insignificant by 1980.

In 1962, some 100 000 tonnes out of total production of 327 000 tonnes were fed to livestock, especially in the Hauts Plateaux, where it was often used as fodder for penned cattle. Elsewhere it was likely to be used primarily as a reserve against famine, so that potential resources in cassava in an average year were thought to be about double the amount actually consumed for subsistence or marketed. Often plots would be left unharvested as a sort of domestic larder, either because commercial demand and price were too low in the locality or because subsistence consumption was directed by preference to rice and vegetables - often for both reasons.

In 1972 it was stated that no increase in the area of cassava was recommended, instead better utilization of areas already planted was advocated.

c. Other tubers. Sweet potatoes, potatoes and taro are produced in large quantities (see Table 3); the increase in production of these, and maize, has partially compensated for the short-fall in rice production, although rice remains the greatly preferred foodstuff. Wild roots and tubers are also harvested, although no reliable figures for consumption are available.

d. Coffee is the single most important Madagascan export and is grown along the east coast and in the north-west (in the lower Sambirano region and on Nosy Bé). In 1983 it was reported to cover an area of around 220 000 ha along the east coast and its production is said to involve about 25% of the island's population. Production has been relatively stable at around 80 000 tonnes per annum, though is noted to have peaked in 1979 at 81 000 tonnes and to have declined since. Most of the bushes are now well past their best and the government launched a scheme 'Operation Café arabica' in 1979 to replace them, improve cultivation techniques and increase the price paid to producers; although this has resulted in the planting of some 425 000 new coffee bushes in 1981 and an increase in price to the growers of around 50% since 1979, it is still said to be behind schedule. Under IMF terms the government is currently committed to exporting 60 000 tonnes of coffee a year. Collection from outlying areas has been hampered by the deterioration of the secondary road network.

e. Vanilla is grown mainly in the north-east, also in the north-west. Thompson and Adloff (1965) quote a figure of 5000 ha planted to the crop, with 4700 ha of this in the region of Antseranana. Madagascan vanilla accounts for 90% of the world's sales of that commodity, in 1983 apparently all to USA; however it faces strong competition from synthetic subsitutes. Production fell during the 1970s partly because of poor plantation maintenance, from around 8000 to 2000 tonnes per annum. Prices to the producer were more than doubled between 1979 and 1982 and output was reportedly increasing again.

f. Cloves are reportedly grown almost exclusively on the eastern coastal plain, on Nosy Borah and around Fenoarivo Atsinanana; in 1965 the crop was said to cover around 35 000 ha. Clove production follows a 3-4 year cycle which was reportedly at a low in 1983. Production decreased from 11 000 tonnes in 1979 to 8000 in 1980 (presumably this could be part of natural cycle), as did the Malagasy share in a joint marketing venture with Tanzania, started in 1977. All exports are apparently to Malaysia. However it was noted that the area under cultivation had been steadily increasing and producer prices raised, which could give good results in 1985/1986.

g. Sugar is grown on four government estates and many small-holdings; production in 1981 was estimated at 1.4 million tonnes. However yields from the small-holdings are low and mostly go into rum, with production of refined sugar having reportedly declined. A few thousand tonnes are exported.

h. Cotton is grown for local processing; in 1967 it was noted that important areas of cotton existed in the region of Toliara in the deltas of the Fiheranana and Mangoky Rivers and around Ankazoabo. It was hit by drought in 1980, with yields of seed cotton dropping from around 35 000 tonnes in 1979 to 25 000 tonnes in 1980; by 1983 production had recovered to around 30 000 tonnes and producer prices have doubled over the past few years.

i. Sisal is grown principally in the arid regions of the south and south-west (together producing four fifths of the country's total), but also around Antseranana and on the lower Betsiboka. Areas conceded to sisal companies in 1960 covered 25 000 ha of which 16 000 ha had been planted to the crop. Production of sisal in 1965 was given as 24 300 tonnes while estimates for 1979-80 were 22 000 tonnes per annum; production of this long-established crop has thus remained relatively stable. It was noted in 1967 that international competition made export difficult.

j. Oil crops. Groundnut production has decreased, but the government was reported in 1983 as encouraging soya bean planting (on 70 000 ha) and copra from coconuts (3000 ha) and groundnuts (60 000 ha) and had plans to build another oil-mill.

k. Tobacco. Production has remained relatively stable and stood at around 4000 tonnes in 1981.

Livestock

Estimates for livestock numbers and products are given in Tables 4 and 5.

a. Cattle are by far the most important form of livestock and traditionally there is one head of cattle per person in Madagascar. In 1981 the registered herd numbered 7.3 million; estimates of the true number vary widely, though it is almost certainly higher than this (as reflected in FAO estimates quoted above). The principal cattle producing areas are the provinces of Toliara and Mahajanga in the west and the prefectures of Alaotra, in the Hauts Plateaux, and Vohimarina in the north-east. These areas in total hold some 2/3 of the national herd, and in 1972 had a reported surplus production of 11-13%. Cattle tend to be valued more in social than in economic terms and official slaughtering was only 2.5% of the herd in 1981. In principle, cattle in the traditional pasturage areas of the south and west are only slaughtered on ceremonial occasions; however, such occasions are frequent enough that meat consumption is high - in 1972 per capita consumption of beef in such areas reportedly averaged 66 pounds (30 kg) each year.

Most of the Hauts Plateaux and eastern region constitutes an area of net cattle consumption, with 8-12% (in 1972) of the herd being imported from cattle producing regions. Some meat is also exported. Overall, however, 75% of total output (in 1972) was consumed as subsistence, with only 25% entering the money exchange economy. Money from sales tends to go into replacing the herds; the livestock sector is thus something of a closed circle economically. In 1982 less than 20% of the current export quota was being met and a recent study showed that the country may need to import by 1985. Supply was not a problem but commercial networks - rounding-up, slaughtering, veterinary care and transport - posed organizational difficulties which raised costs above prices.

In 1972, cattle taxes were abolished as an encouragement to stock-raising, yet the need to pay such taxes had obliged farmers to sell some cattle and thereby kept something of a monetary circuit going. Government policy is now tending towards the suppression of agricultural subsidies. Permits to move cattle across country may also soon require payment. Vaccination has been free, but may now be charged to farmers, although in 1982 the World Bank, FAO and the Madagascan Government began joint financing of an immunization campaign and other measures in Mahajanga province to improve stock-rearing and increase the income of the estimated 120 000 herders in the province. The country is looking for export markets and hopes to sell meat this year to the EEC, North Africa and within the Indian Ocean.

Cattle are generally free-roaming and subject to minimal husbandry; the burning off of pasture to provide new growth for grazing during the start of the dry season is probably the major cause of deforestation in western regions (see Part III.4.).

b. Pigs can be raised in all parts of the island; however, Thompson and Adloff noted in 1965 that commercial hog-raising was widespread only in the Hauts Plateaux region, one of the principal reasons for this being that pigs and pork were 'fady' (taboo) for many of the coastal

TABLE 4. LIVESTOCK ('000 HEAD)

Year	1974-76	1982	1983	1984
Cattle	8543	10 281	10 322	10 400 F
Goats	1308	1730	1750 F	1800 F
Pigs	607	1240	1300 F	1350 F
Sheep	632	740	630 F	700 F
Chickens	13 000	18 000	18 000	18 000
Ducks	2000	4000 F	5000 F	5000 F
Turkeys	1000	3000 F	3000 F	3000 F

F = FAO estimates

TABLE 5. LIVESTOCK PRODUCTS (TONNES)[1]

Year	1974-76	1982	1983	1984
Beef and veal	108	135	136	138
Poultry meat	36	63	66	70
Pigmeat	23	31	32	34
Goat meat	3	9	9	9
Mutton and lamb	2	2	2	2
Milk (whole, fresh)	30	39	41	43
Hen eggs#	9808	13967	14164	14360
Eggs (excl. hens)#	3012	4320	4500	4680
Honey	11	4 F	4	4
Silk (raw and waste)	15	15 F	15	15

[1] All figures for 1982-84 are FAO estimates

Number of eggs ('000).

Source: FAO Production Yearbook 1984.

tribes, including any with Arabic influence. FAO estimate that pigmeat production increased by just under 50% from 1974 to 1984 (Table 5).

c. Sheep. In the early 1960s the only important area of sheep production was in the Androy region in the extreme south-west, although other areas were climatically suitable and the Hauts Plateaux region had previously supported significant numbers of sheep. As with pigs, sheep were considered 'fady' by several of the coastal tribes. According to FAO estimates (see Table 4), the number of sheep decreased in the period 1982-84, although the 1984 estimate showed a 10% increase over the 1974-76 population.

d. Goats increased in number from 1974 to 1984 at approximately the same rate as pigs. Thompson and Adloff (1965) noted that these were found very largely on the west coast and, like sheep, mostly in the extreme south-west, despite large areas of the rest of the island being climatically suitable for rearing them.

e. Poultry, especially chickens, are ubiquitous and provide an important source of protein, both as eggs and as meat.

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PART III. FLORA, VEGETATION AND FOREST COVER

III.1. FLORA

Diversity

i. Estimates of the size of Madagascar's flora vary between 7370 and 12 000 species. The lower figure is that of Perrier de la Bathie (1936) and includes Pteridophytes; it is almost certainly too low. Largely due to research for the *Flore de Madagascar et des Comores* (Humbert, 1936-), the flora is much better known now, and more recent estimates give the figure as much higher: 8200 species (Leroy, 1978; Raven, 1985); 8500 vascular plants known (White, 1983); 10-12 000 species, (though this may include Pteridophytes) (Guillaumet and Mangenot, 1975); 10 000 Angiosperms (Rauh, 1979), also quoted in White (1983); 12 000 species (Guillaumet, 1984). Greater credence is given to the lower of these figures since they seem to be the only ones based on the known flora rather than on estimates.

Lebrun (1960) gave Madagascar an area-richness index of 5.4, which he based on the figure of 7800 from Humbert (1959). Even so, this high area-richness figure is close to that of the south-west cape of Africa with an area-richness index of 5.6. The latter area has been described as one of the richest areas botanically in the world. If the true number of species in Madagascar is 10-12 000, then the area-richness index should be nearer 8, which could perhaps make it unequalled (Guillaumet and Mangenot, 1975).

Figures for the numbers of genera and families in the flora show rather less variation: Perrier de la Bathie (1936) gives 1289 genera and 191 families; Guillaumet (1984) gives 1600 genera in 180 families; Leroy (1978) gives over 160 families; White (1983) gives 1200 genera.

ii. The distribution of the flora between the two main regions of the island is as follows, based on the figures of Perrier de la Bathie (1936) and Humbert (1959), and quoted in Koechlin (1972): in the Eastern Region there are 500 genera and 5500 species; White (1983) gives 1000 genera and 6100 species in this region; in the Western Region there are 200 genera and 1800 species; White (1983) gives 700 genera and 2400 species in this region. 600 species are common to both regions. 605 species of the total are introduced and naturalized, and 945 species are native but non-endemic; the rest are endemic.

iii. The biology of the introduced species is strikingly different from that of the native species (Dejardin *et al.*, 1973; Leroy, 1978): 53% of naturalized species are annuals, as against only 3% of the indigenous flora. Remarkably, 83% of the introduced flora is herbaceous, and has largely not penetrated the primary forest, but keeps to the secondary, man-modified formations. Of the indigenous species, more than 80% are woodland plants.

Endemism

i. Endemic families. Out of 191 families, White (1983) identifies eight as endemic: Asteropeiaceae (1 genus, 5-6 species); Didiereaceae (4 genera, 11 species); Didymelaceae (1 genus, 2•species); Diegodendraceae (monotypic); Geosiridaceae (monotypic); Humbertiaceae (monotypic); Sphaerosepalaceae (Rhopalocarpaceae) (2 genera, 14 species); Sarcolaenaceae (Chlaenaceae) (10 genera, 35 species). Guillaumet (1984) gives "6 or 7" endemic families. Perrier de la Bathie originally listed three as endemic: Rhopalocarpaceae, Chlaenaceae and Didiereaceae.

The endemic Didiereaceae is ecologically the most important family on the island, forming the most striking feature of the spiny desert in the south and south-west. Certain of the species resemble the American Fouquieriaceae in habit, and the family is reputed to have strong affinities with the Cactaceae (Rauh and Reznik, 1961).

ii. Endemic genera. Of the 1289 genera to which Perrier de la Bathie (1936) refers, 238 (20%) are endemic . These figures are also quoted in White (1983).

iii. Endemic species. Out of the whole flora, Perrier de la Bathie gives a figure of 5820 species (86%) as strictly endemic. Humbert (1959) gives the figure 6400 or 81% of his known 7800 species. Raven (in press) estimates that 4500-5000 species (55-61%) are endemic. Guillaumet (1984) says 85% of his 12 000 species are endemic.

Endemism is most marked in woodland and forest formations where an estimated 89% of species are endemic (Perrier de la Bathie, 1936). Other figures are: rocky outcrops, 82% specific endemism; marsh, 56%; littoral formations, 21%.

Percentages of specific endemism are given for different biological types: trees, 94%; shrubs, 94%; perennial grasses, 85%; annual grasses, 58%.

iv. Area based endemism. Area based endemism (generic/specific) is as follows (figures from Perrier de la Bathie, 1936): South Domain: 48% and 95%; West Domain: 41% and 90%; East Domain: 37% and 90%; Sambirano Domain: 23% and 89%; Centre Domain: 21% and 89%. At the regional level, endemism is more pronounced in the Western Region, with 38% generic and 89% specific endemism; White (1983) gives 20% generic and 79% specific endemism. In the Eastern Region Perrier de la Bathie (1936) gives 22% generic and 82% specific endemism; White (1983) gives 16% generic and 79% specific endemism. Of the species which are common to both, there is 9% generic and 47% specific endemism.

Affinities of the flora

On the basis of his species counts, and his knowledge of the Madagascan flora and that of the rest of the world, Perrier de la Bathie (1936) quantified the relationships between the Madagascan and other floras of the world . These figures are widely quoted (Dejardin *et al.*, 1973; Koechlin, 1972; Koechlin *et al.*, 1974; Leroy, 1978) although there seems to have been some guesswork in their origin.

Around 27% of the Madagascan flora is estimated to have African affinities; the pantropical element is around 42%; the Oriental element 7%; the austral element accounts for 3%, and the recent element whose transport is due to long distance dispersal 15%. The remaining 6% represents the true endemic element. In addition to these, Dejardin *et al.* (1973) recognise the existence of a neotropical element, and also a paleotropical one. They also unite Perrier de la Bathie's recent and exotic elements.

Exactly what these figures represent is unclear, but phytogeographers often quantify foreign elements as the number of species in the flora belonging to genera which also occur in the relevant foreign countries or areas.

i. All cosmopolitan and pantropical families of both Pteridophytes and Angiosperms are represented in Madagascar (Dejardin *et al.*, 1973), and account for a large proportion of the flora. In contrast, Gymnosperms are represented only by the genus *Podocarpus*. Most of the species are ruderals, or weedy plants of grassland, borders and clearings, or are hydrophytes.

ii. The African element is related to the Sudano-Zambesian flora of eastern and southern Africa rather than the Guineo-Congolian flora of the west; notable examples include the genus *Coffea*, which is represented in Africa by 15-20 species, and in Madagascar by about 50 species (Guillaumet and Mangenot, 1975). Among bryoflora, the family Rutenbergiaceae is striking, being found in Madagascar and the Mascarenes, and also on the old crystalline mountains of Tanzania (Pocs, 1975). Leroy summarises the African element in some detail, dividing it into seven broad types, and citing numerous examples.

iii. The Oriental element is much less important than the African element, accounting for 7% of the flora including (following Dejardin *et al.*,) some seven families and two subfamilies (Dejardin *et al.*, 1973). Notable generic examples (out of some 50 cited) include *Nepenthes* and *Pandanus*. The former has its centre of diversity in Borneo and Sumatra and eastern limit in New Caledonia; there is one endemic species in Sri Lanka, one in the Seychelles and two in Madagascar, (*N. madagascariensis* plus one undescribed from Cape Masoala) (Dejardin *et al.*, 1973). *Pandanus* is distributed in all the floras of the tropical Old World, Australia and Oceania, but is completely absent from America. About 700 species are described with some 550 in Asia and Oceania. 76 species occur in Madagascar, and all but two are endemic. A further 30 species occur in the Mascarenes, the Comoros and the Seychelles, and only 22 in Africa (all but one in the east and centre).

iv. The Southern element appears somewhat less well defined; Perrier de la Bathie considered it accounted for around 3% of the flora and included in it a few species in common with South Africa, several endemic species related to plants in South Africa, and 77 genera in common with South Africa, South America or Oceania, or relatives of genera confined to those areas. The most important of these are African. Dejardin *et al.* adopted a somewhat broader view, including in this all taxa which are predominantly found in the southern hemisphere, and those that are confined to some part of the southern hemisphere, either African or eastern. Other taxa which are now widespread in the northern hemisphere probably have a southern origin, for example the palms, which show considerable diversity in Madagascar (see Appendix 4). Dejardin *et al.* (1973) recognise 13 families and subfamilies in this element concluding that the southern element in the Madagascan flora probably exceeds 3%.

v. The Palaeotropical element is defined by Dejardin *et al.* (1973) as the tropical taxa absent from continental America but not confined to any one region of the Old World Tropics; 8 families and 73 genera are cited in this group.

vi. There is a small but significant element in the Madagascan flora which has affinities with America - the Neotropical element. These taxa show a variety of distributions from wide continuous ranges, like that of *Sabicea* (with c. 50 species in Tropical America and the West Indies, 85 species in continental tropical Africa, and 5 species in Madagascar), to the extremely discontinuous ranges shown by *Ravenala* (with one species in Madagascar and one in Brazil and Guiana) and *Oplonia* (with one species in Peru, 8 species in the West Indies and 5 species in Madagascar). Stearn (1971) cites 9 families restricted to America and Madagascar only, while Dejardin *et al.* (1973) cite 26 genera which are common to Madagascar and America, and present or not in Africa.

vii. Undoubtedly, a substantial part of the Madagascan flora has been introduced relatively 'recently' and by long distance dispersal. The exact definition of 'recent' in this context is unclear, since it could include long distance dispersal by way of oceanic islands any time after the breakup of Gondwanaland, and so overlap with most of the other floristic elements. Some species introduced by man (e.g. species of *Pavonia, Sida, Cyperus*) have already given rise to new endemic species or varieties (Koechlin, 1972).

Origins of the flora

Theories of continental drift or plate tectonics help provide explanations for many of the plant distributions outlined above. Raven and Axelrod (1974) review the state of knowledge to date, with particular reference to the origin of the Angiosperms. Where not otherwise stated, the original source of the following information is Raven and Axelrod (1974).

During the Jurassic, the major landmasses existing today were joined together into two large continents: Laurasia, including North America, Europe and Russia; and Gondwanaland, including Africa and most of the rest of the southern hemisphere. Africa as we know it was joined to South America, and on the other coast Madagascar was nestled between Africa, India and Antarctica. By the upper Jurassic, about 150myBP, these supercontinents had started to break up into recognisable shapes, and move, by a process not yet fully understood, across the surface of the globe. Antarctica and Australia moved south, while South America moved west, leaving Africa, Madagascar and India still joined together. From evidence reviewed in Axelrod and Raven, 1978, it is likely that Madagascar and India remained together longer than they remained attached to the African mainland, and that they split from Africa sometime in the mid-late Cretaceous (100-80myBP); India and Madagascar probably separated in the early Paleocene (c.65myBP).

The exact position of Madagascar during the Jurassic has been a point of considerable controversy, but according to Smith (1976a, 1977b) the matter is settled with the presentation of palaeomagnetic evidence. This is based on the comparison of the orientation of the magnetism solidified into the ancient rocks of Madagascar and the eastern part of Africa. The two possibilities most often presented are: 1. that Madagascar was attached to the east coast of Somalia/Kenya/Tanzania, the so-called northern position; and 2. that Madagascar originated in a southern position, attached to the east coast of Mozambique, more or less opposite its present position. The overwhelming evidence to date, both geological and biological, suggests a northern Gondwanaland position for Madagascar (Embleton and McElhinny, 1975; Hilliard and Burtt, 1971; Smith and Hallam, 1970; Smith (1976a); Smith (1976b); Wild 1975) and that the island has subsequently moved south and east to its present position.

According to Raven and Axelrod (1974), and concurred by Leroy (1978), primitive angiosperms originated in the western part of Gondwanaland, probably in the lower Cretaceous (c.125myBP). By the end of the lower Cretaceous, before Laurasia had separated from Gondwanaland, these had spread north and diversified, so that by the upper Cretaceous a large flora was established in each of the two supercontinents: Magnoliaceae, Ranunculaceae, Amentiferae, etc. in Laurasia; Annonaceae, Winteraceae and Myristicaceae in Gondwanaland. By the early Paleocene, almost all modern families were in existence, and had spread to the peripheral parts of each continent.

The spread and subsequent diversification of this Gondwanan angiosperm stock explains the presence in Madagascar of a large pantropical and cosmopolitan element. The very oldest affinities are those at the highest taxonomic level, and well distributed throughout all parts of Madagascar. The southern element, for example, is attributed with being one of the oldest in Madagascar; the taxa have marked archaic characteristics and are distributed all over the island (Koechlin, 1972). As the oceans opened up, the possibility of migration was reduced, and subsequent diversification of the separated parts raised the level of the floristic affinities.

The American element in Madagascar, and some parts of the southern element, can be explained on this basis, if the original stock inhabiting the South American and African landmass was split when these two continents parted, and if there were sufficient changes in the environment of continental Africa for a proportion of this stock subsequently to become extinct. There is considerable evidence now that there were indeed major climatic changes in Africa concurrent with the Quaternary glaciations in the polar regions; particularly the widespread occurrence of aridity (Axelrod and Raven, 1978; Coetzee, 1964; Coetzee and van Zinderen Bakker, 1970; Diamond and Hamilton, 1980; Hamilton, 1981; Livingstone, 1975; Raven and Axelrod, 1974; Richards, 1973; Stearn, 1971). This could have caused widespread extinction of taxa in Africa compared with South America and Madagascar, whose climates appear to have remained stable for a very long time. Richards (1973) highlights the uniqueness of the African forests, and remarks on the paucity of their flora.

Because of its relatively recent attachment to the African continent, Madagascar has very strong African links in its flora. This is borne out by the fact that most of these affinities are at species level. Even after the continents had split apart, there was the possibility of migration across water on numerous small islands probably into the upper Miocene, although this became less as the distances increased. The existence of dwarf hippos in both Africa and Madagascar suggests links up until the end of the Pliocene (Koechlin, 1972).

III.2. VEGETATION

The following is a summary account of the native vegetation of Madagascar. More comprehensive descriptions, from which this is taken, are found in Humbert (1959), Humbert and Couts Darne (1965), Koechlin *et al.* (1974), Perrier de la Bathie (1936), and White (1983). The terminology and delimitation of vegetation types are after (White, 1983).

Descriptions of the secondary formations are given below in a separate section.

Eastern Region

The Eastern Region (or East Malagasy regional centre of endemism) covers the eastern part of Madagascar and includes the central highlands which run most of the length of the island. It extends from the highlands eastwards down to sea-level and westwards down to an altitude of approximately 800 m. The Sambirano Domain is separate and forms a small enclave on the north-west coast.

The original vegetation of the region was almost entirely forest. Evergreen rain forest occurred everywhere below 800 m, and three other forest types above 800 m: moist montane forest and sclerophyllous montane forest occurred on the eastern slopes of the highlands, while 'Tapia' forest grew on the western slopes. Above 2000 m forest is replaced by montane thicket. Rocky outcrops above and below 2000 m support rupicolous communities.

i. East Malagasy primary lowland rain forest. This once covered the whole area along the east coast up to about 800 m, the region being characterised by high rainfall (usually more than 2000 mm, rising to 3000 mm or more) and low altitude. On windswept ridges it is replaced by shorter forest with a canopy of 10-15 m.

The main canopy is at 25-30 m, but there are no large emergent trees as in most other types of tropical moist forest. The lower canopy is made up of small trees and large shrubs with larger and less coriaceous leaves than in the upper canopy. Deciduous species are absent except near the upper altitudinal limit. Palms are better represented than in African forests (Richards, 1973), especially below 200 m. The dwarf palm genera *Dypsis* and *Neophloga* are important in the lowest layers. Bamboos, including lianoid species, are scattered throughout all layers. Tree ferns occur at low altitudes, but are rarer in this forest type than in submontane forest. Large humus-collecting epiphytic ferns grow on the trunks of trees. Epiphytes are abundant and increase with altitude; especially common are Orchidaceae, Melastomataceae and ferns, the last of which tend to grow on the stems of tree ferns.

This type of forest is very rich in species, varying in species composition from place to place. Dominance by individual species or groups of species does not occur.

ii. East Malagasy moist montane forest. This grows chiefly between 800 and 1300 m, but may ascend to 2000 m in sheltered places on well-watered soils; it is transitional between lowland rain forest and the sclerophyllous forest of higher altitudes. The main canopy is lower than in lowland rain forest, at 20-25 m, and the trees are often branched from near the base, so that the boles are rarely straight. The leaves in the canopy are more sclerophyllous; epiphytes, especially mosses, are more abundant. Lichens cover the trunks and branches in an almost continuous layer. Large lianes are abundant, especially Compositae, Rubiaceae and monocarpic bamboos. The herb layer is better developed and includes ferns and other species with large non-xeromorphic leaves.

Moist montane forest is as rich in species as lowland rain forest. There are many species endemic to this formation, but others, such as *Podocarpus madagascariensis*, extend from sea level to the summits of the highest mountains.

iii. East Malagasy sclerophyllous montane forest. This occurs between 1300 and 2300 m, but also lower than 1300 m on shallow soils of exposed ridges. Compared with moist montane forest, the environment is characterised by lower temperatures with greater daily and seasonal variations, stronger winds, and greater variation in humidity.

The canopy is lower than that of Malagasy moist montane forest (10-13 m) and less well differentiated from lower strata, since most of the trees are branched more often, and lower down. Structurally it is intermediate between forest and thicket, but closer to the former. The leaves of the canopy species are smaller and more xeromorphic. When the canopy is relatively open, several ericoid species, which are more characteristic of montane thicket, occur in the understorey. Bryophytes and lichens are more abundant than in moist montane forest, and many trees are covered with the lichen *Usnea.* The ground is covered with a thick layer of bryophytes and lichens. Included in it are species more usually found as epiphytes, such as ferns, orchids and *Peperomia*; most of the layer consists of pleurocarpous mosses, but there are also mounds of *Sphagnum.* This type of forest is very susceptible to fire, which can easily spread through the thick layer of humus.

iv. East Malagasy 'Tapia' forest. This grows between 800 and 1600 m on the western slopes of the upland massif. It is much drier than forest on the eastern slopes, lying in the rain-shadow of higher ground further east. Temperatures are higher, and insolation is more intense, and because of its resulting sensitivity to fire, 'Tapia' forest has mostly been replaced by secondary grassland or open woodland.

Tapia forest is similar in appearance to Mediterranean Cork Oak forest, but there are more species present in the canopy, which is at 10-12 m. The canopy trees have evergreen, often small coriaceous leaves. Although the crowns are in contact they cast little shade, so there is a well developed understory, composed largely of ericoid shrubs. Lianes are quite frequent, but small. Tree ferns are absent, and the only palm is *Chrysalidocarpus decipiens* which is confined to the wettest places. Epiphytes are rare, with only a few small ferns and species of *Bulbophyllum.* Lichens are the only epiphytes at the lowest altitudinal limits. There is no ground layer of bryophytes.

The canopy is composed mostly of *Uapaca bojeri*, for which Tapia is the local name. It is very resistant to fire, and often persists as the dominant species of secondary open woodland long after its normal associates have disappeared.

v. East Malagasy montane bushland and thicket. This occurs wherever conditions are suitable between 2000 m (or exceptionally 1800 m) and 2876 m, the highest point on the island. It is an extremely depauperate derivative of montane sclerophyllous forest, and is found above it. It consists of a single stratum of woody plants, most of which have ericoid habit with short twisted stems. It is never more than 6 m high, and is often impenetrable. All the species are evergreen, and most have ericoid, cupressoid or myrtilloid leaves.

Lianes and vascular epiphytes are almost completely absent, except for a few small orchids, though epiphytic bryophytes and lichens are plentiful. There is a discontinuous ground layer of bryophytes and lichens on poorly drained sites. The field layer is poorly developed.

vi. East Malagasy rupicolous shrubland. The most characteristic vegetation of large rocky outcrops on the African mainland is bushland and thicket. On similar outcrops in Madagascar the tallest plants rarely exceed 2 m, and so Malagasy rupicolous vegetation is classified as shrubland even though there are some floristic affinities with African rupicolous bushland.

Rupicolous communities do occur in western Madagascar, but are most frequent in the Central Domain and the Domain of the High Mountains in eastern Madagascar. They also occur in the Oriental Domain, but the flora is poor and not well known.

The plants are rooted in crevices or, more often, in mats of coarse shallow soils on less steep slopes, and are easily washed away by heavy rainfall. The soil dries out rapidly after rain and the plants are strongly xeromorphic as a result of strong sunlight during the day, low temperatures at night, and strong winds.

Species diversity is not very high, but there is a wide range of growth forms including leaf succulents, stem succulents, reviviscent pteridophytes, grasses, cactoid or coralliform species, and spartioid species with large subterranean structures and a fugaceous rosette of leaves borne at ground level.

The presence of grasses in this formation is interesting, since it is possible that they have spread from these habitats to dominate the grasslands which now cover so much of the island.

Above 2000 m, the flora on rocky outcrops becomes very impoverished, although some genera grow to quite high altitudes, and are often represented by endemic species on each mountain. A few genera (for example *Sedum*) are confined to this high altitude rupicolous shrubland. There are also many bryophytes and lichens, including the fruticulose *Cladonia pycnoclada*.

Western Region

The Western Region (or West Malagasy regional centre of endemism) covers the western side of the island up to 800 m. From the flat plains on the west coast, which are wider than the east coast equivalent, the land slopes up slowly towards the east. Because the region is in the rain shadow of the south east monsoon, there is a dry season of seven or more months.

The Western Region is less rich floristically than the Eastern Region, but the flora is large and varied. As with eastern moist forests, single species or groups of species are very rarely dominant.

There are two main types of primary vegetation: dry deciduous forest and deciduous thicket (the so-called spiny desert). As discussed below, most of this has been destroyed, so that secondary grassland is the predominant feature.

i. West Malagasy dry deciduous forest. This used to cover most of the Western Domain, where the mean annual rainfall varies from 500 mm in the south to 2000 mm in the north. Most of the wet season rain is brought from the north or west, rather than by the south-east monsoon. The mean annual temperature is mostly 25-27°C.

Dry deciduous forest is less dense than most of the moister forests in the east, with a rather open upper canopy at 12-15 m, and with scattered emergents to 25 m. Lianes are abundant and the shrub layer is well developed. The soil is mostly bare except for small patches of Acanthaceous subshrubs which die back in the dry season. There are very few vascular epiphytes (a few small orchids in the wetter types), and few lichens. Ferns and palms are absent, as are bryophytes. The trees of the main canopy are always deciduous. Some species stay green for about four months, while others lose the last of their old leaves only when the new ones unfold, which happens in all species shortly after the rains begin. Some species of, for example, *Adansonia, Dalbergia* and *Cassia*, flower before the new leaves appear. Some herbs, for example species of *Kalanchoe* and *Plectranthus*, have large membranaceous leaves during the rainy season and small leaves in the dry season.

Excluding riparian forest, there are three main types of dry deciduous forest, growing on different substrates:

- *On lateritic clays.* These soils, derived from basalt and gneiss, support the most luxuriant type of dry deciduous forest. The humus layer is deeper than in the moister forests in the east.

- *On sandy soils.* These are derived from Liassic, Jurassic and Cretaceous sandstones. The forest is similar to that on lateritic soils, but is shorter, especially on dry soils, where it is more like thicket.

- *On calcareous plateaux.* Forests of this type are similar to those on sandy soils but lower. There are fewer lianes and evergreen species. Trees and shrubs with swollen stems, e.g. *Adansonia, Bathiaea, Harpagophytum*, are relatively more abundant. Among the rocks, height falls off very quickly, the upper and lower canopies merge, and the forest turns to thicket; lianes and shrubs appear, and succulents and plants with swollen stems become more numerous.

Dry deciduous forest also occurs in small areas in the moister parts of the Southern Domain, but only as a transitional form between deciduous thicket and forest; members of the Didiereaceae occur in the canopy.

ii. West Malagasy deciduous thicket. This characterises the dry Southern Domain, which has 300-500 mm rainfall per year, most falling in the summer as local heavy showers. The dry season lasts at least eight months, and because the rainfall is so irregular, droughts can last from 12-18 months. The soil substrate is usually shallow and stony.

The height and density of the thicket vary enormously in relation to rainfall and soil moisture. The shorter, more open types are mostly confined to rocky situations. Most undamaged stands are impenetrable or nearly so. At one extreme there is a transition to dry deciduous forest, and at the other, on shallow soils, the canopy is less than 2 m tall.

The thickets are commonly 3-6 m tall, and they may have a very discontinuous stratum of emergent trees, exceptionally reaching 8-10 m tall. Otherwise there is no stratification, and the thicket consists of a complex mixture of plants of different sizes. Lianes are numerous and rather small. The ground flora is sparse. Many species are spinous. Physiognomically, the most distinctive elements are the Didiereaceae and arborescent Euphorbias; these are usually present in, and almost restricted to, this vegetation type.

Didiereaceae is a small endemic family of bushy or arborescent pachycauls of distinctive ascending branched habit, with fascicles of very small leaves scattered along the main stems. It consists of four genera and twelve species: two species of *Didierea, D. madagascariensis* and *D. trollii*; the genus *Alluaudia* with six species; two species of *Alluaudiopsis*, and *Decaryia madagascariensis*, in a monotypic genus. Some reach 8 m or more, though most are lower.

The photosynthetic organs are very variable in behaviour and structure. In some species, large leaves appear suddenly after heavy rainfall, and are shed equally suddenly. In other species, more fugacious leaves are produced irregularly. Many shrubs have narrow greyish leaves, which persist longer so there may still be leaves on some shoots while shoots in another part of the plant have a crop of new leaves. A few rare shrubs are evergreen. Many species have green photosynthetic stems, and may or may not also produce fugacious leaves. In some of these, for example some cactiform Euphorbs, and species of *Cissus* and Asclepiadaceae, the photosynthetic stems themselves are caducous. Several taller species have distended water storage stems of characteristic bottle-like appearance.

Mangroves are discussed in Part IV.

Secondary Formations

i. East Malagasy secondary lowland rain forest. Although the area of degraded formations in the Eastern Region is very large, little of it is secondary forest (which is known locally as Savoka). There are two main reasons for this: firstly, Madagascar has very few indigenous secondary forest species, and these are much less vigorous than the corresponding species in tropical Africa. Secondly, the indigenous secondary forest species are unable to compete successfully with smaller plants which are not indigenous, or with the introduced tree species *Psidium cattleianum* and *P. guajava* which are more invasive than the indigenous secondary forest species.

The most important indigenous secondary forest tree is *Ravenala madagascariensis* (Musaceae), the Travellers Tree, which is widespread in eastern Madagascar to 800 m. Other indigenous secondary forest species include *Harungana madagascariensis*, *Psiadia altissima*, species of *Canarium*, *Croton*, *Dombeya* and *Macaranga*, and the bamboo *Ochlandra capitata*.

The ease with which secondary forest can become established is largely dependent on the nature of the soil. Forest regeneration is favoured by porous soils of good structure and rich in decomposing minerals. Compact ferallitic soils formed from impoverished parent material do not support secondary forest, and destroyed forest is replaced by grassland with *Ravenala*, although the *Ravenala* is progressively eliminated by fire. Coastal forest on leached sand dunes is replaced by a totally different type of secondary forest dominated by *Philippia*. This is highly combustible and degrades rapidly to grassland.

ii. East Malagasy secondary grassland. This formation covers enormous areas, particularly in the Central Domain. Several variants have been recognised:

- In the coastal region, a succession of grass associations follow after the destruction of forest regrowth by fire. On certain soils this type of grassland can revert to forest if fire is excluded.

- The grassland of the 'Tanety', the region of hills between 1200 and 1500 m, has widely spaced tufts of low ground cover with hard infertile soil in between each. Throughout most of the area, one species of grass is dominant: *Aristida rufescens*.

- The grassland of the 'Tampoketsa', the plateaux to the north and north-east of Tananarive, is very uniform floristically and dominated by very few species; the total flora is only 34 species.

- The grassland on the western slopes occurs between 800 m and 1600 m on ground which formerly supported Tapia forest, and is intermediate in stature between the short grasslands of the plateaux and the taller grasslands of the Western Region. Again, this formation is floristically very poor and homogeneous.

- The grassland on the mountain slopes above 2000 m replaces most of the montane bushland and thicket which used to occupy much of the Eastern Region; it seems that this formation is fairly recent. It is maintained by regular grazing and burning.

iii. West Malagasy grassland. More than 80% of the surface of the western Malagasy Region is covered with secondary grassland or wooded grassland, and this is burnt each year. The dominant species are taller than those of the eastern Malagasy grassland, with broader flat, ribbon-like leaves with less sclerenchyma.

The presence of trees and bushes distinguishes the secondary grasslands in the west from those in the east. Tall trees are rare, and are either relics from forest or, like the palm *Medemia nobilis*, grow otherwise on hydromorphic soils. Most trees are no more than 8-12 m tall. Apart from their ability to coppice after fire, the trees show few adaptations to fire, and this is an argument in favour of the recent origin of the communities in which they live.

The grasslands of the western region are very poor, despite their great extent and their varied climate and edaphic conditions. There are at the most 300 species, and more than half of these are transient ruderals. If those species which only grow in the shade of trees, or are confined to swampy places, are also excluded then only 84 heliophilous species are left which occur on well drained soil and can withstand annual burning.

Most species in the western grassland are neither characteristic nor faithful, and this reflects its origin. Most species are introduced from other countries, or are forest species which can survive destruction of the forest without showing notable modifications. Of the 84 typical grassland species, 31 are adventive. Of the others, 42 are certainly, and 11 probably indigenous. Of these, 24 have originated in forest, 4 in the deciduous thicket in the south, and 2 species of palm (*Medemia nobilis* and *Borassus madagascariensis*) are from riparian forest. Eighteen other species are from the dry deciduous forest.

Only 18 endemic species are confined to the grasslands. Four are phanerophytes; eight are hemicryptophytes. Certain other species which are confined to grassland in Madagascar also occur in Africa or Asia. The presence of these heliophilous endemics is evidence for the occurrence in Madagascar before man of small open communities which perhaps occupied stations least favourable to forest, such as compact soils and rock outcrops. In such situations the forest was probably stunted, with an open canopy, permitting the persistence of shade intolerant species.

III.3. FOREST COVER AND DESTRUCTION

There are no recent measurements of either the extent of surviving forest cover on Madagascar or the rate of its destruction; figures for the former are usually derived from estimates made in 1958 from aerial photos taken mostly in 1949 (Guichon, 1960), those for the latter are taken from a study by Delord in 1965 concerning the eastern region. It appears that recent quotations for surviving forest cover are usually extrapolations from the 1958 figures using the estimated rate of destruction from Delord. However, there are discrepancies between various estimates, such as those given by Chauvet (1974) and the FAO Tropical Forest Resources Assessment Project (1981) although both are apparently based on the same sources; these may in part be a result of differing classifications and criteria for inclusion of forest types, though this should be clarified.

The most important consideration, however, is that at least 70% (and probably 75%) of the land surface of the island no longer has significant native woody plant cover, and that this percentage is increasing annually. These deforested areas are mostly pseudosteppes and savannas with very low species diversity. The floristic composition of these and other vegetation types are discussed above.

Summary approximations as given by Chauvet (1972), and derived from Guichon (1960) are:

Eastern type	6 150 000 ha
Western type	2 550 000 ha
Southern type	2 900 000 ha
Transition	900 000 ha
Total	12 500 000 ha (21% of land area)
Degraded forest	4 300 000 ha
Overall total	16 700 000 ha (28% of land area)

With the rapid rate of forest destruction (discussed in more detail below), more recent estimates will obviously be lower than this.

Eastern Forests (including Sambirano Domain)

i. Area

FAO/UNEP (1981) quotes the following figures for the eastern rain forest:

Primary forest	1 200 000 ha
Exploited forests	3 570 000 ha
Inaccessible areas	1 650 000 ha
Reserves	535 000 ha
Total	6 955 000 ha

This, however, exceeds the total estimated by Guichon (1960) for 1958 (6 150 000 ha), without taking into account forest destruction since then (see below); this is likely to be because the FAO/UNEP category of exploited forests includes some component of Guichon's degraded forest.

Battistini and Verin noted in 1972 that primary rain forest was by then found in only a relatively few places - the most extensive areas being in the Maroantsetra and Antongil Bay regions, though also on the steepest slopes of the great escarpment and in the Tsaratanana Massif. It is worth noting, however, that according to Le Bourdiec (1972) the southern flank of the Tsaratanana Massif appeared to be one of the most heavily eroded areas on the island.

ii. Forest destruction

The principal agent of destruction is 'tavy' (slash-and-burn) cultivation, carried out by subsistence farmers. Areas are cut, the vegetation is dried and fired some months later. The ground is then cultivated, mainly with dry land rice, but with also with maize, manioc and other crops, for a year or sometimes two and is then left fallow with the process repeated elsewhere. Degraded vegetation types (secondary forest, savoka) regrow on the land which is then normally recleared after an average interval of 10 years (i.e. intervals of 6, 10 or 15 years). This cycle is repeated; however, progressive deterioration of soil structure and nutrient content leads to the regrowth vegetation becoming more degraded after each clearance, until finally the area becomes grassland or bracken-covered. Chauvet (1972) estimated that a maximum of 10 to 15 clearances was possible on any given site until this stage was reached, though the actual number will depend on the interval between clearances, the slope of the ground, the soil type and other factors. Tavy cultivation is often practised on very steep slopes (often over 20%) when the risk of erosion becomes very great.

A gross estimate was made in the mid-1960s of 150 000 ha of forest cleared each year. Taking a generous estimate of 15 possible cultivation cycles on any given site, this leads to a minimum total loss of forest (i.e. degeneration to uncultivable land) of 10 000 ha per annum. This rate has almost certainly increased over the past fifteen years, owing to both the rapidly growing population and the ever-decreasing area of easily accessible cultivable land, which leads to shorter intervals between clearances on individual sites. It has also been pointed out that farmers always prefer to clear virgin or near-virgin land when the choice arises as this will ensure as rich a soil as possible. FAO/UNEP (1981) gave a figure of 40 000 ha of previously undisturbed closed forest cleared per year for the years 1976-80, and projected 35 000 ha for the years 1981-85; the great majority of this is expected to be in the eastern forests. Guichon (1960) estimated an area of perhaps 3 600 000 ha of savoka in 1958 although the 1981 FAO/UNEP report quotes 2 235 000 ha, despite the fact that its area must have increased considerably in the intervening period.

Clearance is greatest around settlements and in accessible areas, though with increasing population pressure, more and more regions are cleared. The great majority of the eastern coastal plain, the most densely populated part of the island (along with part of the central highlands), has been either cleared for permanent crops such as coffee or has degraded to savoka which is often very poor, consisting only of bamboo or *Ravenala*.

Western Forests

i. Area

Guichon (1960) estimated 2 600 000 ha surviving in 1958, with around 590 000 ha of this on calcareous soils (mainly limestones).

FAO/UNEP (1981) quotes:

'Virgin forest'	500 000 ha
'Exploited forest'	1 500 000 ha
'Degraded massifs'	650 000 ha
Reserves	495 000 ha
Total	3 145 000 ha

The most recent assessments (early 1970s) indicate a few large areas of western forest remaining, it otherwise persisting in small isolated residual patches; overall it survives mainly in areas inaccessible to tribesmen or unsuitable for clearing, usually because of edaphic factors.

It was noted in 1972 that dense forests occupied relatively large areas on limestone slopes and also on the sandy soils along the coast below a height of 300 m. Battistini and Verin (1972) reported extensive forest surviving on the Antsingy of Maintirano, which covers the dip slopes of the Bemaraha limestone cuesta (part of this the area is in the Réserve Naturelle Intégrale de Bemaraha), while Koechlin (1972) additionally noted the limestone plateaux of Ankarana, Kekifely and Mahafaly as forested (though this last is normally included as part of the Southern Domain). The Ankarafantsika forest clothed the dip slope of the cuesta in the Upper Cretaceous sandstones and basalts of the Mahajanga region, though it was reported as only intact in the north (in the Réserve Naturelle Intégrale de l'Ankarafantsika). Further south, the forest of Zombitsy near Sakaraha survived on hard-pan red sands which were unsuitable for shifting cultivation; in 1962 this forest was recorded by the Service des Eaux et Forêts as 21 500 ha in extent. Battistini and Verin (1972) noted that it showed the features of a remnant of previously much more widespread forest cover and was undergoing gradual attrition as outlying trees suffered from the annual grass fires on surrounding areas - this is likely to be a virtually universal phenomenon in the surviving western forests (see below). FAO/UNEP (1981) also notes the following areas as forested: Bara, Manasamody, the Bongolava Massifs, the area between Analalava and Ambato-Boéni and between Antsalova and Mangoky, as well as along the Mangoky river.

ii. Forest destruction

The principal threat to the western forests is undoubtedly fire, much of it deliberately started. The western region is the principal stock-raising area of Madagascar and fires are set each year to encourage new grass growth for grazing, normally during the dry season when the vegetation is particularly vulnerable. It has been stated that a third of the land area of the island is burnt every year, and in 1969 an estimated 2 000 000 ha of woody vegetation were burnt, though only 2000 ha of this were said to be strictly forest, the rest being shrubby vegetation or bush (these figures apparently refer to the west).

The western forest is far more susceptible to fire than the east, rapidly giving way to bush and then wooded savannah, with a few fire-resistant palms and trees, and eventually forming sterile grassland, a formation which already covers perhaps 75% of the island. Annual burnings and grazing by livestock (principally zebu cattle, of which there are some 10 000 000 on the island) prevent significant regeneration taking place and it seems certain that in many areas degradation of soil has proceeded to such an extent that no natural regeneration is possible even without further disturbance. FAO/UNEP (1981) estimated net degradation of western forest to have been perhaps 200 000 ha since 1955. As noted above, the great majority of the western forest has already been destroyed and that which survives tends to be in areas more resistant to fire; however, as land is progressively overgrazed and population pressure increases even these areas come under threat, undergoing wholesale burning or suffering annual attrition as trees at the edge are burnt and the savannah extends - viz. the figure given above of 2000 ha of 'true forest' burnt per annum.

In addition FAO/UNEP (1981) estimated a net degradation through fire of 1000 ha of productive savanna and 4000 ha of unproductive savanna per annum, supposing that a certain amount of natural regeneration (to bush) took place. They thought that perhaps 50 000 ha was recolonized annually by shrubs, almost all of this in the west.

Although fires for livestock grazing are undoubtedly the most important factor in the destruction of these forests, much land has also been cleared for crops such as maize or groundnuts, usually for shifting cultivation. FAO/UNEP (1981) notes that from 1936 to 1948 large areas were cleared for the cultivation of maize as a result of policies of the colonial administration; ecological consequences were disastrous and policies were reversed in the 1950s, with a resultant marked decrease in the rate of clearance for maize.

Land so cleared is usually rapidly exhausted and is often replaced directly by bush or grassland, unlike in the east where several cycles of secondary forest formation are possible; reafforestation then becomes a very lengthy or non-existent process.

Southern Forests

Guichon (1960) estimated some 2 900 000 ha in 1958, which is similar to that quoted in FAO/UNEP (1981) (2 990 000 ha, also referring to the 1950s).

This is generally agreed to be the least deteriorated of the island's climax formations, especially on the extensive limestone lithosols which are unsuitable for agriculture, such as the plateau covering a large part of the Mahafaly territory and the area to the north of the Onilahy river. Human population is generally low in the region (though it is increasing, as everywhere on the island) and the vegetation is relatively unaffected by fire, combustible material being scarce.

However, large areas have been cleared, for example in the region south of the Androy where, according to Battistini and Verin (1972), the *Alluaudia* forest existed only in patches in the region of Tsihombe and on the lower Mandrare. Clearing is carried out for production of food or cash crops such as castor-oil and sisal; much of it, such as that practised by the Mahafaly and Masikoro peoples, is in the form of shifting cultivation with large areas burnt and drought-resistant sorghum or maize sown in the ashes. Cleared areas usually form grassland which is quickly grazed bare. Continuing grazing pressure on many disturbed areas prevents, or at least hampers, regeneration and Koechlin (1972) has noted that the floristic composition of areas that do recover tends to differ from that in undisturbed forests. In the Androy and Mahafaly districts, however, the main staples of subsistence - cassava, maize, beans, and sweet potato - may be grown around the villages in permanent fields enclosed by hedges (Nelson *et al.*, 1973). The collection of wood for conversion to charcoal for fuel is considered perhaps the principal threat to the southern forests and appears to be increasing rapidly in extent, although virtually no quantitative data are available (Richard *et al.*, 1985). Charcoal is both used locally and taken for sale to major population centres. Charcoal production is theoretically controlled by a licensing system, with a small annual tax payable, but the extent to which this is enforced is unclear (O'Connor pers. comm., 1986). 'Fantislotra' (*Alluaudia*) is also collected for use as building material and *Adansonia* trees are felled to provide moisture for livestock from their swollen trunks.

There do not, however, appear to be any overall estimates for the rate of destruction of the natural vegetation of the south.

Central Highlands

The Hauts Plateaux region in the centre of Madagascar is the area which has suffered the greatest deforestation. Here the forest has been reduced to a few scattered remnants, such as that on the Ankaratra Massif south of Antananarivo and the Ambohitantely forest on the Ankazobe tampoketsa north of the capital (though the former should be more correctly considered a montane forest, discussed below). The latter was estimated in 1964 as covering perhaps 3000 ha, of which 2000 ha was in one continuous forest, the rest being in small, scattered tracts at the heads of the valleys. These areas were all recorded by Bastian (1964) as rapidly disappearing, mostly through the annual grass fires eroding the forest edges. This area was reported in 1969 as being developed as a Special Reserve of around 15 130 ha in extent.

Montane Vegetation

FAO/UNEP (1981) considered that the area of montane shrub (above 2000 m altitude) had remained roughly constant at around 600 000 ha. This vegetation is present on the large isolated massifs on the island - Tsaratanana and Marojejy in the north, Ankaratra in the centre and Andringitra in the south-east. While most of these areas are unlikely to be used by local people, they are extremely susceptible to fire and it seems likely that some accidental or natural burning will have taken place in the last 30 years.

III.4. FOREST EXPLOITATION

Timber

Madagascan forest is relatively poor from an economic point of view. The area of commercially usable timber trees is small, and even here many individual trees have rotten or hollow trunks. Large areas are virtually unexploitable because of the steep terrain. Elsewhere transportation of timber is extremely difficult - there are no open public roads facilitating forest exploitation.

Other than in cases of established land-use rights, exploitation is authorised by permit which is allotted either by adjudication or by private contract for a fixed time through payment of dues based on the land area or on the amount of production. Permits are allocated to public services or individuals in regions where there are no existing foresters capable of satisfying local needs. Produce resulting from these permits is not allowed to be commercially exploited. The Direction des Eaux et Forêts itself apparently only exploits some reforested areas. Although permits are apparently accompanied by sylviculture plans, control of exploitation remains slight. Forest exploitation lots are scattered along or near communication routes and vary in size from a few dozen to some thousands of hectares. Trees currently exploited include species of *Dalbergia, Canarium, Cryptocarya, Ocotea, Sideroxylon, Hernandia, Vernonia, Symphonia, Afzelia* and *Calophyllum*.

The Service des Eaux et Forêts records 402 000 m^3 of rough timber exploited in 1979 (probably based on the number of permits in force in that year). From the same source, the return per ha was around 30 m^3 for eastern forests and 10 m^3 for western forests, giving 9100 ha of exploited eastern forest, 4200 ha of western forest and 700 ha of southern forest.

Most exploitation uses traditional methods: felling is by axe, and wood is extracted and cut into planks or cross-sections with a long-saw or axe. Yield is very low (ca 20%). There is little mechanised exploitation. Here, felling is carried out either with axes or chain-saws, and trimming with chain-saws. Timber is extracted, as rough logs, which are cut up either on site or at the saw-mill. Use of chain-saws is not general but is spreading. The use of tractors for clearing and wood-peeling as much as for creation of tracks, is now fairly widespread on mechanised sites. Most of the relatively accessible forest has already had the best timber systematically removed and there are virtually no remaining areas where the standing crop is economically viable.

Since 1975 no valuable unworked wood (e.g. of *Dalbergia*) can be exported; only worked timber (de-barked, cut into planks) is allowed to leave.

Most of the forestry industries (especially timber-mills) are in the private sector; timber-mills, numbering 60 at the end of 1975, are scattered throughout the island with a heavy concentration in the province of Antananarivo. Their capacity varies from 500 m^3 per year to 3000 m^3, with 80% having a capacity lower than 1500 m^3 per year.

Other forest products

The rural population exercises rights of usage which allow them to freely obtain wood for the construction and preparation of dwellings, firewood and other products for their own use. Theoretically, these should be under the control of permits issued without charge though in practice exploitation is often carried out without them. FAO (1978) estimated 400 000 m^3 of 'bois de service' (timber for building), 5 200 000 m^3 of firewood and charcoal (wood equivalent).

A 1980 Direction des Eaux et Forêts report gave annual production of 2 520 000 tonnes of fire-wood and 71 000 tonnes of charcoal.

Honey, beeswax, resins and raphia (4225 tonnes according to the above) are important mincr forest products.

III.5. REAFFORESTATION

Reafforestation projects have been undertaken for several decades, especially in the Hauts Plateaux. One of the earliest on any scale apparently was the establishment of broadleaves, especially eucalyptus, along the railway from Antananarivo in 1910 to provide fuel-wood for the locomotives (since the introduction of diesels, these plantations have been used for other purposes). Most plantations have been of eucalyptus for firewood and local building, though conifers have been increasingly used since the 1950s following success with *Pinus patula.*

FAO/UNEP (1981) distinguishes between industrial and non-industrial plantations:

i. Industrial plantations - estimated 112 000 ha

These are very largely based on pines, some for the production of industrial timbers, others for pulp-wood. Species used include *Pinus patula, P. kesiya, P. pinaster* and *Cupressus lusitanica.* There are some plantations of mixed pines and cypress and of pines and eucalyptus, and also very limited areas of other timber trees such as *Afzelia bijuga, Terminalia superba, Cedrela odorata, Tectonia grandis, Eucalyptus* spp. and other species.

In 1980 it was envisaged that 35 000 ha of industrial plantations would be planted between 1981 and 1985, of which 85% would be conifers and 15% broadleaf trees.

ii. Other plantations - estimated 154 000 ha

These are principally for firewood and 'bois de service'. Different *Eucalyptus* species are used, including *E. grandis, E. camaldulensis, E. saligna, E robusta, E. viminalis, E. racemosa, E. citriodora, E eugenioides* and the hybrid *E.* 12 ABL, either in monocultures or mixed with *Acacia mearnsii, A. dealbata, A. melanoxylon, Casuarina equisetifolia, Terminalia superba, Afzelia* spp, *Tectonia grandis* or conifers.

In 1980 it was envisaged that 25 000 ha of non-industrial plantations would be planted between 1981 and 1985, of which 20% would be conifers and 80% broadleaf trees.

According to the 1981 FAO report about three quarters of plantations are state owned; 15% belong to local communes and 10% are private. These figures are based on a questionnaire sent out in 1973 and can be expected to be approximate at best.

Important reafforestation projects undertaken since 1968 by the Direction des Eaux et Forêts et de la Conservation des Sols include:

- Industrial plantations in the Haute Matsiatra, covering in 1976 an area of around 35 000 ha, almost totally planted with *Pinus patula*;

- Industrial plantations in the Haut Mangoro, covering in 1976 nearly 50 000 ha of *Pinus kesiya*;

- Manankaso, where plantations of *Pinus patula* totalling some 10 000 ha were planned; several hundred hectares had been planted by the end of 1976;

- Plantations in the Vakinankaratra, a region which could be joined to that of the Haut Mangoro to supply the same industry; in 1969, 1200 ha of *Pinus patula* were planted.

- Planting of cashew *Anacardium occidentale* in Mahajanga and Antseranana provinces. The objective, apparently attained by 1981, was the planting of 40 000 ha of cashews to supply factories processing the nuts. By 1969, 11 000 ha had been planted around Mahajanga, 10 000 ha at Ambilobe, and around 9000 ha scattered through the two provinces.

- A scheme in the Morarana area which envisaged the planting of softwoods to supply a match factory at Moramanga as well as other industries. The final aim was the creation of 1500 ha of poplars, of which 350 ha had been planted in 1969 (in 1984 it was reported that the factory had closed (Jolly *et al.*, 1984)).

- A scheme to provide wind-breaks in the south of the island which aimed to plant some 100 km per year.

No significant replanting using native species has been undertaken, though small scale experimental planting has been undertaken at some forest stations.

III.6. ETHNOBOTANY

Introduction

Madagascar is currently a net importer of pharmaceuticals (World Bank figures of 3664.5 million Madagascan Francs for 1977, equivalent to ca U.S.$14 500 000). In 1977, the World Health Assembly of the World Health Organization (WHO) adopted a resolution urging governments to promote interest and research on their traditional medical systems. The rationale behind this was that, where proven effective, traditional medicine could provide an important health care resource in developing countries since it is both culturally acceptable and economically feasible (Akerele, 1984). Furthermore, medicinal plants of proven effectiveness could theoretically be cultivated and exported, thereby reducing import expenditures while increasing employment opportunities and generating foreign exchange (Plotkin, 1982). WHO has established Collaborating Centres for Traditional Medicine in Ghana, Mali, Nigeria, Sudan, India, China, Italy, Mexico, and the United States (Gyllenhaal, 1985). Appreciating the richness and uniqueness of its cultural heritage as well as its flora, the Malagasy government has expressed a strong interest in research on traditional medicine and medicinal plants, and has established a Department of Ethnobotany within the Centre National de Recherche Pharmaceutique (C.N.R.P.).

The potential value of the Madagascan flora

The Madagascan Rosy Periwinkle (*Catharanthus roseus*) belongs to the family Apocynaceae, whose species are often rich in alkaloids. *C. roseus* is the source of over 75 alkaloids, two of which are used to treat childhood leukemia and other cancers with a high rate of success. Other experimental pharmacological activities - diuretic, hypoglycaemic and antiviral - have also been associated with alkaloids extracted from this species (Svoboda and Blake, 1975). It should be noted that *C. roseus* was first subjected to laboratory investigation because of its use by local peoples as an oral hypoglycaemic agent (Cordell and Farnsworth, 1976)[2]. Sales of these anti-cancer drugs worldwide in 1980 were estimated to be worth approximately $50 million wholesale prior to 100% retail mark-up (International Marketing Statistics, 1980, quoted in Myers, 1984; Svoboda, 1981; Myers, 1984). Myers (1984) forecasts that demand for these drugs will increase by 15% by a year. It is indeed significant that Madagascar received nothing in royalties from these sales, since the drugs are currently extracted from Rosy Periwinkles cultivated in other countries (Myers, 1984). Furthermore, there are several other species of *Catharanthus* on the island and one of these, *C. coriaceous*, is considered to be in "utmost danger" of extinction (Thompson, 1984).

The actual and potential utility of the Madagascan flora is not limited to the field of medicine. Two of the important agricultural commodities on the island are coffee (*Coffea arabica*) and vanilla (*Vanilla planifolia*). In 1980, Madagascar produced 80 000 tons of coffee, which amounted to 35% of the dollar value of the country's entire exports for 1981 (see Part II). Coffee exports in 1982 were worth 34.91 billion Madagascan francs (International Monetary Fund, 1985). Although *C. arabica* originated in Ethiopia, Madagascar is home to a number of wild species, perhaps as many as fifty (Guillaumet and Mangenot, 1975). Some of these species may have potential in commercial breeding since they produce beans with little or no caffeine (Guillaumet, 1984). As far as we could ascertain, none of the Madagascan *Coffea* germplasm has been collected to conserve them for future genetic work.

Next to petroleum, coffee is one of the most important commodities in international trade and is a mainstay of the economies of several tropical countries (Imle *et al.*, 1977). Nonetheless, commercial coffee (primarily *Coffea arabica*) is rather susceptible to certain fungal diseases. The spores of these fungi are very short lived, yet rapid modes of transportation have already resulted in at least one introduction of the disease from the Old World to the New World tropics (R.E. Schultes, pers. comm.). As a result, both Central American and Brazilian coffee crops were attacked by a rust disease in the 1970s. Fortunately, a rust-resistant strain from Ethiopia was introduced with successful results. Not only is the continued success of commercial coffee cultivation dependent on the conservation of wild relatives, but coffee germplasm must also be maintained in living collections, since prolonged seed storage is not feasible (Ferwerda, 1976). Guillaumet (1984) reported finding five different coffee species within a 2 km area in a lowland rain forest reserve, and he claimed that most *Coffea* species in Madagascar exist only in reserves and protected areas.

Artificial pollination of commercial vanilla (*Vanilla planifolia* was first developed in the late 1800s, making cultivation possible in many areas, including Madagascar (Correll, 1953). Vanilla plantations were first established on Nosy Borah (Ile Ste Marie) and Nosy Bé, and were then initiated on the mainland (Koechlin *et al.*, 1979). Today, Madagascar produces most of the world's commercial vanilla: in 1982, vanilla exports were worth 16.76 billion Madagascan francs (International Financial Statistics, 1985). Despite the fact that cultivated vanilla has a very narrow genetic base (G. Wilkes, pers. comm.) and that commercial vanilla plantations on the island are periodically ravaged by fungal diseases (Guillaumet, 1984), we were unable to learn of any attempts to collect, preserve, or otherwise employ the germplasm of the 5-6 species of wild *Vanilla* endemic to Madagascar.

Madagascan fibre plants like the *Raphia* palm should also be investigated for their commercial potential. Rattan from South-east Asia is the basis of a multimillion dollar industry, yet overcollecting has severely reduced available stands in some areas (Dransfield, 1981; Myers, 1984).

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[2] Interestingly, its use was originally reported from Jamaica; nevertheless, records of its use as a folk medicine in Madagascar exist as well (see Appendix 5).

Previous studies of ethnobotany in Madagascar

More than seventy books and papers dealing with at least some aspect of the useful flora of Madagascar have been published to date. As far as we are able to ascertain, only one of these publications (Debray *et al.*, 1971) was based on field study which included collection of voucher specimens. The great majority of the works are either taxonomic or anthropological and demonstrate a paucity of first-hand ethnobotanical information.

This statement does not intimate, however, that there are not many useful data available. Excellent compilations on the ethnobotany of Madagascar (e.g. Heckel, 1910; Pernet and Meyer, 1957; Boiteau, 1974; etc.) contain information on the utility of hundreds of local species. Vernacular and scientific names as well as actual uses are presented, but there are no voucher specimens, no methodologies and sometimes no method of preparation given. The most useful works on the ethnobotany of Madagascar include (in chronological order):

1) **Heckel, 1910** - Heckel presents a compendium of ethnobotanical data from various peoples of Madagascar. Although most of the information seems to be based on the use of plants by the Merina, utilization of species by other tribes (including the Betsileo, Betsimisaraka, and the Sakalava) are also presented. This book contains data on names and/or uses of over 700 species of plants, and entries are cross-referenced by both scientific and vernacular names.

2) **Dandouau, 1922** - This paper on the charms and remedies of the Sakalava and Tsimihety notes that these tribes believe that all sickness is caused by spirits. Treatments are specified for all of the maladies listed, although unfortunately the plants are for the most part referred to only by vernacular name. The author notes, however, that *Aphloia theaeformis* and *Cassia occidentalis* were being prescribed by medical doctors at that time to treat both common and hepatic fevers.

3) **Linton, 1933** - Linton's monograph on the Tanala contains a section on alcohol and narcotics employed by members of the tribe.

4) **Dubois, 1938** - This monograph of the Betsileo contains an important contribution to Madagascan ethnobotany. The study features a section on the plant medicines of the tribe, including alphabetical listings of both the illnesses and the plants employed in their treatment. Fifty of the plants discussed are identified by their scientific name.

5) **Terrac, 1947** - Terrac's thesis represents the second major compilation of the medicinal plants of Madagascar. The work includes data on some 800 phanerogamic and 30 cryptogramic species.

6) **Robb, 1957** - A little known paper which presents an excellent overview of the use of ordeal poisons in both Africa and Madagascar. The author lists three species employed in Madagascar:

   a) "Tanghin" - *Tanghinia venenifera* (Apocynaceae). "Tanghin" was employed as an ordeal poison in the judgement of all crimes, especially sorcery. The nut or kernel of this tree of the eastern forests is highly toxic, containing a cardiac glycoside, the physiological properties of which are similar to those of strophanthin and ouabain, the active principles of an ordeal poison employed in West Africa. The use of "tanghin" to find and kill sorcerers once resulted in the death of 6000 people. It is still employed in some areas for the purposes of assassination (D. Gade, pers. comm.).

   b) "Ksopo" - *Menebea venenata* (Asclepiadaceae). "Ksopo" was the ordeal poison of the Sakalava and is found in their arid tribal homeland in the west/north-western part of the island. Like the aforementioned "Tanghin", the toxicity of "Ksopo" is attributed to the presence of a powerful cardiac glycoside.

c) "Couminga" - *Erythrophleum couminga* (Leguminosae). The toxic bark of "Couminga" was employed as an ordeal poison throughout Madagascar and the Seychelles. So poisonous did the locals consider this species, that they claimed that the fragrance of its flowers, the rain water that washed the leaves, and the smoke from burning parts of the plant all would be fatal; this is reminiscent of the stories told of the "upas" tree (*Antiaris toxicaria*) of tropical Asia (R.E. Schultes, pers. comm.). As in the two preceding examples, the active principles of "couminga" were cardiac glycosides.

Although the article concludes that the use of ordeal poisons was not practised after 1920, current reports suggest that these rituals may still persist in some of the more remote areas of the island.

7) **Pernet (1957, 1959)** - These works are regarded as the forerunner of the pharmacopeia of Madagascar. They draw on the research conducted at the Laboratoire de Chimie Vegetale in Madagascar between 1954 and 1959.

8) **Pernet and Meyer, 1957** - The *Pharmacopée de Madagascar* presents an excellent compilation of ethnomedical uses of plants. Drawing on 58 references, this work contains data on 1171 uses of over 450 species. Although no information is provided on vernacular names, use by particular tribe or chemical composition, data are cross-referenced by taxonomy and ethnomedicinal use.

9) **Decary, 1964** - An overview of the useful palms of Madagascar, this paper contains information on 31 local species and on two introduced palms. Data are presented on local distribution, scientific and vernacular names, fibre, fruit, edible starch, vegetable salt, palm hearts, and palm wine. Specific mention is made of palms used by the Sakalava and Betsimisaraka.

10) **Boiteau** *et al.*, **1968a,b** - These papers furnish data on bitter barks used for ethnomedical purposes by various peoples in Madagascar. Information is offered on practical and economic uses, etymology of vernacular names, and particular species employed.

11) **Ratsimamanga** *et al.*, **1969** - This work represents the initial effort to publish an official Madagascan Pharmacopeia along the lines of the Codex Français -- the Pharmacopeia of France. Unfortunately, it covers only the first 39 elements (i.e., it does not go beyond the letter "A"), and no subsequent portions appear to have been published.

12) **DeBray** *et al.*, **1971** - Published by ORSTOM, this book represents the single most important primary reference yet published on the ethnomedicine of Madagascar. The first section deals with the plants of the south-west and their use by the Bara, Mahafaly and Sakalava. Section two offers data on the plants of the east coast -- those employed by the Antaimoro and the Betsimisaraka. The last section is the largest of the three and details the plants of the plateau employed by the Merina.

    The importance of this work is multifold: it is all based on original fieldwork; it features exact collecting localities and voucher specimens; it offers vernacular and scientific names; and it gives the results of chemical analyses of the useful species. On the negative side, it makes virtually no reference to earlier works on the ethnobotany of the peoples or the plants. Furthermore, none of the tribes studied (with the possible exception of the Merina) was examined in depth. Nevertheless, this work represents a benchmark for future field and laboratory research on the ethnobotany of Madagascar.

13) **Rarafindrambao, 1973** - A study of *Buxus madagascarica*, a plant which is employed for a variety of purposes in Madagascar.

14) **Taylor and Farnsworth, 1975** - Although much has been written on the genus *Catharanthus*, this book offers one of the best overviews available, featuring data on the botany, distribution, taxonomy, chemistry, phytochemistry, pharmacology, and synthesis of *Catharanthus* alkaloids. Chapters include:

1. A Synopsis of the Genus *Catharanthus* (Apocynaceae) by William T. Stearn

2. The Phytochemistry and Pharmacology of *Catharanthus roseus* (L.) G. Don. by G. Svoboda and D.A. Blake

3. The Phytochemistry of Minor *Catharanthus* species by M. Tin-Wa and N.R. Farnsworth

4. Structure Elucidation and Chemistry of the Bis *Catharanthus* Alkaloids by Ronald J. Parry

6. Tissue Culture Studies of *Catharanthus roseus* by David P. Carew

7. Biochemistry of Dimeric *Catharanthus* Alkaloids by William A. Creasey

8. Clinical Aspects of the Dimeric *Catharanthus* Alkaloids by R.C. DeContin and W.A. Creasey

15) **Boiteau, 1974-79** - Boiteau was a French agronomist who founded the botanical garden and zoo at Tsimbasasa, currently under the Directorship of one of the co-authors of this report. In 1974, Boiteau began publishing the *Dictionnaire des Noms Malgaches des Végétaux* in serial parts in the Italian journal *Fitoterapia*. The entries were filed alphabetically by vernacular name, and it was originally envisioned that this work would include virtually all of the available information on the useful species of the island. Unfortunately, Boiteau died in 1980 and the *Dictionnaire* reached only the letter "L." Boiteau's wife and daughter assembled the data posthumously, and the second half of the work still exists in typescript. Since the journal *Fitoterapia* is of limited distribution and as the *Dictionnaire* is of rather limited use in its current half-published form, it is strongly suggested that the entire manuscript be published as a complete work with financing from an international conservation organization or botanical garden.

16) **Boiteau and Potier, 1976** - A general overview of the importance of ethnomedical knowledge, this article cites examples from Madagascar (such as the anti-cancer *Catharanthus roseus* and the biodynamically active species of *Evodia* employed in circumcision rites).

17) **Ratsimamanga, 1977** - A general overview by the noted Madagascan ethnobotanist Rakoto Ratsimamanga of the potential of ethnomedical species for the production of local pharmaceuticals.

18) **Boiteau, 1979** - Information on Madagascan plants specifically organized for doctors wishing to use local resources for medicinal purposes. This work contains a breakdown of useful plants by category of use (insecticide, purgatives, febrifuge, etc.) with over 90 categories, a list of simple tisanes and their uses, and other recommended preparations and their uses.

19) **Scarpa, 1980** - This paper is yet another overview of the importance of traditional medicine, offering a number of examples from Madagascar. The author concludes that traditional treatments should not be discarded but rather blended with modern scientific knowledge, hopefully with holistic results.

20) **Rabesa, 1985** (unpublished) - Dr Zatera Antoine Rabesa, Minister of Scientific Research, recently completed an ethnobotanical study of the people living near Lac Alaotra (Sihanaka?); it has not yet been published. Dr Rabesa is currently in the process of initiating a similar study of the Sakalava living near Mahajara. It is this type of research, conducted by local scientists, that bodes well for the future of ethnobotany in Madagascar, and that should be financially and logistically supported by international conservation organisations, pharmaceutical companies, and botanical gardens and museums.

Appendix 5 contains a preliminary ethnobotany database for Madagascar, detailing plants and their medicinal uses, classified both by plant species and by use.

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PART IV. MARINE AND COASTAL ECOSYSTEMS

IV.1. RELIEF

Littoral and coastal relief is characterized by marked east-west asymmetries in the same manner as the continental relief (Battistini, 1972; Guilcher and Battistini, 1967); these have strong influence on the distribution of coral reefs and mangroves, Madagascar possessing significant areas of both.

The continental shelf is very narrow on the east coast, with the 100 m depth contour 3 to 5 km offshore and the 1000 m contour 15 to 30 km offshore; by contrast, on the west coast the 100 m contour is 30 to 80 km offshore, the 1000 m contour 40 to 150 km. The shelf is notably wide between Cap d'Ambre and Mahajanga, between Soalala and Morondava, and between Taolanaro and Androka.

Tidal amplitude differs considerably - on the east coast high-tide level is very low (some 50 cm), while on the west it commonly reaches 3 to 5 m. This (and the very wide extent of the western coastal plain) allows the development of extensive brackish water areas in the west, while in the east the transition from sea to fresh water is usually very rapid.

Following Battistini (1972), littoral relief can be divided into four main regions:

i. The north-west between Cap d'Ambre and Cap Saint-André shows a characteristic submerged continental relief and has the most indented coastline of the island, with many bays and capes (often of relatively high elevation) and large numbers of offshore islands.

ii. Along the west and south-west between Cap Saint-André and Cap Sainte-Marie, the coastline is low-lying and monotonous in appearance, being more or less without indentations and having very long sandy beaches, with mangrove swamps behind. There are many large deltas, only the largest of which (e.g. Mangoky and Tsiribihina) extend for a short distance out to sea; others are aborted to a greater or lesser degree by ocean swell shaping a straight coastline. This contributes to the formation of a large, low-lying littoral plain.

iii. The extreme south is characterised by considerable quaternary dune accumulations; the oldest of these are sandstone with cross bedding, and lead to a rocky coast in many regions. Elsewhere (such as along the Mahafaly coastline in the south-west) there are vast sandy beaches. No mangrove swamps of any size are found.

iv. The east coast between Taolanoro and Foulpointe is more or less straight for over 700 km and is low lying with a continuous offshore sandbar, behind which is a string of lagoons linked together by the artificial Canal des Pangalanes. North of Foulpointe relief is more varied, and becomes quite high in the Mananara region, in Antongil Bay and around Cap Masoala.

IV.2. MANGROVES

Madagascar possesses the largest areas of mangrove in the western Indian Ocean. In 1972 Keiner estimated there to be ca 330 000 ha of mangroves on the island; at least 321 000 ha of this was along the western coast. On the east there were only eleven mangrove sites of any size, the largest of these being ca 2220 ha in Rodo bay.

On the west coast mangroves could be divided into some 29 separate areas. Seven of these were over 20 000 ha in extent, with the largest, in the Bay of Bombetoka, covering some 46 000 ha. In total, there were 320 000 ha of mangroves in areas of over 1000 ha with an additional 10 000 ha of small or very small areas of mangrove often at the mouths of streams or in small bays. Of particular note are the 18 000 ha of mangrove in the Loza, a very large lagoon in the north-west of the island.

Floristic composition and zonation are typical of Indian Ocean mangrove systems. The following widespread species reportedly occur: *Rhizophora mucronata, Avicennia marina, Sonneratia alba, Ceriops tagal, Bruguiera gymnorrhiza, Xylocarpus granatum, X. moluccensis, Lumnitzera racemosa* and *Heritiera littoralis*. The *Ceriops* is sometimes considered an endemic species, *C. boiviniana*.

Economic importance

Mangroves are very important for inshore fisheries, serving as nursery areas for many species of fish and crustacea. There are otherwise few data on utilization of mangroves, though it is noted that generally the most extensive mangrove areas are in regions of low population density which are inaccessible for part of the year (Keiner, 1963, 1965, 1972).

Amongst crustacea, Penaeid shrimps (especially the large species *Penaeus monodon* and *P. indicus*) and the crab *Scylla serata* are important (see Part V.10), and among fish the families Carangidae, Carcharinidae, Mugilidae, Serranidae, and Sparidae.

Fisheries of sharks and saw-fish are important in all mangrove areas; salted-dried meat is the object of many transactions, especially in the region of Mahajanga.

IV.3. CORAL REEFS

Reefs on Madagascar are extensive and numerous and include good examples of almost all of the main classical reef types. Some of these have been very well studied; the barrier reef at Toliara (see separate account) has probably been studied more than any other reef in the Indian Ocean, while others, particularly on the east coast, remain largely undescribed. Most of the work done on Madgascan reefs has been from the French group led by Battistini, Pichon and Picard, and much of the following is derived from the extensive bibliography of this group (see 'References'). Most information is taken from Battistini (1960 and 1964), Clausade *et al.* (1971), Pichon (1971a, 1972a, 1972b, 1974 and 1978b) and UNEP (1982b). Bibliographies of marine studies up to the early 1970s are given in ORSTOM (1973 and 1975). Most research has been carried out at Nosy Bé in the north-west and Toliara in the south-west where the French authorities maintained research stations. Research still continues in these areas, the stations having been handed over to the Madagascan authorities.

Regional variations in water conditions influence the distribution of reefs. Tidal amplitude differs considerably. On the east coast high-tide level is very low (some 50 cm), while on the west it commonly exceeds 3 m at spring-tide. Western tides are regular semi-diurnal, with low tides at noon and midnight. Currents also vary regionally. They are predominantly southerly on the east coast, where they are derived directly from the South Equatorial Current; on the west coast they are usually northerly, derived from either the South Equatorial Current as it flows around the south of the country or from a counterflow to the Mozambique Current. On reefs which have been well studied, local current patterns have been found to be complex because of the large and irregular expanse of many of the reef areas and the large tidal range. Surprisingly, the temperature differences between north and south (between which there is a difference in latitude of 10°) do not appear to have any influence on the richness of the coral fauna. At Toliara (Tuléar) stony corals disappear at a depth of about 30 m; off Nosy Bé they extend to depths of 45-60 m. At Toliara temperatures in the lagoon average 21.5°C in July/August and 30°C in January/February. Sixty-three genera of reef-building corals have been found in the Nosy Bé region and sixty-two at Toliara where the waters are colder.

Distribution of reefs

Reefs of the east coast are least known. There are rudimentary but extensive fringing reefs behind which run a chain of shallow lagoons. Behind the reefs and a series of coastal dunes the lagoons were once connected to form an inland waterway called the Pangalanes Canal. This was once navigable for about 700 km but much of it is now colonized by herbaceous plants (UNEP, 1982b). In the north-eastern part around Antseranana there is an emergent reef with a channel up to 8 metres deep (Pichon, 1972a). South of Antseranana are two superimposed emergent reefs, the older elevated to 16 m and partly covered by dunes. Nearer the coast this system becomes fragmented, and has the appearance of a chain of coral islets connected to the land. This series of structures includes the Leven Islands (Pichon 1972a) which are bordered at their outer edge by a discontinuous fringe of coral. Such coral reefs are numerous amongst the small islands of the east coast (Rabesandratana, 1984). Further south, Nosy Borah (Ile Sainte-Marie) has fringing coral growth, while in the Toamasina region there is a submerged and fragmented barrier reef. This also has coral growth on the seaward periphery, with a reef flat covered with seagrasses. The sand bar to the south which runs for 700 km is considered by Pichon (1972a) not to have reef formations, although a few coral communities may be found which are isolated and not true reefs.

The west coast has the main reef formations covering a distance of more than 1000 km (Pichon, 1972a; Rabesandratana, 1985). These are located in the north-west (from Cap d'Ambre to Narendy Bay), and south-west, separated by a central region with relatively sparse reef growth between the Mangoky delta and Androka. In the far north-west, the coast is bordered by emergent fossil reefs up to 10 metres above present sea level. Living fringing reefs are well developed along the mainland coast and around offshore islands, except in the vicinity of deltas and their adjacent bays. Fringing reefs are well developed between Cap d'Ambre and Narendy Bay; narrow reefs occur between Courrier and Bejotaka Bays; small reefs are found off Cap Sebastien. Fringing reef is found on either side of Ambavatoby Bay and along the west coast of Ampasindanva Peninsula from the Kakamba estuary to the Bay of Rafaralahy. There is a long fringing reef between Ramanetaka Bay and Ansatramahavelona and on the west coast of Nosy Lava. Further south there are a few small isolated reefs, in particular north of the entrance to Mahajamba Bay, at the entrance to Mahajunga Bay, north-east of Boina Bay, on either side of Baly Bay and between the latter and Antaly Bay. No detailed studies have been made south of Narendy Bay. Fringing reefs are found around some of the small volcanic islands along this coast such as Nosy Vahila, Nosy Mananono, Tanykely, the Radama Islands, Nosy Saba, etc. Extensive coral formations are found in some of the bays along the coast where there is little sedimentation, e.g. Lotsoina Bay, Ampanasina Bay. The more exposed reefs, notably some around the island Nosy Bé (see separate account), have typical well-developed structures, including boulder zones and spur and groove systems. The Baie d' Ambaro, also in the north-west, has been studied in detail because of its rich shrimp stocks (Daniel *et al.*, 1970; Daniel, 1972). Off shore in this area, coral formations occur on the Banc du Leven (Daniel *et al.*, 1972). Octocorals from north-western Madagascar are described by Verseveldt (1973).

In addition to these inshore and fringing reefs, there is a rise in the sea floor 10-60 km further off shore, at the edge of the continental shelf (Pichon 1972a). This rise may be a submerged barrier reef or a cuesta formed during an emergent phase. Much of it lies 5-15 metres deep or less in places, but is cut by several channels opposite large river deltas. At its northern extent parts are emergent, forming reefs which support the sand cays of Nosy Anambo, Nosy Fasy, Nosy Faty and Nosy Foty. Elsewhere the surface of the barrier is covered with vast sandy plains and has a coral cover of only 10% in most places; it is likely the reef is not growing, though no explanation is available for this.

The central section of the west coast has no reefs or has poor fringing reef, although off shore there are two groups: the Pracel Shoal and reefs around the Barren Islands. The former are separated over 100 km, but only two parts, Chesterfield Island and Nosy Vato, are permanently above water and in both cases the island is in the north-east of the reef flat, which shows the influence of the dominant seas from the south-west (Pichon, 1972a). The Barren Islands support a greater number of emergent reefs and sand cays and extend over 50 km. It is possible that these are the southernmost extent of the offshore barrier described for the north-west part of Madagascar. Little work has been done on the reefs of the central sector, and further study is required.

Reefs of the south-west sector are well developed and the best known (Clausade *et al.*, 1971; Pichon, 1972a, 1972b, 1978a, 1978b, Thomassin, 1978b; Vasseur, 1981; Weydert, 1973a, 1973b). Fringing reef, barrier reefs and reefs with sand cays are all represented, together with intermediate types. Due to the narrowness of the continental shelf, the reef often changes from barrier to the fringing type. Winds and wave energy come from the south-west with enough strength to allow crustose coralline algae to dominate in shallow water. Sand cays are particulary numerous in the northern part of this sector, between the Bay of Assassins and the Mangoky delta. Two kinds of cay exist: those which rest on isolated parts of a barrier well offshore and are separated from it by up to 30 metres of water, and those located on a fringing reef situated behind the barrier. Both exhibit adaptation to the prevailing south-westerly seas, with a clearly marked succession of spur and groove system to seaward, an algal flat and a boulder tract and an inner reef flat with corals before the island. To leeward of the islands are seagrass patches, before a leeward slope with spurs and grooves.

From the Mangoky delta there is almost continuous reef to the Onilahy River (Pichon 1972a). The first part of the Bay of Assasins has a series of small fringing reefs. South of this, the fringing reef becomes 2-3.5 km wide, extending for almost 80 km. It is interrupted by occassional passages, and contains a channel between it and the shore which is 10 metres deep in the north, shallowing to 1.5-5 metres in the south, and disappearing at Manombo. South of Manombo, the coral reefs move offshore opposite Ranobe Bay and Toliara Bay, although between these there is a fringing reef adjacent to the mainland. The reefs of Ranobe Bay are described by Clausade *et al.* (1971). Opposite Toliara is the Grand Récif which extends for 18 km, and is up to 3 km wide (see separate account). From the Onilahy River, a fringing reef extends southwards almost unbroken for nearly 100 km although it is rather depauperate in comparison with more northern reefs. Its width varies greatly from 0.5 to 3.5 km in the northern part because of a very embayed shoreline. This reef disappears at Lanivato. A small fringing reef appears south of this at Itampolo and then at Androka. South of the latter, reefs only exist offshore around the sand cay of Nosy Manitsa and the Etoile Shoal (Pichon, 1972a). The latter are the highest parts of another submerged barrier reef on the edge of the continental shelf which runs for about 50 km.

Conservation and utilisation of reefs

A general description of marine and coastal resources is given in Anon. (1985). Reef areas, cays and lagoons are important habitats for many groups of animals which are epxloited locally, or in some cases for national or international markets, including marine turtles, the Dugong *Dugong dugon*, molluscs, crustaceans and fishes. Reef fish on the west coast are described by Fourmanoir (1963); other groups are fully discussed in the relevant sections of Part V and in Appendix 3.

The impact of current human activities on the reefs is virtually unknown. A threat of possible importance to Madagascan reefs is sediment accumulation as a result of the massive erosion and concomitant soil runoff which affects much of the island (Pichon, 1984, and see Parts I and III).

Sediment accumulation is acute in many areas, as illustrated by the loss of use of the port of Mahajanga due to the deposition of 100 million cubic metres of silt in 25 years. Elsewhere, in the north, river deltas have expanded and sediments have reportedly been deposited on beaches and reefs, changing lagoonal current patterns and having potentially adverse effects on local fisheries. However, there appear to be no concrete data on the effects of sediment on Madagascan reefs.

Over-fishing is reportedly becoming a serious problem, especially on the Grand Récif (see separate account). Pollution on the western coast, where most reefs occur, appears to be of minor importance at present and dynamiting for fish, which is a common practice in many countries, is not a major threat (Pichon, 1984). Corals have reportedly been used in the past for building materials (Rabesandratana, 1984), though it is not clear if this continues.

There is at present no legislation to protect coral reefs, though the Grand Récif at Toliara has twice been proposed as a Marine Park (see separate account). It is recommended that surveys of the more accessible reef areas, particularly Nosy Bé, Toliara and Nosy Borah, should be carried out to determine their status and the establishment of marine parks should be seriously considered (Anon., 1985). Randrianarijaona and Razafimbelo (1983) stress the need to take into consideration socio-economic factors in any such areas. Multiple use Marine Parks might be suitable, to ensure that the economic benefits to be gained from tourism are not overlooked.

A series of projects concerning coastal zone management were presented at a conference on Conservation des Ressources Naturelles au Service du Développement held in Antananarivo in November 1985. These included a study to evaluate coral reef resources, the establishment of the Parc National du Grand Récif de Toliara, and a number of projects relating to fisheries and pollution (Anon., 1985).

Data for three reefs or groups of reefs of particular interest are provided below. This information is taken from the forthcoming Directory of Reefs of International Importance. Details, where available, are provided under the following headings: Name; Geographical location; Area, depth, altitude; Physical features; Reef structure and corals; Noteworthy fauna and flora; Scientific importance and research; Economic value and social benefits; Disturbances or deficiencies; Legal protection; Management; Recommendations.

NAME Grand Récif proposed Marine National Park

GEOGRAPHICAL LOCATION South-west Madagascar, near Toliara. 23°25'S, 43°40'E.

AREA, DEPTH, ALTITUDE Grand Récif is over 15 km long from north to south, and up to 3 km wide. Depths on the seaward slope exceed 50 m.

PHYSICAL FEATURES The following is derived principally from the work of Clausade *et al.* (1971) and Pichon (1971a, 1972a and 1978b), Thomassin (1978b), Vasseur (1981) and Weydert (1973a, 1973b).

The reefs of Toliara, including Grand Récif, are protected from the south-east trade wind by the mainland. South-west winds blow for much of the year but are stronger and more persistant in winter, and are reinforced by thermic wind effects. These raise a rough sea, even in the lagoon area behind the barrier reef. In the absence of this wind, a heavy swell of remote origin can be detected. Cyclones in the Mozambique channel can also create a disturbed sea state for several days. Tides are semi-diurnal, with a maximum range of 3.2 m. This is a lower range than occurs in the north of Madagascar, though it is fairly substantial for coral reef areas. Low spring tides at noon and midnight have a strong controlling influence on the biota of the reef flat; the tidal amplitude is such that there are strong localised currents during ebb and flow. Rainfall is sparse in this area, but sufficient rainfall in the interior results in permanent rivers and a marked terrigenous component to the sediments near the coast. Surface water temperatures vary seasonally from 22.5°C to 27.5°C. Sediments in the reef area are described by Thomassin and Cauwet (1985).

The Bay of Toliara (Tuléar) is connected to the sea by two channels, Passe Nord and Passe Sud, which dissect Grand Récif, a barrier reef 18 km long and 1100-2900 m wide. Nosy Tafara is an islet situated to the south of the Grand Récif. In the southern part of the bay there are three lagoon reefs - Beloza, Dimadimatsy, and Norinkazo, which are separated from the shore by a littoral channel 1 km wide with maximum depth 2 m. These reefs (about 1000 x 1000 m) are separated from each other by passes about 300 m wide and 4-5 m deep, with strong currents. North of the inner reefs lie two sandstone banks, Mareana and Ankilibe, which have a scattering of isolated coral heads (Clausade *et al.*, 1971). On the south of the bay, there is a fringing reef on the west side of the sandy Sarodrana peninsula, 3500 m x 450-1000 m wide (Pichon, 1978b).

REEF STRUCTURE and CORALS There have been numerous ecological and descriptive studies of the Toliara reefs (Clausade *et al.*, 1971; Harmelin-Vivien *et al.*, 1982; Jaubert and Vasseur, 1974; Pichon, 1972a, 1972b, 1978a, 1978b; Peyrot-Clausade, 1977; Thomassin, 1978b, 1983; Thomassin and Cauwet, 1985; Vasseur, 1974, 1977, 1981, 1984; Weydert, 1973a, 1973b). Several distinct zones on the Grand Récif have been described in detail by Pichon (1972a, 1978b). The 'frontorecifal ensemble', or seaward reef slope, is very steep but rarely vertical. Scleractinian corals are abundant, extending to at least 30 m deep, depending on local reef profiles and sedimentary conditions. The deep seaward slope, 300-400 m wide, gives way to a gently sloping terrace which drops from 20 to 50 m, with an average depth of 20 m. The morphology of this '20 m terrace' is characterised by large furrows at right angles to the reef, the floors of which are sand-filled, with ridges covered with corals. The terrace extends up to the edge of the reef flat, which it joins in a short but vertical wall of corals. This wall consists of a groove and spur system aligned with the coral ridges on the deeper terrace. The grooves are part filled with coral debris; the spurs are constructed of corals and abundant calcareous red algae. Numerous tunnels are formed by grooves which have coalesced at the top. Some of these caverns communicate with the reef flat by blowholes, while others become blocked with sediments. This network of overhangs, grooves and tunnels houses a diverse cryptic community of ahermatypic corals and other sessile invertebrates which has been described by Jaubert and Vasseur (1974) and Vasseur (1974, 1977).

The spur and groove structures are best developed on parts of the reef most exposed to the south-westerly seas. On the deeper part of the seaward slope below the terrace, coral diversity decreases with depth, and there is a simultaneous decline in abundance (Pichon, 1978b). The dominant coral family is the Pectiniidae, in particular the genera *Echinophyllia* and *Oxypora*; *Pectinia* is less common. Other common genera are the agariciids *Leptoseris* and *Pachyseris*, a *Pocillopora* species and the mussids *Cynarina lacrymalis* and *Blastomussa* sp. Gorgonia and the ahermatypic coral *Dendrophyllia* are also common, with antipatharians and alcyonarians. On the terrace, coral diversity is greater on shallower parts of the terrace and species characteristic of the deeper part become less abundant. Common genera are *Acropora*, *Porites*, *Lobophyllia* and several faviids. On the buttresses, these species decrease in shallower, more turbulent water, and are replaced by encrusting species from the genera *Pavona*, *Hydnophora*, *Montipora* and *Acropora*. The tops of the buttresses support numerous Pocilloporidae, and a high cover of calcareous red algae. In the most exposed parts, *Acropora* is the principal genus, but coralline algae may be dominant, although there is no true algal ridge either here or in any other part of Madagascar (Pichon, 1972a).

The vast plateau of the reef flat of Grand Récif is exposed by a few decimetres at low spring-tides and has been termed the 'epirecifal ensemble'. On the outer reef flat there is an upper platform of spurs, dominated by crustose coralline algae. Shoreward of this is an outer moat with algae and corals, followed by an outer pavement with encrusting coralline algae but few corals. A boulder tract is then reached, consisting of corals and blocks of limestone deposited by strong sea conditions. This provides the highest elevation on the reef flat, reaching 1 m above the surrounding level. Several corals, zoanthids and algae grow on the boulder surfaces while beneath them is a very rich mollusc, crustacean and echinoderm fauna. Inside this there is an inner moat remaining covered at low spring-tides, which is flat and covered by sandy patches, with many corals whose growth is truncated by the low water level. Microatolls are common, as are groups of corals whose growth is peripheral only. The reef flat at this point is friable and irregular. Corals become less abundant as a third zone of seagrass beds is reached which lie on a slightly raised part, occupying half of the reef flat. Large accumulations of sediments are found here with a typical seagrass-sediment fauna, notably echinoderms (Clausade *et al.*, 1971; Pichon, 1978b).

Behind the Grand Récif, the reef flat gives way to a 'postrecifal ensemble' (Clausade *et al.*, 1971; Pichon, 1978b), the reef slope descending to a lagoon floor with a maximum depth of 20 m. Currents mostly run parallel to the shore, and the sediments have an increasing terrigenous component as shore is approached. A variety of seagrasses characterize the area, with abundant coral patches and pinnacles, particularly near the reef. These are formed largely by massive faviid corals, with *Acropora*, several foliaceous species, and *Millepora*. Such reefs also occur adjoining the mainland, where their tops support seagrasses which grade into the littoral zone.

Altogether, 62 hermatypic coral genera have been reported (Pichon, 1978). Amongst the corals, the genus *Horastrea* appears to be fairly common. Thomassin (1969, 1973, 1978a, 1978b) and Thomassin *et al.* (1976) have described the sandy bottom communities of the area.

NOTEWORTHY FAUNA and FLORA The marine fauna has been extensively studied. For example, the fish fauna of the outer slope of the Grand Récif is described by Harmelin-Vivien (1977). The mollusc fauna on the boulder tracts is described by Thomassin and Galenon (1977); sponge distribution is described by Vacelet and Vasseur (1977). Mangroves are found around Saradrano.

SCIENTIFIC IMPORTANCE and RESEARCH More research has been done on the reef morphology and coral communities of the Grand Récif than on any other single reef in the Indian Ocean. Accompanying this is a wide range of marine studies with direct relevance to the reef and its communities, resulting in a very substantial body of detailed literature. For this reason, the reef is of great importance to comparative and temporal studies of reef systems in general. The marine station of the University of Madagascar is situated at Toliara. Up until 1955, the work carried out there was conducted almost exclusively by French researchers (generally from the Station Marine d'Endoume, Marseille). Currently, research is carried out by Madagascans and visiting scientists. Productivity of the reef has recently been studied by Pichon and Morrissey (1985).

ECONOMIC VALUE and SOCIAL BENEFITS Commercial harvesting of fish and invertebrates takes place, the former at least, on an increasingly large scale. The Toliara reefs are the main area of exploitation of reef fish, local consumption exceeding 100 tonnes annually. Rabesandratana (1985) provides further details. Prawns are collected on the inner slope of the lagoon where littoral mangroves grow in proximity to the reefs. The Spiny Lobster *Panulirus penicillatus* is collected for local consumption (see Part V.10). *Scylla serrata* is occasionally caught on seagrass beds on the Grand Récif. Molluscs collected include *Charonia tritonis*, *Cypraeacassis rufa*, and *Pinctada (Meleagrina) margaritifera* (Rabesandratana, 1984, 1985 and see Part V.8). The massive coral *Porites somaliensis* is collected from the Grand Récif for use in septic tanks and cesspools. Branching corals are also collected for sale to tourists in the shell market at Toliara. Corals were exported until at least 1980, when an export figure of 4.1 tonnes was recorded by the Toliara customs office (Rabesandratana, 1985). Shells are exported in large quantities for the ornamental shell trade from the Toliara region, and certain species are considered to be coming rare (Rabesandratana, 1985). The area has a high potential for tourism, as yet largely unrealized. A French-run hotel caters for the few SCUBA divers who visit the area and an underwater trail has been set up (Pichon, 1983).

DISTURBANCE or DEFICIENCIES Corals, such as *Porites somaliensis*, have in the past been collected for building purposes (Rabesandratana, 1984), though it is unclear to what extent the practice continues. Over-fishing is becoming a serious problem. Pichon reported in 1983 that up to 200 boats used the Grand Récif daily; in the early 1970s the area was virtually unfished. Populations of benthic fishes had been noticeably depleted, though pelagic fish populations were as yet apparently largely unaffected (Pichon, 1983). Fishing is carried out with nets, often with mesh below the legal size, with harpoons and with toxins extracted from plants (e.g. *Euphorbia*). This last method is noted as being particularly destructive as it kills indiscriminately. Amongst invertebrates, *Pinctada (Meleagrina) margaritifera* has reportedly been overharvested to the point of virtual extinction and *Cypraeacassis rufa* has become noticeably rarer; concern has also been expressed for *Charonia tritonis*, of which large numbers, including small specimens, are reportedly on sale in Toliara; minimum size regulations, where these exist, are largely ignored (Rabesandratana, 1984).

LEGAL PROTECTION There is at present no legal protection for the reefs.

RECOMMENDATIONS The Grand Récif has been proposed as a National Marine Park; this designation has been refused twice by the Ministry of Animal Production and Forests (Rabesandratana, 1984). The proposal is for the creation of two reserves: an integral reserve, containing the Grand Récif de Toliara (within the area 23°20'-23°38'S, 43°30'-43°42'E), and an adjacent partial reserve, containing the 'postrecifal channel', the mangrove area of Sarodrano, and the reefs fringing the coastline of Barn-Hill Point. The proposal aims to assure conservation of the reef, while developing its potential for scientific research and tourism (both national and international) and managing fisheries resources to allow sustained harvests by local fishermen. Under the proposed decree, access to the integral reserve will be limited to authorised personnel, though this will include tourists accompanied by officials. Licensed artisanal fishermen will also be permitted, though fishing will be under strict control (e.g. all underwater fishing and use of toxins, explosives and monofilament nets banned). Access to the partial reserve will be uncontrolled, though again fishing will be controlled and limited to licensed artisanal fishermen. The importance of a local education programme to demonstrate the value of such conservation measures is stressed (Rabesandratana, 1984).

NAME **Nosy Bé**

GEOGRAPHICAL LOCATION Island off north-west coast; 13°20'S, 48°15'E.

PHYSICAL FEATURES Nosy Bé is a volcanic island on the continental shelf of Madagascar (Battistini, 1960). Its coast is a very embayed, low Quaternary plain, and reef flats are found around much of the island. Seaward of the reef flats, the reef slopes are extensive, reaching to at least 20 m deep, and sometimes to 45 m. Deeper slopes exist, but these are sedimented (Pichon, 1971a).

Dominant seas come from the north-west or north-north-west, while in winter the south-east trade winds occur, from which Nosy Bé is protected to a great extent by the Madagascan mainland. Rain is abundant in the southern summer, and infrequent in the cooler season. In common with other reefs near Madagascar, this results in a relatively high proportion of terrigenous sediment mixed with the limestone sediments, and turbidity is always high. Surface temperatures are relatively stable, ranging from 24° to 29°C. The area is subjected to cyclones (UNEP, 1982b), but the swell is usually weak. The reefs experience a tidal amplitude of 4.2 m (Pichon, 1972a).

REEF STRUCTURE and CORALS The geology of the reefs has been described by Battistini (1960), and their biology by Pichon (1971a and 1972a). The morphological and sedimentological characteristics of Nosy Bé, as well as the reef communities, are characteristic of a low energy regime. Common corals are fungiids, and crustose coralline algae are lacking. Approximately 63 genera have been recorded (Pichon, 1978b). The most typical reefs are Andilana Reef on the north-west coast, and Amphoraha and Navetsy Reefs on the north coast. These have developed on the most exposed parts of the island and exhibit typical spur and groove structures with well developed boulder tracts. On the eastern coast, the reefs Antsatrabevoa, Antafianambitry and Befefiky are exposed only to a local breeze which blows from the south-east and which therefore has a small fetch. These reefs may have extensive reef flats up to 1.5 km wide, a rudimentary spur system, and a small boulder tract both of which are thickly covered with corals with typical genera such as *Caulastrea*. Other anthozoans and calcareous red algae are not extensive. On the outer flats is a seagrass bed of *Thalassodendron ciliatum* and *Syringodium isoetifolium* which forms a 20 m wide, uninterrupted strip just in front of the boulder zone, on a layer of sand of skeletal origin 15-25 cm thick. Seagrass beds are also extensive on the inner parts of the reef flats (Pichon, 1972a). On the west and south-west, the reefs are poorly developed and not very active; reef flats are absent, but their place may be taken by accumulations of broken coral fragments.

Reef slopes of the fringing reefs extend to only 8 or 10 m depth. A rudimentary spur and groove system is discernible only at low tides on the more exposed reefs (it is absent from sheltered reefs) and appears to be formed from an alignment of corals rather than substantial algal constructions. Coral species are diverse, composed of massive and foliaceous forms, but few *Acropora* species. A notable antipatharian, *Eucirripathes*, is a constant element on these reefs. At 8-10 m depth the rough alignments of corals disappear, and the grooves become filled with sediment. On the sedimented slope below the reef slope, communities of the corals *Heteropsammia michelini* and *Heterocyathus aequicostatus* exist, with some *Trachyphyllia geoffroyi*. In general terms, these reefs are regarded as 'inner reefs' analogous to the inner reefs of Toliara to the south (see separate account) (Pichon, 1972a), while the muddy bottom coral community is analogous to that of a lagoon floor. In this case, the 'lagoon' extends from the base of the fringing reefs out to the reefs of an outer barrier, which is submerged.

Reef slopes of the outer, submerged barrier formation, which lies to the west, extend deeper than those which fringe the island itself. There are two principal types of slope: gentle slopes (up to 45°) with rich scleractinian communities, notably tubular *Acropora* corals to about 45 m deep, with abundant *Peyssonnelia* and *Halimeda* algae; and near-vertical slopes, which support abundant coral to about 20 m, below which diversity is much poorer. At 50-70 m depth, these walls are covered with a fine sediment composed of *Halimeda* fragments.

NOTEWORTHY FAUNA and FLORA Mangroves are abundant in many of the bays and estuaries. *Eretmochelys imbricata* is reportedly present, though it is not known whether it nests here. *Cypraea* species are abundant and species recorded include *C. nucleus*, *C. diluculum*, *C. onyx*, *C. oweni*, *C. lamaki* and *C. chinensis* (Magnier, 1981). The Tropic bird *Phaethon lepturus lepturus* breeds on nearby islands (Cooper *et al.*, 1984).

ECONOMIC VALUE and SOCIAL BENEFITS Nosy Bé is one of the few important tourist centres in Madagascar (Jolly, 1980; Magnier, 1981); coral reefs appear to be a significant tourist attraction, though it is unclear to what extent their full potential has been developed. *Pinctada margaritifera* has reportedly been heavily exploited, to the point of virtual extinction, having formerly been abundant in the area (Rabesandratana, 1984). Ornamental shells are collected in the Nosy Bé area (Randrianarijaona and Razafimbelo, 1983).

SCIENTIFIC IMPORTANCE and RESEARCH Previously ORSTOM had a research station at Nosy Bé which carried out fishery studies. A National Oceanographic Institute is based at Nosy Bé. Projects have reportedly been funded on fisheries and pollution, though the latter does not appear to be a serious problem in this part of Madagascar at present (Pichon, 1983).

DISTURBANCE or DEFICIENCIES Overexploitation of *P. margaritifera* (see above).

LEGAL PROTECTION The small island Nosy Tanikely, about 8 km south of Nosy Bé, is protected for its terrestrial fauna, and the surrounding waters are considered a Marine Reserve but have no legal protection (Rabesandratana, 1984).

The 740 ha Réserve Naturelle Intégrale de Lokobé (R.N.I. no. 6) is situated in the south-east corner of Nosy Bé. The coast line forms the southern edge of the reserve (See Part VI); Pichon (1972a) indicates that at least part of this has a reef front, though it is not clear whether protection extends offshore.

NAME Offshore sand cays: Nosy Foty, Nosy Anambo, Nosy Fasy, Nosy Faty, Nosy Faho, Nosy Langna

GEOGRAPHICAL LOCATION North-west continental shelf; between 12° and 13°20'S, 48 and 49°E.

PHYSICAL FEATURES Data for these small islands are taken primarily from Pichon (1972a). Low islands with surrounding reef, some (Nosy Fasy and Nosy Faty) emergent only at low tide. Nosy Langna also has an outcrop of Cretaceous pre-coralline basement at the level of the reef flat. The direction of the swell affecting the reefs is predominantly from the north-west and north-north-west, with only gentle seas along the sides facing the Madagascan mainland. Temperatures range from about 24°C to 29°C.

REEF STRUCTURE and CORALS The reefs of Nosy Anambo, Fasy, Faty and Foty represent emergent parts of the offshore barrier reef structure (see 'Introduction'). The coral structures topped by these sand cays show marked adaptations to the dominant north-west seas. The cays generally lie on the leeward edges of the reef flats. Facing the direction of maximum exposure, the reef flat is edged by a spur and groove structure which is dominated by calcareous red algae, behind which is a boulder tract. Most of the flats have sandy expanses alternating with coral formations. On the leeward sides of the cays is a sandy shore, followed by large expanses of corals with alcyonarians and *Millepora*, followed by deeper beds of the seagrass *Thalassodendron ciliatum* (Pichon, 1972a).

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PART V. FAUNA

The fauna of Madagascar is unique. The large size of the island, its geological history and varied climate and topography have resulted in a diverse fauna with a remarkable degree of endemicity, both at species and higher taxonomic levels.

In general, individual faunal groups are less diverse than in equivalent (tropical) continental areas - this applies to, for example, birds, mammals, freshwater fish and butterflies (qv); however other groups, such as reptiles and terrestrial molluscs, show relatively high species diversity, well comparable with continental areas.

The great majority of native terrestrial species, in all faunal groups, appear to be dependent on forested or wooded areas, lending support to the contention that originally (that is before human settlement) much of the island was forested - this in contrast to present-day conditions whereby only 20-30% of the land area bears woody cover (see Part III.4).

The following section provides summaries for: birds; mammals; amphibians and reptiles; freshwater fish; lepidoptera; freshwater, terrestrial and marine molluscs; non-marine and marine crustacea; other non-arthropod invertebrates.

Data sheets for individual species for some of these groups, extracted from the relevant IUCN Red Data Book, are provided in Appendix 3 and annotated species lists in Appendix 2. Preliminary faunal lists for each reserve are included in Part VI.

Reference lists are provided at the end of each of the following sections; in addition extensive references are provided with the data sheets on individual species in Appendix 3.

The most important reference work for animal species on Madagascar is the on-going *Faune de Madagascar* (1956-). Of the 64 volumes published to date, one concerns birds (vol. 35), two deal with mammals (vols 36,44), three with reptiles (vols 33,36,47), one with zoogeography (vol. 13) and the remainder with invertebrates [in French].

The volume *Biogeography and ecology in Madagascar* (1972, *Monographiae biologicae* 21, edited by R. Battistini and G. Richard-Vindard, Junk Publishers, the Hague), contains chapters on the following groups: arachnids, terrestrial molluscs, insects, freshwater and euryhaline fish, reptiles, birds, insectivores, rodents, carnivores, and primates [part English, part French].

Madagascar, un sanctuaire de la nature (1981, edited by P. Oberlé, Lechevalier, Paris) also has (more generalized) chapters on invertebrates, reptiles and amphibians, birds, and mammals [in French].

Key environments: Madagascar (1984, edited by A. Jolly, P. Oberlé, and R. Albignac, Pergamon Press, Oxford) also has introductory chapters on invertebrates, amphibians, reptiles, birds, and mammals with separate chapters for insectivores, carnivores and lemurs (the chapters on invertebrates, birds, reptiles and mammals are English translations of the equivalent chapters in *Madagascar, un sanctuaire de la nature*).

V.1. BIRDS

The avifauna of Madagascar, as much of the rest of the fauna, is characterised by two factors - a relative poverty in number of species (compared with equivalent continental areas), and a high degree of endemism at family and lower taxonomic levels.

Forbes-Watson *et al.* (1974) listed 250 species in the avifauna of Madagascar, including 2 introductions, 53 non-breeding visitors, and 197 native breeding species. Of these 197 residents, 106 are endemic (a further 25 are shared only with the Comoros). Among these 106 species, there are 32 endemic genera (a further eight are shared only with the Comoros). An annotated list of bird species recorded in Madagascar, based on Forbes-Watson *et al.* (1974) and Dee (in press) is provided in Appendix 2.

The following five families are endemic to the Madagascar Region:

Mesitornithidae (Mesites)	3 spp.	
Brachypteraciidae (Ground-rollers)	5 spp.	
Leptosomatidae (Cuckoo-roller)	1 sp.	(also occurs on the Comoros;)
Philepittidae (Asitys)	4 spp.	
Vangidae (Vangas)	14 spp.	(one species also occurs on the Comoros)

One subfamily is also endemic to the region:

Couinae (Cuculidae) (Couas)	10 spp.	(one probably extinct)

The Leptosomatidae and Brachypteraciidae have been considered subfamilies of the Coraciidae but are now generally recogised as distinct families.

Status

One species - *Coua delalandei* - is regarded as (probably) recently extinct; 27 others are currently considered threatened or probably so,[3] all of which are endemic to Madagascar (Collar and Stuart, 1985). Four species are considered 'endangered', comprising one grebe, *Tachybaptus rufolavatus*, one duck, *Aythya innotata* and two raptors, *Haliaeetus vociferoides* and *Eutriorchis astur*, the second of which is in a monotypic genus. Of the remaining species, one is 'vulnerable', twelve are 'rare', five 'indeterminate', and five classified as 'insufficiently known'. In addition, a further fourteen species are identified as near-threatened, although two of these, *Ardeola idae* and *Circus maillardi*, are not endemics.

The endemic families Mesitornithidae and Brachypteraciidae are of particular note - all three species of the former are assigned categories, two as 'rare' (*Mesitornis variegata* and *Monias benschi*) and one as 'insufficiently known' (*Mesitornis unicolor*); four of the five ground-rollers are classified as 'rare', with *Atelornis pittoides* being considered near-threatened at present.

Threatened or possibly threatened bird species in Madagascar are:

K	*Tachybaptus pelzelnii*	Madagascar Little Grebe
E	*Tachybaptus rufolavatus*	Alaotra Grebe
K	*Ardea humbloti*	Madagascar Heron
V	*Anas bernieri*	Madagascar Teal
E	*Aythya innotata*	Madagascar Pochard
E	*Haliaeetus vociferoides*	Madagascar Fish Eagle
E	*Eutriorchis astur*	Madagascar Serpent Eagle

[3] Full explanations of threatened species ('RDB') categories are provided in Appendix 3.

R	*Mesitornis variegata*	White-breasted Mesite
K	*Mesitornis unicolor*	Brown Mesite
R	*Monias benschi*	Subdesert Mesite
I	*Sarothrura watersi*	Slender-billed Flufftail
K	*Amaurornis olivieri*	Sakalava Rail
R	*Charadrius thoracicus*	Madagascar Plover
Ex	*Coua delalandei*	Snail-eating Coua
I	*Tyto soumagnei*	Madagascar Red Owl
R	*Brachypteracias leptosomus*	Short-legged Ground-roller
R	*Brachypteracias squamiger*	Scaly Ground-roller
R	*Atelornis crossleyi*	Rufous-headed Ground-roller
R	*Uratelornis chimaera*	Long-tailed Ground-roller
I	*Neodrepanis hypoxantha*	Yellow-bellied Sunbird-asity
R	*Phyllastrephus apperti*	Appert's Greenbul
R	*Phyllastrephus tenebrosus*	Dusky Greenbul
R	*Phyllastrephus cinereiceps*	Grey-crowned Greenbul
R	*Xenopirostris damii*	Van Dam's Vanga
I	*Xenopirostris polleni*	Pollen's Vanga
K	*Monticola bensoni*	Benson's Rockthrush
I	*Crossleyia xanthophrys*	Madagascar Yellowbrow
I	*Newtonia fanovanae*	Red-tailed Newtonia

Full data sheets are provided in Appendix 3 (taken from Collar and Stuart, 1985).

Geographical distribution

The geographical distribution of the 106 endemic bird species of Madagascar can be analysed on a very simple level by dividing the country into four regions, east, north, south and west, corresponding roughly to the major phytogeographic divisions of eastern rainforest, sambirano, western deciduous forest and southern thorn bush.

From this the following figures emerge:

	No. spp. in region	No. spp. confined to region
East	83 (20)	30 (12)
North	49 (5)	0
West	52 (12)	2 (2)
South	42 (7)	10 (5)
Total	106 (28)	

Figures in parentheses indicate number of species assigned RDB categories in each group.

These figures highlight the over-riding importance of the eastern region of the island in terms of the number of species supported - 79% of endemics are found in at least part of the eastern region, while 29% are confined there on current knowledge, 40% of which are currently considered to be under some degree of threat. The second most important of the four domains is the south, which has ten species not known to occur elsewhere on the island - half of these are assigned RDB categories at present (Collar and Stuart, 1985).

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V.2. MAMMALS

The living native land mammals of Madagascar are confined to five orders: Primates; Chiroptera; Insectivora; Carnivora and Rodentia. A single representative of the order Artiodactyla is also present - *Potamochoerus larvatus* - though this is thought likely to have been introduced by man, and there is a recently extinct (subfossil) hippopotamus *Hippopotamus lemerlei*. One member of the order Sirenia - *Dugong dugon* - occurs in inshore coastal waters.

The taxonomy of some of these groups, notably the Primates, Insectivores and Rodents, is uncertain, and the number of species contained in them is a matter of contention, though the great majority are endemic.

Insectivora The insectivores on Madagascar comprise representatives of two families - the Soricidae, of which two widespread species are present (*Suncus murinus* and *Suncus etruscus*, though the Madagascan form of the latter is sometimes considered a separate, endemic species - *Suncus madagascariensis*) and the Tenrecidae, a family which has been considered endemic to the Madagascan region, though the African genera *Potamogale* and *Micropotamogale* are now generally included, though in a separate subfamily, the Potamogalinae.

The taxonomy of the Tenrecidae is unstable and many taxa are poorly known, often from only one or two specimens; however some 30 species in 9 genera are generally recognized. One species *Tenrec ecaudatus* has been introduced to the Comores, Réunion, Mauritius and the Seychelles; all others are confined to Madagascar and its offshore islands.

Chiroptera Some 28 species of bats have been recorded on Madagascar, nine of these endemic (though one, *Triaenops humbloti*, may only be a colour variant of another, *T. rufus*), with an additional three nearly endemic (one also occurs on the Comores, one on Aldabra and one on Réunion). One endemic species *Myzopoda durita* is in its own monotypic and hence endemic family, the Myzopodidae; all other species are in non-endemic genera.

Primates The number of extant species of Madagascan primates depends on the classification adopted. This report recognizes 28 species in four different families - the Cheirogaleidae, Lemuridae, Indriidae and Daubentoniidae; the first two families are sometimes lumped together in the Lemuridae, while conversely the genera *Lepilemur*, *Hapalemur* and *Varecia* are sometimes split off into a separate family, the Lepilemuriaae. The taxonomy of *Lepilemur* is highly complex, with recent classifications varying from a single species with five subspecies to seven species, one with five subspecies; in this report seven species are recognized.

Two species of the genus *Lemur* are found on the Comores as well as on Madagascar, all other species are endemic to Madagascar and its offshore islands.

Carnivora There are seven indigenous species of carnivore in Madagascar, each in its own monotypic genus in the family Viverridae and all endemic. As well as feral dogs and cats, the palm civet *Viverricula indica* has been introduced, though is reported to live predominantly in savanna regions near villages and to be generally absent from true forest.

Rodentia Ten species of native rodents in seven genera are currently recognized on Madagascar, all are endemic and are ascribed to the same endemic subfamily, the Nesomyinae, of the family Cricetidae. Little is known of the distribution or status of these species: one (*Eliurus myoxinus*) is apparently widespread; two (*Hypogeomys antimena* and *Macrotarsomys ingens*) have restricted ranges in parts of the west; one (*Macrotarsomys bastardi*) is widespread in the west; the others occur in the eastern forests and have generally been rarely recorded though at least some are likely to be fairly widely distributed in this region (*Nesomys rufus* is also known from one specimen collected at Maintirano on the west coast though this individual is distinctive and may represent a separate species).

The following lemurs have been assigned threatened species categories, following the 1986 IUCN Red List of Threatened Animals:

K	*Hapalemur griseus*	K	*Lepilemur mustelinus*
E	*Hapalemur simus*	K	*Lepilemur ruficaudatus*
K	*Lemur catta*	K	*Lepilemur septentrionalis*
K	*Lemur coronatus*	I	*Varecia variegata*
E	*Lemur macaco flavifrons*	E	*Allocebus trichotis*
V	*Lemur macaco macaco*	K	*Microcebus coquereli*
V	*Lemur mongoz*	K	*Phaner furcifer*
I	*Lemur rubriventer*	K	*Avahi laniger*
K	*Lepilemur dorsalis*	E	*Indri indri*
K	*Lepilemur edwardsi*	V	*Propithecus diadema*
K	*Lepilemur leucopus*	K	*Propithecus verreauxi*
K	*Lepilemur microdon*	E	*Daubentonia madagascariensis*

Five of the Madagascan viverrids have been assigned categories as follows:

V	*Cryptoprocta ferox*	K	*Galidictis fasciata*
K	*Eupleres goudotii*	K	*Salanoia concolor*
K	*Fossa fossa*		

Insufficient information is available at present to assign categories to mammal species from other groups, although amongst insectivores, the aquatic *Limnogale mergulus* is believed to present most cause for concern.

An annotated list of all non-marine mammal species is given in Appendix 2 and data sheets for all lemurs and the Dugong are provided in Appendix 3.

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N.B. Full references for the lemurs are provided with the data sheets in Appendix 3.

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V.3. AMPHIBIANS AND REPTILES

The herpetofauna of Madagascar is of very great interest in several respects.

1. With about 144 amphibians and 257 reptiles, Madagascar is, for its size, relatively rich in species (the reptiles are particularly numerous). Many species, including nearly 40 amphibians, have been described since 1970; doubtless a number remain to be discovered. Several recent descriptions are based on material collected some years ago but only recently studied.

2. The great majority of species (over 90%) are endemic to the island; this includes all but two of the 144 amphibians.

3. There is a distinct contrast between:-

   a. a small group of species-poor genera, usually endemic and often monospecific, apparently relict forms representing archaic lineages present since the first fragmentation of Gondwanaland. Examples: *Erymnochelys*, the boas *Acrantophis* and *Sanzinia*, the seven malagasy iguanids.

   b. a group of very species-rich genera, some endemic, apparently representing separate adaptive radiations from several chance immigrations (eg. by rafting from the African mainland) subsequent to the geographic isolation of Madagascar. Examples: *Chamaeleo* and *Brookesia* among chamaeleons (Madagascar has two-thirds of the world's species), *Scelotes* among scincids, *Boophis* and *Mantidactylus* among frogs.

4. The affinities of the reptile fauna are mainly with Africa, while those of the amphibians are with Africa and the Orient. However, the zoogeographic relationships of certain forms are especially noteworthy. For example, the pelomedusid turtle *Erymnochelys* is most closely related to the South American genus *Podocnemis*; similarly the boid genera *Acrantophis* and *Sanzinia* are most closely related to boas in South America (in both these examples related fossil material is known from intervening sites in Africa and/or Europe, but no extant forms are present in these areas). The seven malagasy iguanids, very distinct from all other iguanids, contribute in large measure to the highly enigmatic distribution of the family (present in Madagascar, Fiji-Tonga, and the New World; the family is unknown in Africa).

5. The microhylid genus *Pseudohemisus* (a monotypic form endemic to Madagascar) has recently been shown to be precisely intermediate in regard to tadpole anatomy between the families Ranidae and Microhylidae. The taxonomic position of the Scaphiophryninae, to which *Pseudohemisus* (and *Scaphiophryne*, tadpole unknown) are assigned therefore remains unclear (the possibility that *Pseudohemisus* is in some sense a link between ranoid and microhyloid lineages cannot be discounted since the discovery of 'living fossils' is more likely on an island such as Madagascar where ancestral populations, possibly competitively inferior, can be isolated from their descendants).

The taxonomic composition of the herpetofauna is as follows:-

CLASS: AMPHIBIA	species (genera)
Family: Hyperoliidae	8/9 (1)
Family: Microhylidae	
Subfamily:	
Cophylinae (endemic)	33 (9)
Dyscophinae (endemic ?)	3/4 (1)
Scaphiophryninae (endemic)	5 (2)
Microhylinae	1 (1)
Family: Ranidae	
Subfamily:	
Mantellinae (endemic)	60 (3)
Raninae	3 (3)
Family: Rhacophoridae	30 (2)

CLASS: REPTILIA

Family: Testudinidae	5 (3)
Family: Cheloniidae	4 (4)
Family: Dermochelyidae	1 (1)
Family: Pelomedusidae	4 (3)
Family: Crocodilidae	1 (1)
Family: Gekkonidae	63 (12)
Family: Iguanidae	7 (2)
Family: Chamaeleontidae	53 (2)
Family: Scincidae	47 (10)
Family: Cordylidae	12 (2)
Family: Typhlopidae	9 (2)
Family: Boidae	3 (2)
Family: 'Colubridae' (plus 2 sea snakes)	48 (15)

All the amphibians present are frogs; there are no caecilians, newts or toads. Most of these are forest-living treefrogs; there are few savannah forms and very few burrowers. Around 10% of the 144 species present can persist or thrive in open and/or human-dominated landscapes; 30% live in one of the three high mountain areas; but 60% are restricted to low-medium altitude moist forest. A few forest forms appear to be restricted to single localities, but probably most are widely distributed in the eastern escarpment rainforest; many are obligate tree-axil dwellers.

This distribution pattern is not repeated among the reptiles. Presumably due to their much greater tolerance of non-humid conditions, many species occur in the seasonal western forests and in the truly arid south.

It has been suggested that the herpetofauna is highly sensitive to human modification of the environment; this is presumably of minimal concern to the small number of wide-ranging forms abundant in various marginal or secondary habitats, but is likely to be important to the many highly localized species and perhaps to rainforest species in general. Examples of the former are the ranid frog *Ptychadena madagascariensis* (occurs throughout, especially in rice fields), the hyperoliid *Heterixalus betsileo* (common in cleared forest) and the scincid *Mabuya gravenhorsti* (favours secondary 'savoka' vegetation); examples of the latter are the tortoise *Geochelone yniphora* (at Cape Sada), the ranid *Mantella aurantica* (in the Périnet forest), and two *Lygodactylus* geckos at the summit of Mt Bity.

Loss of habitat is probably the predominant factor adversely affecting the malagasy herpetofauna; other factors include relaxing of traditional tribal taboos ('fady') protecting certain forms (eg. tortoises, boid snakes, crocodiles at some localities), and persecution or over-exploitation (eg. Nile Crocodile, freshwater turtles). Overall it must be stressed that the distribution, ecology and conservation status of most elements of the herpetofauna are inadequately known.

Only one species, the 'Angonoka' *Geochelone yniphora*, is known to be critically threatened at present; it is currently the subject of a conservation project. There are, however, many other poorly-known forms of special concern, often known only from a single specimen: for example, the colubrid snake *Liophidium apperti*, known by one specimen collected in 1968 in deciduous forest near Befandriana-sud; this forest has now been cleared but for a few isolated trees and the survival of the snake must be in question.

The sea turtles, terrestrial tortoises, the freshwater turtle *Erymnochelys madagascariensis*, and some larger frogs are utilized for food (or trade material, ie. tortoiseshell, in the case of Hawksbill *Eretmochelys*); the condition of these resources should be investigated and appropriate management applied. The tortoises *Geochelone yniphora* and *G. radiata*, and the boid snakes *Acrantophis* and *Sanzinia* are nominally protected by law (decree of 16 February, 1961). Export of all wild animals, or parts thereof, is nominally controlled.

Some 22 species of amphibians and 70 species of reptiles, listed below have been assigned IUCN threatened species categories or are being considered for inclusion in a category. The many Insufficiently Known species ('K' in the annotated lists, Appendix 2) do not appear below. Those already categorized consist of nine members of the order Testudines and *Crocodylus niloticus*. With these exceptions (marked by an asterisk in the list below), the designations are those suggested by the one or two competent authorities, but CMC do not yet have the requisite corroborative data, thus these should *not* be regarded as 'official' IUCN designations. In the case of taxa not restricted to Madagascar, the designations refer to the world range.

AMPHIBIA			
Hyperoliidae			
R	*'Hyperolius' nossibeensis*		
Cophylinae			
R	*Paracophyla tuberculata*	R	*Platypelis milloti*
Dyscophinae			
I	*Dyscophus antongili*		
Mantellinae			
R	*Laurentomantis horrida*	R	*Laurentomantis malagasia*
R	*Laurentomantis ventrimaculata*	V	*Mantella aurantica*
R	*Mantidactylus argenteus*	V	*Mantella laevigata*
R	*Mantidactylus domerguei*	R	*Mantidactylus eiselti*
R	*Mantidactylus glandulosus*	R	*Mantidactylus grandisonae*
R	*Mantidactylus klemmeri*	R	*Mantidactylus peraccae*
R	*Mantidactylus punctatus*	R	*Mantidactylus pseudoasper*
R	*Mantidactylus webbi*		
Rhacophoridae			
R	*Boophis albilabris*	R	*Boophis leucomaculatus*
R	*Boophis microtis*		
REPTILIA			
Testudinidae			
V*	*Geochelone radiata*	E*	*Geochelone yniphora*
I*	*Pyxis arachnoides*	I*	*Pyxis planicauda*
Cheloniidae			
V*	*Caretta caretta*	E*	*Chelonia mydas*
E*	*Eretmochelys imbricata*	E*	*Lepidochelys olivacea*
Pelomedusidae			
I*	*Erymnochelys madagascariensis*		
Crocodilidae			
V*	*Crocodylus niloticus*		
Chamaeleonidae			
R	*Brookesia decaryi*	R	*Brookesia ebenaui*
R	*Brookesia nasus*	R	*Brookesia tuberculata*
I	*Chamaeleo antimena*	R	*Chamaeleo balteatus*
R	*Chamaeleo bifidus*	R	*Chamaeleo boettgeri*
I	*Chamaeleo campani*	R	*Chamaeleo cucullatus*
I	*Chamaeleo fallax*	R	*Chamaeleo gallus*
I	*Chamaeleo gastrotaenia*	R	*Chamaeleo globifer*
R	*Chamaeleo malthe*	R	*Chamaeleo minor*
I	*Chamaeleo parsonii*	R	*Chamaeleo willsi*
Scincidae			
R	*Amphiglossus splendidus*	E	*Amphiglossus stumpffi*
R	*Androngo trivittatus*	R	*Mabuya boettgeri*
R	*Paracontias brocchii*	R	*Paracontias holomelas*
R	*Pygomeles braconnieri*	R	*Scelotes ornaticeps*

Colubridae

R	*Alluaudina bellyi*	R	*Alluaudina mocquardi*
V	*Geodipsas heimi*	V	*Geodipsas infralineata*
R	*Heteroliodon torquatus*	V	*Ithycyphus goudoti*
V	*Ithycyphus miniatus*	V	*Langaha alluaudi*
V	*Langaha nasuta*	I	*Liophidium apperti*
V	*Liophidium rhodogaster*	V	*Liophidium torquatus*
?R	*Liophidium trilineatum*	?R	*Liophidium vaillanti*
?E	*Liopholidophis grandidieri*	I	*Liopholidophis pinguis*
R	*Lycodryas arctifasciatus*	R	*Lycodryas betsilineatus*
R	*Lycodryas gaimardi*	R	*Lycodryas guentheri*
R	*Lycodryas inornatus*	R	*Lycodryas maculatus*
R	*Lycodryas variabilis*	R	*Micropisthodon ochraceus*
I	*Pararhadinea albignaci*	R	*Pararhadinea melanogaster*
R	*Pseudoxyrhopus ambreensis*	I	*Pseudoxyrhopus dubius*
R	*Pseudoxyrhopus heterurus*	R	*Pseudoxyrhopus imerinae*
R	*Pseudoxyrhopus microps*	R	*Pseudoxyrhopus occipitalis*
V	*Pseudoxyrhopus tritaeniatus*	I	*Pseudoxyrhopus quinquelineatus*

An annotated list of Madagascan Amphibian and Reptile species is provided in Appendix 2, and data sheets for those species marked * above in Appendix 3.

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V.4. FISHES

This account has largely been drawn from Kiener (1963), Kiener and Richard-Vindard (1972), Moreau (1979,1983a,1983b,1984), and FAO (1980,1983).

The native freshwater fish fauna of Madagascar is relatively depauperate, presumably in part as a result of the early geographical isolation of the island. It consists largely of representatives of euryhaline groups and contains few of the characteristic major families inhabiting the freshwaters of Africa or Indo-Malaya. However, a high proportion of the freshwater fish species are endemic, also probably as a result of the early isolation of Madagascar; these include all the freshwater atherinids and the nine native cichlids, some of which may be among the most primitive in the family. Some species, such as *Oxylapia polli* and *Rheocloides pellegrini*, are endemic to isolated river basins within the island, apparently thus restricted by physical barriers, often the saline water at the mouth of the rivers. This is particularly so on the eastern side of the island where the steep river profiles, narrow coastal plain and low tidal amplitude give rise to sharp salinity gradients at the river mouths. On the west coast river profiles are much shallower with a far broader coastal plain and continental shelf, and much higher tidal amplitude; salinity changes in rivers and estuaries are correspondingly more gradual, favouring the development of a euryhaline fauna. Habitat diversity is generally greater along this coast, with extensive mangrove and coral reef development (see part IV). There is also a greater chance of colonization from African continental waters in the west.

Information on the present status and distribution of the native fish fauna is scanty and further research is desirable. Given the size of the island and the variety of aquatic biotopes, it is possible that several species remain as yet undiscovered (T. Roberts, pers. comm.).

Threats

Given the sparsity of recent information on the fish fauna, it is difficult to discuss the manner in which it is threatened other than in a general and speculative way.

The increasing human population has led to increasing pressure on the land and, in particular, to a decline in the extent of the forest cover, principally through clearance for 'tavy' (slash-and-burn) cultivation (see Part III.3). In turn, this is likely to have had serious effects on the fish fauna as the forests exert significant control over the water regime in their catchment areas. Thus, for example, deforestation tends to lead to an increase in the volume of water passing to rivers as runoff; large discharges are liable to remove soil from denuded banks leading to an increase in turbidity and loss of habitat for many species. The Betsiboka River has been cited in this regard, as have many high altitude and forest streams which now become turbid following only slight rainfall. Waterborne silt may cover the substrate and aquatic vegetation, thus reducing the availability of food. Water temperature may rise when tree cover is removed (particularly in the headwaters of a catchment), and this may affect the lifecycle of both fish and aquatic invertebrates by reducing the viability of eggs and the survival of the young.

Introduced species, both animal and plant, also pose problems. The water hyacinth (*Eichhornia crassipes*) has invaded many lakes and rivers in Madagascar and has blocked several of them. Consequent reduction in water flow can lead to increased siltation and reduction of visibility; the latter is particularly likely to affect active predatory species which hunt by sight. Introduced fish species, several of which are now of great economic importance, have almost certainly had considerable impact on the native fish fauna, either as competitors or predators. These include *Oreochromis* spp. which are predominantly herbivorous and have high reproductive rates; these could have adverse effects on habitats by reducing vegetation cover and thus removing breeding and feeding sites for fish, invertebrates and birds. *Paretroplus kieneri*, for example, typically found in heavily vegetated areas, could be so affected.

Few native Madagascan fish are currently of interest to the aquarium trade, an exception being *Bedotia geayi*. However, difficulties in transporting fish may have hindered development of the trade. Overall, inland fisheries effort appears to have declined in recent years, although over-fishing has almost certainly occurred in easily accessible sites; however most fishing effort appears to be aimed at introduced species and no native species are thought to be threatened with extinction as a direct result of fishing.

Threatened species

The following species have been identified as likely to be threatened by Kiener (1983). His categories should be regarded as provisional and *not* as official IUCN designations.

'Highly threatened'	*Oxylapia polli* *Ptychochromoides betsileanus*
'Rare'	*Acentrogobius therezieni* *Oryzias madagascariensis* *Pachypanchax playfairi* *Rheocloides pellegrini* *Typhleotris madagascariensis* *Typhleotris pauliani*
'Vulnerable'	*Paratilapia polleni* *Paretroplus dami* *Paretroplus kieneri* *Paretroplus maculatus* *Paretroplus petiti* *Ptychochromis oligacanthus*

An annotated list of all endemic species is included in Appendix 2.

FISHERIES

Inland

The inland fisheries of Madagascar account for 80% of total fish harvest. Approximately 550 000 ha of the 600 000 ha of waterbodies present on the island may be potentially exploitable for fisheries (Kiener and Richard-Vindard, 1972). Freshwater fisheries research is carried out by the Division des Recherches Piscicoles (Department of Fisheries Research) which has two principal research stations supported by a number of secondary units.

The principal species caught at present are introduced tilapias and carp. This is in contrast to former years when the native *Paratilapia polleni* was most important. Principal target groups in order of importance are:

1. Cichlidae (primarily introduced tilapias since 1950, although prior to this native cichlids were important).
2. Mugilidae (both marine and freshwater).
3. Cyprinidae (an introduced group).
4. Anguillidae (most widely distributed group in the island).

In addition the Ariidae, Chandidae, Gobiidae and Eleotridae are all important.

Aquaculture: 25 000 ha of rice fields are now used for fish production; there are also ca 1000 ha of freshwater fish ponds (FAO, 1983). Formerly, over 85 000 ponds existed, mainly concentrated around Antananarivo and Fianaratsoa; this total is now nearer to 10 000 (Moreau, 1984). Aquaculture could be substantially increased, perhaps by 480 000 ha, by including further rice fields and mangrove areas, although the construction of hatcheries is likely to be a constraint to future development. Carp and tilapia are the most widely used fishes and *Chanos chanos* has been successfully cultured in brackish water. A project, financed by FAO/UNEP, designed to assist with inland fisheries and aquaculture ended in 1982.

Fishing: As in many African countries, inland fishing tends to be a part-time activity undertaken when time is available away from other agricultural activities. The small size of the canoes used has resulted in a concentration of activity near to the lake shores where fish stocks (particularly juveniles) are now being overexploited. This problem is thought to be particularly serious in the Pangalanes, Lake Alaotra, Lake Itasy, lower Betsiboka River, and around Toamasina, Antananarivo, and Taolanaro, where there are large numbers of fishermen. Elsewhere there is a high potential for fishing, but few fishermen. Moreau (1983a) considers that there has been a gradual change from commercial fishery towards subsistence fisheries, largely as a result of difficulties with transport and obtaining and repairing equipment. Fewer fish are now reaching the large markets which are apparently experiencing shortages. Fish consumption is reportedly declining overall. Most fish (75%) is consumed fresh; salting is rarely used for preservation and fish are generally smoked if they are to be taken any distance for sale.

Production: Production figures in 1972 are as follows (Kiener and Richard-Vindard, 1972):
25 000 tons/annum (25 400 tonnes/annum) in natural waters (45 kg/ha/year)
2000 tons/annum (2032 tonnes/annum) in fishponds (1 tonne/ha/year)
160 tons/annum (162 tonnes/annum) in rice fields (400 kg/ha/year)
Total 27 160 tons (27 594 tonnes)per annum.

These differ from the FAO catch statistics for 1975-1980, where the annual catch for cyprinids, cichlids and other freshwater species was estimated at 13 000, 23 000 and 5000 tonnes respectively, totalling 41 000 tonnes for each year. These estimates will be approximate at best: collection of fisheries statistics is extremely difficult as fishing is a very widespread, generally low level activity, largely for local subsistence.

The following observations on inland fisheries in different parts of Madagascar have been located.

River Fisheries: These are generally for subsistence rather than for commercial purposes and are poorly quantified. Recruitment in certain areas may be poor, and breeding that normally occurs in flooded areas will not take place in drought years. The introduction of trout at sites over 1700 m altitude does not appear to have benefitted river fisheries. Fishing in rivers used to occur on a larger scale than at present; more use is currently made of artificial water bodies and lakes (Moreau, 1983b).

North West: Commercial eel fisheries are important here, particularly for *Anguilla mossambica*. In the lower part of the Betsiboka River, tilapia and carp had a potential fishery of around 2000 tonnes/year, but the catch today is not known. There is little information for the remainder of the region (Moreau, 1983b).

Pangalanes: these artificial channels could be highly productive for a large variety of fishes. However, in 1979, with relatively low fishing effort, production was only ca 8 kg/ha. Migrating fish, such as the mugilids, are present; some, such as *Liza macrolepis*, have declined (Moreau, 1983b).

Masianka lagoon: This 15 sq. km lagoon, south of the Pangalanes, has a potential production of 140 tonnes. However, there is currently low fishing effort soley for subsistence use (Moreau, 1983b).

Taolanaro: A series of separate lagoons of 2500 ha has been providing a catch of around 30 tonnes annually with relatively low fishing effort (Moreau, 1983b).

Lake Alaotra: *P. polleni, C. carpio* and tilapia are the major species caught. Eels are also taken. In 1963-1967 a peak catch of around 3000 tonnes per annum was reached, decreasing by 1976 to approximately 2000 tonnes. This was a similar figure to those of the mid-1950s although the fishing effort had greatly increased. Catches have probably since decreased (Moreau, 1983b).

Lake Kinkony: Projected maximum sustainable yield is ca 700 tonnes per annum; possibly half of this is currently being caught, principally tilapia. The lake is too far from Antananarivo for easy marketing (Moreau, 1983b).

Lake Ihotry: Projected maximum sustainable yield is 150 tonnes per annum. There is, however, no fishery as the use of fishing equipement is proscribed by a 'fady' (Moreau, 1983b).

Lake Itasy: *Ptychochromoides betsileanus* has declined due to the introduction of the water hyacinth. *Oreochromis niloticus* is the main fish caught at present. However, recruitment has substantially declined and catches decreased to 275 tonnes in 1976. This lowered catch may also be attributed to difficulties in obtaining new nets and other equipment (Moreau, 1983b).

Marine

Traditional subsistence marine fisheries are limited to coastal lagoons and shallow inshore waters protected by coral reefs. Some 80% of the artisanal fleet works off the west coast. The east coast and north and south extremities of the island are difficult to work due to poor weather, currents and difficult bottom substrates. The artisanal marine catch is about 8000 tons/year (8,128 tonnes). The boats are simple wooden outrigger canoes, 4-8 m long, propelled by oars or sails. Vessels only carry one or at the most two fishermen using hook and line, gill nets, beach seines or traps. Approximately half the marine catch is marketed fresh locally in the towns, absence of a distribution system generally preventing internal marketing of smoked, dried or frozen marine fish. Freshwater fishes are cheaper than marine fishes which are usually more expensive than meat. Experimental fishing in the early seventies encouraged industrial exploitation by foreign enterprise and in 1974, 10 000 tons (10 :60 tonnes) of skipjack tuna were landed. Agreements with Japanese, Russian and East German fishing interests have been reached; the resultant fishing is thought to have seriously depleted the stocks. International fishing has now ceased due to internal problems and the international economic crisis. The marine waters are not thought to be particularly rich in fish resources, the total available potential (excluding tuna) being about 150 000 tonnes per year, although not all of this would be economically exploitable. The most promising demersal species are the Sparidae and the Lutjanidae. However, catch rates in exploratory fishing have not been high. Areas where pelagic shoaling fishes may be found appear to be highly localised, with very few on the western side south of 16°S. North of this, anchovy and sardinella shoals appear to be more frequent. FAO/UNDP assisted the marine sector until 1974.

A guide to the commercial fishes of Madagascar has been produced by FAO (Bauchot and Bianchi, 1984).

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V.5 LEPIDOPTERA: RHOPALOCERA (BUTTERFLIES)

The island of Madagascar is separated from mainland Africa by straits which are nowhere less than 400 km wide. Madagascar has been separated from the mainland for at least 60 million years and probably much longer (Owen, 1971). The island is rich in flowering plants but relatively poor in animals, especially when compared with other large islands like New Guinea. Nevertheless, there are some striking endemic groups of animals, including butterflies (Owen, 1971). The Malagasy subregion became isolated before any major evolutionary development of butterflies had occurred, and probably before butterflies had properly diverged from their ancestors. The ancestors of the present Malagasy fauna must therefore have flown or travelled in other ways across the ocean, most of them probably from Africa (Owen, 1971). Colonization from the distant African mainland must occur infrequently and rather randomly, and this is presumably why the Malagasy butterfly fauna is rather poor in species but at the same time rich in endemics (Owen, 1971).

The biogeographical affinities of the butterfly families are strongly Afrotropical, as is the case for most Malagasy arthropods. For the Papilionidae at least, dispersion to Madagascar seems to have been from eastern rather than southern Africa. Hancock (1982) states that there is no evidence of dispersal from Madagascar back to the African mainland, but Owen (1971) notes that *Graphium evombar* of Madagascar is replaced by a very similar species, *Graphium junodi*, in a narrow strip along the African coast facing Madagascar.

There are some important exceptions to the generalization that the Malagasy fauna has its origins in Africa. *Atrophaneura antenor*, a swallowtail in the otherwise Oriental and Neotropical tribe Troidini, appears to have evolved from an Indian ancestor before that genus reached Asia proper (Hancock, 1982). The genus *Euploea* (Danaidae) is essentially Oriental and Australasian in distribution and, although not found on Madagascar, *E. euphon* is endemic to the Mascarenes, and *E. mitra* to the Seychelles.

A chain of mountains runs from north to south in Madagascar; the eastern side is wet and forested, the western side is relatively dry with a variety of woodland and savanna ecosystems. Species richness and endemicity tend to be high in the highland and forested areas, and low in lowland and more arid regions. However, for some butterfly families forests are not the preferred habitats (e.g. many Hesperiidae, Lycaenidae and Pieridae).

The southern, and particularly south-western, regions are rather poor in species while the deciduous and evergreen forests of the western, northern and eastern regions are richer. Some Papilionidae are confined to the deciduous western forests (*Papilio morondavana*, *P. grosesmithi*), which are clearly important ecosystems for protection. Other species and genera are confined to the rain forests (e.g. *Graphium endochus* (Papilionidae) and *Charaxes* species (Nymphalidae)). The central highlands and eastern rain forests probably include the most important localities of all. High altitude areas in central and northern Madagascar include important localities, such as Montagne d'Ambre and the Massif de Tsaratanana.

The butterfly fauna is strongly endemic at the generic, specific and subspecific levels, although many other lesser-known insect groups exhibit even higher levels. There are over 300 species of butterflies distributed in over 80 genera in the Malagasy subregion (Madagascar, Comoros, Mascarenes and Seychelles), of which 233 are endemic (Owen, 1971). At least 17 genera are endemic to Madagascar (see Table 6). The levels of species endemism in Madagascar itself are: Papilionidae 77% (10 out of 13 species), Pieridae 34% (10 out of 29 species), Nymphalidae 78% (133 out of 170 species), Libytheidae 50% (1 out of 2 species), Riodinidae 100% (3 species) and Lycaenidae 58% (25 out of 43 species). In addition, there are many endemic subspecies within these families. There are relatively few Lycaenidae in Madagascar because the Lipteninae are absent. The Hesperiidae have not been considered here but are well represented in the area. Seven of the seventeen genera endemic to the Malagasy subregion are in the Hesperiidae (Owen, 1971).

An annotated list of Butterfly species, in all families except the Hesperidae, occurring in Madagascar is included in Appendix 2. The conservation status of the Papilionidae, Charaxidinae, Acraeinae, Danainae and Nymphalidae has been assessed, but it has not yet been possible to assess the threats to the Pieridae, Satyrinae, Libytheidae, Riodinidae or Lycaenidae.

Conclusions

The main findings are summarized in Tables 6 and 7. If the relative numbers of species identified as threatened in the families considered are extrapolated to the entire butterfly fauna of Madagascar, then about 45-50 species may be assumed to be threatened.

Those species in the families Papilionidae and Nymphalidae identified as threatened in Madagascar are:

R	*Graphium endochus*	R	*Papilio grosesmithi**
V	*Papilio morondavana**	R	*Papilio mangoura**
R	*Euxanthe madagascariensis*	R	*Charaxes cowani*
R	*Neptis decaryi*	I	*Neptis sextilla*
R	*Apaturopsis kilusa*	R	*Smerina manoro*
R	*Acraea sambavae*	R	*Neptis metella*[1]

[1]Panafrican but very scarce in Madagascar.

* Data sheets for these species are provided in Appendix 3; notes for all species considered are given in Appendix 2.

TABLE 6. ENDEMIC BUTTERFLIES FROM THE MALAGASY SUB-REGION

Genus	Family	Number of species
Genera in which all species are Malagasy sub region endemics		
Gideona	Pieridae	1
Smerina	Nymphalidae: Nymphalinae	1
Houlbertia	Nymphalidae: Satyrinae	8
Masoura	"	5
Admiratio	"	1
Heteropsis	"	2
Strabena	"	41
Saribia	Riodinidae	3
Trichiolaus	Lycaenidae	2
Rysops	"	1
Hovala	Hesperiidae	5
Fulda	"	4
Arnetta	"	3
Malaza	"	3
Miraja	"	9
Perrotia	"	6
Ploetzia	"	1
Other genera with five or more Malagasy sub region endemic species		
Papilio	Papilionidae	7
Charaxes	Charaxidinae	8
Acraea	Acraeinae	13
Henotesia	Satyrinae	45
Hemiolaus	Lycaenidae	5
Lepidochrysops	"	5

(from D'Abrera, 1980; Owen, 1971; Viette, 1956)

TABLE 7. THREATENED MADAGASCAN BUTTERFLIES

Family	Number of species	Madagascar endemics	Subregional endemics	Number threatened	% of total threatened
Papilionidae	13	10	1	4	31
Pieridae	29	10	5	?	?
Nymphalidae					
Danainae	3	1	1	1	33
Charaxidinae	9	8	0	2	22
Nymphalinae	41	17	4	4	10
Acraeinae	17	9	4	2	12
Satyrinae	100	98	1	?	?
Libytheidae	2	1	0	?	?
Riodinidae	3	3	0	?	?
Lycaenidae	43	25	3	?	?
Totals	260	182	19	(13)	-

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V.6. TERRESTRIAL MOLLUSCS

Since 1949, Professor Fischer-Piette has been studying the snails of Madagascar at the Museum National d'Histoire Naturelle Paris, where there is now a collection of some 10 000 lots, comprising what is probably the most important Madagascan shell collection. The collection consists mainly of shells with a few preserved specimens. More than 30 papers were published during 1949-1977 by Fischer-Piette. New species continue to be described from this collection (Tillier, 1979). In 1980, van Bruggen published a preliminary checklist of the terrestrial molluscs of Madagascar, which has been used as a basis for the accompanying list (van Bruggen, 1980b). The fauna has been recently revised by Professor Fischer-Piette, and the revision will be published in the *Faune de Madagascar* (Fischer-Piette *et al.*, in press).

Madagascar has a land snail fauna currently considered to consist of about 380 species (130 prosobranchs and 248 pulmonates, but future revisions will probably change these figures considerably), which is considered one of the most interesting in the world. Twenty-five families (6 prosobranch, 19 pulmonate) and 56 genera (15 prosobranch, 41 pulmonate) are known. There are 361 endemic species (127 prosobranch, 234 pulmonate), 11 endemic genera (4 prosobranch, 7 pulmonate) and no endemic families. The country has a relatively large number of terrestrial prosobranchs (34% of the species present, 27% of the genera, 24% of the families) compared to neighbouring South Africa, and the rate of endemism in this group is particularly high (35% of all species and 36% of all genera) (van Bruggen, 1980b). The dominant families are entirely different from those found in Africa, where the Streptaxidae, Urocyclidae, Subulinidae and Achatinidae are most important. Although all these families occur on Madagascar, they are generally sparingly represented, and the dominant families are Cyclophoridae, Pomatiasidae, Acavidae and Ariophantidae. Accounts of the biogeography of the fauna can be found in Fischer-Piette and Blanc (1972), and Verdcourt (1972) mentions the fauna in the context of East Africa.

Not surprisingly, since these are easiest to collect, the best known genera are those containing large species, such as *Tropidophora, Ampelita, Helicophanta* and *Clavator*. It is to be expected that further survey work will considerably alter the relative importance of different families and genera, as the smaller species found in habitats such as forest soils become better known (Fischer-Piette and Salvat, 1972; Fischer-Piette and Blanc, 1972). Species in the north tend to have the flattest shells, and those in the south the most pointed shells. Many of the rain forest species are slug-like, and new species are certainly still awaiting discovery. At least 82 (23%) of the endemic species are known only from their type localities.

In general, the calcareous areas of the north, west and south have the richest mollusc fauna. Little is known of the ecology of the Madagascan malacofauna but usually terrestrial snails prefer a humid habitat. The great majority of species which have been collected come from the primary forests, particularly in the north. Using the sparse data given in the original descriptions, it has been calculated that of the 142 endemics for which some form of habitat description is given, 91 (64%) species are forest dwellers, 34 (24%) are associated with caves, and 27 come from other habitats. Many of those for which there are no habitat data can be deduced to be forest dwellers by reason of the collection locality. Most species are found along or not far from the coast. *Tropidophora* and many other genera are not found in the centre of the island, possibly because these species are not adapted to grassland habitats (Fischer-Piette, 1948). Millot (Fischer-Piette, 1947) commented that snails were not even found in primary forest in the centre of the island (e.g. forêt de la Mandraka, forêt de Manjakatompo on the slopes of Ankaratra, woods of Ambohimanga, forests of Marovatro and Ankaroaka near Lake Alaotra), although some surveys have shown that at least some species are found there (see Appendix 2).

The northern quarter of the island, the most diverse in terms of climate, physical and geological features and vegetation, is strikingly important for molluscs, with the greatest number of endemic snails, and over 56% of known species, occurring there. The Massif de Tsaratanana is of major interest, with a very particular fauna including many species in the endemic genera *Ampelita* and *Acroptychia* (Fischer-Piette, 1952). Montagne d'Ambre exhibits a remarkable microendemism for plants, probably associated with the climate and physical features of the area, and probably linked to the mollusc endemism (comment by Heim in Fischer-Piette, 1947).

Certain species survive in habitats ostensibly unsuitable for molluscs. Species of the genus *Clavator*, which is found in the southern part of Madagascar, remain under several centimetres of sand in dry weather. After rain they appear one or two hours later, sometimes very abundantly, to feed among bushes (Fischer-Piette and Salvat, 1963). Other species have an unusual relationship with spiders. The spider *Olios coenobita*, found in the bush on the plateau of Mahafaly, uses snail shells for shelter. Empty shells, sometimes 20 times the weight of the spider, are carried up into the bushes and attached by silk threads (Griveaud 1981). *Ampelita chlorozona*, for example, was described from a shell collected hanging from a bush in Beloha. The Snail-eating Coua *Coua delalandei*, known from and likely to have been endemic to Nosy Borah but probably now extinct (see Appendix 3.A), fed principally on snails; it is not known which species were preferred but they may have been Achatinidae rather than any of the endemics.

Endemic genera

(Number in parentheses indicates approximate number of species)

Acroptychia (11)

Ampelita (65)
Contains many abundant and large species. At least 37 of the species have very localised distributions (about 17 in the north); one is known to be widespread. Used to be eaten in large quantities by the people of Lake Alaotra (Griveaud, 1981).

Bathia (1)

Boucardius (8, probably about 40 in new revision)

Clavator (12)
This genus, with elongated shells, is one of the most characteristic of the island. It is known as a fossil from Africa and has been used for geological dating (Griveaud, 1981).

Helicophanta (15)
Includes several species with large and attractive shells.

Kalidos (52)
At least 25 species are very localised (13 in the north), 3 are more dispersed and 4 are widespread.

Leucotaenius (7)
Species in this genus have medium-sized, unusually shaped shells, elongated and heavy.

Madecataulus (2)

Malarinia (1)

Malagarion (1)

The following genus, although not endemic, is of particular importance in Madagascar:

Tropidophora
89 species, of which 87 are endemic.
The largest genus on Madagascar, containing species with comparatively large shells, exceeding 2 cm. The genus *Tropidophora* is also found in the Comoros, Seychelles, and south-east Africa, but has undergone its main radiation in Madagascar where species are most numerous, largest and most varied. Almost all the species found there are endemic and

very few are found throughout the island. The species found on Madagascar have been extensively studied and more is probably known about them than about any other genus. They have been divided into a number of groups on the basis of their shape (Fischer-Piette and Millot, 1949):

T. cuvierana group (includes *occlusa, deliciosa*): shells have two very distinct keels.
T. deshaysiana group (includes *moulinsii, vittata, virgo*): shells are sculpted and very flattened.
T. aspera group (includes *fulvescens*): globose, spiral stripes.
T. semidecussata group (includes *macareae, pyrostoma*).
T. sikorae group (includes *filostriata, balteata*): shells are elongated.
T. philippiana group (includes *coquandiana*): shells are conical and smooth, aperture small.
T. formosa group (includes *pulchella, deburghiae, reticulata*): shells are very variable.
T. tricarinata group: many varieties, although *tricarinata* itself is rare.
T. lineata group (includes *goudotiana, consocia, vesconis, johnsoni, virgata*): shells are small, group least well known as little collected.

Some species, e.g. *T. tricarinata*, show remarkable polymorphism, thought to be linked to habitat. At least 55 species are highly localised (30 in the north), at least ten of the others are more dispersed and a further ten, at least, are very widespread. Their distributions fall into four main groups (Fischer-Piette, 1947,1948), which fit in well with those areas established by Perrier de la Bathie for climate and vegetation (see Part III.2):

a. East from Midongy, south of Ambohivoangy. A narrow, uniform band where *T. bicarinata* is dominant. Tropical humid climate, and relatively abundant primary forest. Due to the similar climate on Nosy Bé and Nosy Komba, these islands have similar fauna. Two magnificent species, *formosa* and *deburghiae*, are found in the Mananara region at Foulpointe and Fenoarivo Atsinanana (Fischer-Piette, 1948).

b. South and south-west from Taolanaro to north of Toliara. *T. philippiana* and *T. coquandiana* are dominant (also *balteata*). These are species with shells with the highest spires. Subdesert.

c. West, from Toliara to Ambongo and Sambirano. *T. macareae* is dominant. Long dry season, calcareous soil; most of forest destroyed.

d. A small area in the extreme north including Port Leven, Antseranana, Montagne d'Ambre, Ankara and Nosy Bé. No one species is dominant but the highest number of species are found there. Many of the species have very flattened shells ranging from the giant *cuvieriana* to the tiny *lamarcki*, and very localised distributions (Fischer-Piette, 1948).

Threats to molluscs

a. Habitat destruction

Humidity is particularly important to molluscs which is why primary rain forest tends to be a favourite habitat. Opening up of the forest exposes snails to the danger of desiccation, particularly as many of the species are slug-like and cannot retract completely into their shells. This is discussed in more detail in the IUCN Invertebrate Red Data Book (Wells *et al.*, 1983), where several examples are given of species in other parts of the world which have become extinct or are now endangered as a result of loss of their forest habitat. It has become clear that much of the Madagascan forest has already been lost or is in the process of disappearing through a variety of factors (see Part III.4); this is undoubtedly the main threat to most Madagascan land snails.

b. Introduced species

A major threat to terrestrial molluscs in the Pacific has been the introduction of the carnivorous snail *Euglandina rosea* from Florida to control the Giant African Snail *Achatina fulica* (Wells *et al.* 1983). In most cases, *E. rosea* has had little effect on *A. fulica*, often preferring to feed on smaller native snails. In Madagascar, *A. fulica* is a serious pest, especially in vanilla plantations on the East coast (Ranaivosa, 1971), and in the Sambirano region where it is reported to attack cocoa trees (Griveaud, 1981). Although regarded as a delicacy in many countries, it is apparently not eaten by the local people in Madagascar. Attempts at biological control by introduced carnivorous snails were tried on a number of occasions:

1. *Euglandina rosea*

January 1965:	5 snails introduced at Station de l'Ivoloina (Taomasina); laid eggs and six months later six specimens were recaptured at various localities in the station.
November 1966-December 1968:	738 adults and 497 eggs at Ivoloina. 158 adults and 20 eggs at Antalaha (Station de la Vanille). Most of these came from breeding colonies established at Antananarivo, 250 only having been imported from Mauritius (where they had been introduced from Hawaii and Bermuda).
March 1970:	122 from Trinidad released at Ivoloina.

Releases were always carried out in sites which were regularly frequented by *A. fulica.* Eggs were released after a period of incubation in a laboratory. In 1971, specimens of *E. rosea* were found regularly at the station and empty shells of *A. fulica* were being found increasingly regularly. It was considered that these introductions were being successful.

2. *Gonaxis quadrilateralis* and *G. kibweziensis*

March 1965:	110 specimens of *G. quadrilateralis* 21 specimens of *G. kibweziensis* Both species introduced from Hawaii; none survived.
October 1969:	120 specimens of *Gonaxis* sp. were raised and laid eggs, but by March 1970 only about 40 individuals still survived; these were sent to Grande Comoro for release.

From these trials it was concluded that *Gonaxis* were not as good biological control agents as *Euglandina.*

3. *Edentulina ovoidea* Brugiere

A carnivorous species, endemic to Mayotte, which is known to be an active predator of *Achatina.*

March 1970:	120 specimens released at Ivoloina.

Further introductions were planned.

Ranaivosa could draw no conclusions in his 1971 paper on the long-term success of these introductions, but was hopeful that *E. rosea* and *Edentulina ovoidea* would prove useful. Long-term studies on the introduced populations were envisaged. There is no information available on the outcome of these studies and it is quite possible that the introductions have died out, but it is most important that the danger of further introductions is made clear; these are detailed in Tillier and Clarke (1983). Surveys should be carried out to determine whether any of the introduced populations have survived.

c. Collecting

Land snails are known locally as 'Akora', and are not collected very much by the Madagascans. However, many species have extremely attractive shells, comparable to those from the Philippines, Papua New Guinea and Florida which are currently involved in the shell trade. For example, *Ampelita viridis* is particularly attractive, bright to olive-green in colour, with brown stripes and 2-3 cm high. The genus *Clavator* contains a number of attractive, large (over 6 cm long), yellowish-brown shells. The genus *Tropidophora* contains many species with attractively shaped, striped (although not particularly colourful) shells, notably the large *T. cuvierana* with its two keels. Other species reach up to 10 cm in size. Although the attractiveness of these species may be a useful tool in conservation publicity, it is recommended that firm measures are taken to ensure that commercial collecting does not start. Interest in terrestrial species among shell collectors has grown markedly in recent years and there would be a ready market for many of the Madagascan species. Since many of these have apparently extremely limited distributions and are still very poorly known to science, collection should currently be limited to specimens for scientific purposes.

Recommendations

a. Further research

Almost nothing is known of the ecology of most of the Madagascan mollusc fauna and there is urgent need to determine this for some of the more important groups in order to make recommendations for their conservation (Fischer-Piette and Salvat, 1972). Since most of the work has been carried out on collections of shells, there is certainly a need for examination of whole preserved specimens for verification and clarification of some of the taxonomical problems. Although most parts of the island have been studied, the faunas of the south-east (between Ihosy-Betroka-Antaniniria and the Indian Ocean), and the area north of the lower Mangoky river are still poorly known (Paulian 1983).

b. Management of reserves

Many of the reserves appear to have extensive mollusc faunas (see Part VI.2). It has been estimated that about 160 of the endemic species may occur in reserves. All the reserves should be inventoried and efforts should be made to determine which species receive sufficient protection from the current system of reserves and which warrant further attention. Mount Tsaratanana requires special attention since it is the most important site for molluscs.

c. Introductions and commercial exploitation

See above.

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V.7. FRESHWATER MOLLUSCS

Twenty nine species of freshwater gastropod have been described in Madagascar including 21 prosobranchs and 8 pulmonate basommatophorans. Five species have been described from brackish-water or damp biotopes. Checklists are given in Brygoo (1968a), Fischer-Piette and Vukadinovic (1973), and Starmuhlner (1969). The total fauna is twice as large as that of Kenya, a country similar in area to Madagascar, but the level of endemicity is much lower than in the Madagascan terrestrial molluscs. *Cleopatra* and *Melanatria* are endemic genera; two *Afrogyrus* species, *Bulinus obtusispira* and *B. bavayi* are endemic species. Lake Alaotra, the largest lake in Madagascar apparently lacks any endemics. The fauna probably contains species derived from the original Gondwanaland fauna, and also species which have reached the island since its formation (Brown, 1980).

Starmuhlner (1969) relates the fauna to three geographical and climatic regions:

1. The freshwaters of the central steppe-like subtropical highlands have no prosobranchs except *Pila cecillei* but have all the pulmonates except *Bulinus mariei*, including *Afrogyrus* which is found only in streams above 1800 m.

2. The escarpments which descend steeply to the east and north-west coasts with extensive primary forest have soft water streams and rivers where *Melanatria* and *Cleopatra* are common. *Cleopatra* species dominate in the smaller brooks with weaker flow whereas *Melanatria*, a primitive genus, is typical of strongly flowing rivers of the coastal tropical rain forest belt.

3. In the south-east and western areas, the surface waters are richer in dissolved salts. A total of nine species has been recorded from the lower Mangoky river (Degremont, 1973), of which the two commonest were *Lanistes grasseti* and *'Anisus'* (probably *Afrogyrus crassilabrum*). *Melanoides tuberculatus* and *Radix hovarum* may also be dominant. The coastal sections of streams have the neritids and *Thiaria amarula*, with *Cerithidia decollata* dominating in the brackish water zone (Starmuhlner, 1969; Brown, 1980).

Conservation

No information is available on the conservation status of endemic freshwater snails. Species occurring in or near reserves are listed in Part VI.2. Since most of the endemic species, and particularly the genera *Cleopatra* and *Melanatria*, are restricted to upland forested areas it is probable that they are highly vulnerable to the current extensive deforestation. The acquisition of further data relating to the conservation status of these species should be considered a high priority.

Schistosomiasis

Schistosomiasis or bilharzia is considered briefly here because of its close relationship with some of the endemic freshwater snails. Its role in Madagascar is the subject of a large number of publications, produced mainly by the Institut Pasteur in Madagascar (see bibliography of publications of Inst. Pasteur Mad.). Some of the more important ones are given in the references. Brygoo (1968a) provides a detailed survey of the infection in Madagascar, and more recent discussions of the situation are found in Degremont (1973), Brygoo (1972) and Brown (1980).

Two forms of bilharzia or schistosomiasis are found in Madagascar. Intestinal bilharzia is caused by the parasitic trematode *Schistosoma mansoni*, and has *Biomphalaria pfeifferi* (considered a separate species, *B. madagascariensis*, by Starmuhlner, 1969) as its intermediate host. It prevails in the east and on the plateaux; *B. pfeifferi* appears to be uncommon in western Madagascar (Brygoo, 1972; Pfluger, 1977). Its ecology and biology are described in Pfluger (1977a,b). In eastern Madagascar it occurs in various habitats including irrigation channels and ricefields (Brown, 1980).

Urinary bilharzia, which prevails in the west, is caused by *S. haematobium*, and is carried by the endemic snail *Bulinus obtusispira* which has a high infection rate (Brygoo, 1972; Wright, 1971). Unlike *Biomphalaria, Bulinus* does not tolerate temperatures lower than 4°C for longer than 24 hours. *Bulinus obtusispira* is most closely related to *B. africanus* but was probably isolated long ago on Madagascar. It was once thought to be synonymous with *B. liratus*, a species which may be a recently arrived isolate of *B. tropicus* from South Africa. *B. obtusispira* and *liratus* are found together in the lower Mangoky, where they have different ecological requirements, but their relative distributions elsewhere remain to be worked out (Brown, 1980). *B. liratus* is probably unimportant in natural transmission as it has proved resistant to *S. haematobium* in the laboratory (Wright, 1971), although two snails from the lower Mangoky area are reported to have shed cercariae (Degremont, 1973). It is, however, an intermediate host for *Paramphistomum microbothrium* (Prod'hon *et al.*, 1968).

The different temperature requirements of *Bulinus* and *Biomphalaria* are largely responsible for the general distribution of schistosomiasis throughout Madagascar. It is predominantly an infection of rural and agricultural communities and is increasing in many countries as a result of the development of water resources and the modernisation of agricultural methods. The creation of man-made lakes, the introduction of new irrigation schemes or the extension of existing ones are important factors in the spread of infection since all these activities provide suitable habitat for snail vectors (Brygoo, 1972; Webbe, 1981). Ideal habitat is often created through careless engineering or construction work.

Control of schistosomiasis is the subject of intensive research in many countries. Recent progress is reviewed in Christie (1978), Hoffman *et al.* (1979) and Webbe and Jordan (1982) and it is concluded that elimination of the disease, rather than eradication of infection, should be the goal. A combination of control methods is likely to be most effective, but the over-riding need in most countries is the development of low cost methods.

Chemical control, using molluscicides, has been used extensively and is likely to remain important, although it needs to be made more cost-effective. The majority of synthetic molluscicides are very expensive and all appear to be toxic in some way to the environment, particularly to fish. There is increasing interest in the possibility of using plants with molluscicidal properties (WHO, 1983), which are likely to be cheaper and available on a longer term.

Biological control is a cheap and environmentally attractive alternative to chemical control but further work is needed. It may play an important role in the maintenance of control programmes but it is important to bear in mind that it may have an effect on non target organisms (WHO, 1981).

Habitat control and appropriate agricultural engineering may be one of the most effective methods as its effect is persistent, but it has disadvantages. Removal of water may be effective but in many cases can only be considered a temporary measure, particularly as snails can survive considerable desiccation (Webbe and Jordan, 1982). Removal of natural habitat is also recommended in some instances and clearly this could have considerable bearing on the survival of non target species. Other control methods which are important in the longer term include curative drugs, and improved water supplies, sanitation and health education. Since schistosomiasis considerably slows down economic development in regions where it is endemic, it is in fact preferable to prevent its introduction.

The Mangoky Irrigation Project in south-west Madagascar was one of the six major control programmes throughout the world involving the control of the snail hosts. It was set up at the same time as the Samangoky Mixed Management Company was developing a vast irrigation system to be used for cotton cultivation. The area readily lent itself to the prevention of schistosomiasis and to the development of control methods. In 1971 the project was transferred to the Madagascan government, a team having been trained to take over the project. At this time, the project was considered to have been successful, as snails had been reduced or eliminated using the molluscicide Frescon. However, the risk of reintroduction was considered to be very high unless certain preventive measures continued to be carried out (Degremont, 1973).

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V.8. MARINE MOLLUSCS

There are a number of publications on the marine molluscs of Madagascar (see Brygoo and Brygoo, 1978; Mars *et al.*, 1972). About 1020 species have been described. The fauna is generally considered to be typical of the Indo-Pacific although the possibility of a separate classification has been raised (Mars *et al.*, 1972). However, consideration of the comparatively extensive studies which have been made on the genus *Strombus* and the family Cypraeidae suggests that there is little basis for this.

Brygoo and Brygoo (1978) provide a checklist of 66 *Conus* species and 56 *Cypraea* species. Cowries are abundant around Nosy Bé and include species such as *Cypraea nucleus, C. diluculum, C. onyx, C. oweni, C. lamarcki*, and *C. chinensis* (Magnier, 1981). At least 15 families of opisthobranchs are represented in Madagascan waters, including 9 tectibranch families, 6 nudibranch families and one family of Opisthopneumones (Vicente, 1966). The only marine mollusc which appears to be endemic to the region (Madagascar to Seychelles) is Delessert's Volute, *Lyria* (= *Voluta*) *delessertiana*, a small red-orange species, which is said to be found off Dzamandzar (Magnier, 1981).

Ecological studies have been carried out only recently. These are outlined in Mars *et al.* (1972), where it is pointed out that some rare genera have recently been found in the region of Toliara: *Berthelinia* in the Caulerpa zone, and the commensal gastropod *Caledoniella montrouzieri* which parasitises the abdomen of stomatopod crustaceans.

Mars *et al.* (1972) point out the importance of reference collections for use in future research work. An 'accord' has been drawn up stating that specimens would be sent to the Muséum National d'Histoire Naturelle at Paris. Following systematic revision of each family, three reference collections would be created, one for the museum, one for the Station marine d'Endoume at Marseilles and one for the marine laboratory at Toliara. It is not known to what extent this has been carried out.

Food Species

Decary (1950) reported that in spite of their variety and abundance, marine molluscs were not used very much for food except in certain areas. However Rabesandratana (1985) noted that with the increasing difficulty of obtaining meat, molluscs had become more important as food items; Table 8, taken from Rabesandratana (1984 and 1985), lists over thirty mollusc taxa which are exploited as a food source in Madagascar. In the north-west, the Sakalava people occasionally eat *Arca* species (Kodiva) while between Antseranana and Toamasina large *Nerita* (Sifotro mamy) are collected at low tide when they come out of the sand. *Tridacna* (Hima), *Turbo* (Betampy) and *Pleuroploca* species are also eaten. Rabesandratana (1972) gives further examples on Nosy Borah. In the 1960s it was common to see children at low tide collecting a variety of molluscs (*Conus, Strombus, Arca, Cardium, Venus, Tridacna*) which are an important part of the local diet, often replacing meat. In the extreme south, the Antandroy people on the coast collect *Cellana capensis*; around Toliara the Vezo fishermen collect *Pleuroploca, Cerithium*, and *Murex* species which they eat cooked. In the region of Lamboharanana (baie des Assassins) people collect chitons for food. Mussels may not be collected less than 3.5 cm in length (Randrianarijaona and Razafimbelo, 1983).

a. Oysters

Oysters (Papakiny, Saja) are certainly the most important food mollusc both locally, e.g. on the coast at Androy and in the region of Taolanaro, or sent inland to the large towns. Rabesandratana (1972) provides a bibliography of species descriptions for this group. The two most important edible species are:

Crassostrea cucullata (Born), the most abundant species and found on almost all coasts; has a wide Indo-pacific range and is cultured in many countries; varies in form according to habitat. *Ostrea vitrefacta* (Sowerby), abundant in the region of Mahajanga, may be a variety of this species.

Crassostrea margaritacea (Lamarck), the 'huitre pied de cheval de Madagascar'; found also in South Africa; occurs mainly around Taolanaro.

Natural oysterbeds in the south and south-west of Madagascar have been studied for several years. On the south-west coast, the beds of *C. cucullata* between Morombe and Lamboharanana which are exploited commercially have practically disappeared, and have been completely exhausted in the region between Ifaty and the Manombo estuary to the north of Toliara. South of Toliara, in the region of Sarodrano, there is an important bed which is partially protected by a provincial decree for the purposes of research and aquaculture experiments. Provincial decree no. 054-AG of 6 May 1966 prohibits collection of oysters throughout the year in the bay of Sarodrano and during the breeding season in the area around Faritany. Studies are being carried out and it has been recommended that the results should be made known widely (Randrianarijaona and Razafimbelo, 1983). The decree of 5 June 1922 prohibits collections of oysters with a diameter of less than 4 cm.

To the south of the bay of Saint-Augustin, oyster population density is much higher. The only other important beds are in the region of Androy: Lavanono, Fanambosa and Ankatravitra. By the 1970s the bed at Ankatravitra had already started to decline.

Beds of *C. margaritacea* are found only between Evatraha and Ambinanibe at Taolanaro. This species is usually collected by skin divers, and although exploitation is not as intense as if other methods were used, collectors have commented that oysters are becoming rarer. *C. cucullata* is usually collected with hammers and chisels. Often whole chunks of substrate are taken and the oysters are separated off later. In general, the methods used lead to great habitat destruction and prevent the settlement of juveniles, since the substrate becomes silted up and overgrown with diatoms. Such methods could result in beds disappearing within only a few years. Major action needs to be taken. Recommendations were made in 1972 but it is not known if these have been implemented:

1. A closed season should be imposed from November to the end of March, during the breeding season.
2. The size limit which was imposed under a decree in 1922 should be strictly adhered to: 4 cm longitudinal axis, a size generally reached at 3 years.
3. Aquaculture must be encouraged; trials were being carried out with *C. cucullata* in the early 1970s.

Other uses

Decary (1950) describes many other uses for marine shells. Near Maroantsetra and Mananara, the large valves of *Pinna* shells ('lelabasy') are used for bailing out canoes and as plates. In the 1920s *Pinna nigra* was collected from sea grass beds for its pearls and byssus threads which were used for making silk. Shells are used for weighting fishing nets. Many molluscs are used as fish bait, particularly *Cerithium palustre*. Shells are used to decorate houses, and in Mahajanga province jewellery is made from small *Trochus* and *Gibbula* shells. The 'felana' or 'fela' is a white disc made from the spire of a *Conus* shell which was worn on the head by warriors in the tribes of the west and north; it is now mainly worn for decoration by women, particularly professional dancers known as Sahafatra in Farafanga province. Small cowries, ('androvo', 'horohoro') are used in games. *Cypraea annulus* is considered a talisman; in the past it was exported to North Africa for use as currency. In the south-west, the operculums of *Pleuroploca* (= *Fasciolaria*) and *Murex* ('fimpy') are used by the Mahafaly and Sakalava people for making a perfume used in sorcery, and shells are used in other magical rituals by the Sakalava people.

The conch, *Charonia tritonis* ('antsiva', 'lavabody') was used as a trumpet in war and on other occasions, for example to call the wind if becalmed at sea, at burials, as a warning that locusts were spreading or a storm was coming. *Pleuroploca* and *Cassis* ('antsiva boriborivody') shells were also occasionally used as trumpets. Shell trumpets are still used sometimes. At Androy there are two forms of trumpet: *Charonia* ('antsiva lahy') is the male, is large and gives a powerful sound; *Pleuroploca* ('antsiva vavy') is the female, smaller and quieter. The male trumpet can be used on its own or with the female; the female can only be used with the male and never on its own. *Charonia tritonis* is used as a trumpet in different countries throughout the Indo-Pacific. It is also a very popular species in the ornamental shell trade. It is listed as Rare in the IUCN Invertebrate Red Data Book (Wells *et al.*, 1983) as its population density is naturally low, and there are fears that it could be threatened by intensive exploitation.

Exports

Madagascar exports substantial quantities of marine shells and shell products, the most important of which is mother-of-pearl from the species *Turbo marmoratus* and *Trochus niloticus* ('betampy'). These species are most abundant on the west coast (both are reef dwellers) and are collected for export around Toliara. Export figures for the years 1976-84 are included in Table 10. Exports principally go to Europe (France, Italy, Spain, United Kingdom) and occasionally to India, Kenya and Japan (Rabesandratana, 1985). Before the second world war, 150-200 tonnes were collected annually with evidence of overexploitation of large specimens (Decary, 1950). In several parts of the world these species have been overfished and legislation has been introduced to control the fishery (Wells, 1980). The four important mother-of-pearl species, *Trochus niloticus*, *Turbo marmoratus*, *Pinctada margaritifera* and *P. maxima*, are categorised as Commercially Threatened. The current status of the fishery in Madagascar is not known, although reported exports have declined considerably from 1978/1979 to 1983.

Second in importance to mother-of-pearl is the Bullmouth Helmet *Cypraecassis rufa* which is principally exploited along the south-west coast from Morombe to Anakao, south of Toliara, being rare further north. Two forms are collected, one, the 'male' shell, is exported, principally to Italy, for the production of shell cameos, the second, the 'female' shell, is used for making ash-trays. Export figures for the years 1976-84 are given in Table 10. Rabesandratana (1985) quotes mean weight estimates for a 'male' shell of 0.8 kg, for a 'female' shell of ca 0.3 kg. From these, the numbers exported from Toliara in the years 1979-82 would be likely to lie between 77 000 (if all 'males') and 185 000 (if all 'females').

Considerable numbers of other species, principally gastropods, are also exported; a breakdown of the figures for 1978 and 1979 is included in Table 11; Rabesandratana (1985) considers that several species are probably being over-collected and recommends some form of control.

Decary (1950) reports that pearls are occasionally found in *Pinctada (Meleagrina) margaritifera*, *M. occa* and *M. irradians* but since the Madagascans do not have a tradition of diving for pearls only the easily accessible specimens are taken. Sometimes pearls are exported to Sri Lanka. The decree of 23 August 1929 imposes controls on collection of pearl oysters, mother-of-pearl shells and sponges (Randrianarijaona and Razafimbelo, 1983).

a. Pearl oysters (*'Meleagrina' occa*, *M. irradians*): 6 cm minimum size, measured from inside edge of valves across largest diameter.
b. Mother-of-pearl oyster (*M. margaritifera*): 10 cm minimum size.
c. Turbos or Bourgos (*Turbo marmoratus*): 55 mm minimum size; 140 mm maximum size.
d. Trochus or Trochas (*Trochus niloticus*): 110 mm minimum size.

The substrates of pearl oysters (corals, etc.) must be thrown back into the sea.

The IUCN Invertebrate Red Data Book (Wells *et al.*, 1982) points out that although most marine molluscs are unlikely to be threatened with extinction through human activities, local overexploitation can easily occur. This is particularly evident with the giant clams in the family Tridacnidae. It is recommended that commercial exploitation of any marine mollusc is carried out under an appropriate management strategy. Further information is required on the shell trade, and it might be necessary to control collection of *Lyria delessertiana* if this proves to be endemic.

TABLE 8. MOLLUSCS EXPLOITED FOR FOOD IN MADAGASCAR

	North-west	South-west	North-east
GASTROPODA			
Patellidae			
Cellana capensis		++(*)	
Turbinidae			
Turbo marmoratus	+++	+++	+++
Turbo coronatus	++	++	++
Turbo argyrostomus	++	++	++
Turbo imperialis	+++		++
Naticidae			
(species not given)	++		++
Neritidae			
Nerita albicilla	++		++
Nerita undata	++		++
Littorinidae			
Littorina kraussi	++		
Littorina acabra	++		
Conidae			
Conus lividus	++		+++
Conus tessulatus	++		+++
Fasciolariidae			
Pleuroploca trapezium	+++	+++	+++
Pleuroploca filamentosa		+	++
Muricidae			
Murex ramosus	+++	+++	+++
Drupa morum	++		
Stombidae			
Strombus gibberulus			+++
Cerithiidae			
Pyrazus palustris	+++	+++	+++
BIVALVES			
Arcidae			
Anadara natalensis	+++	+	?
Cardiidae			
Cardium sp./spp.	+++	+	+++
Mytilidae			
Septifer bilocularis	++		++
Modiolus sp./spp.	+++	+	+++
Ostreidae			
Crassostrea cucullata	+++	+++	+++
Crassostrea margaritacea		+++(#)	
Pteriidae			
Pinctada margaritifera	+++	+++	+++
Tridacnidae			
Tridacna squamosa	+++		+++
Veneridae			
Gafrarium pectinatum	+++	+	+++
CEPHALOPODA			
Octopus sp./spp.	+++	+++	+++
Loligo sp./spp.	+++	+++	+++
Sepia sp./spp.	+++	+	++

+++ much sought after; ++ harvested; + harvested occasionally.
* extreme south; # south-east (Taolanaro).
Taken from Rabesandratana (1984).

TABLE 9. EXPORTS OF SHELLS, 1976-84 (TONNES)

	1976	1977	1978	1979	1980	1981	1982	1983	1984
Turbo marmoratus									
Toliara[a]	-	-	-	89.3	46	10	37	14	5#
Madagascar[b]	87.6	53	96.2	94.2	39.2	15	42.4	14*	
Cypraecassis rufa									
Toliara[a]	-	-	-	14.55	23.08	10	14	-	3#
Total shells (including *C. rufa*, excluding *T. marmoratus*)									
Toliara[a]	-	-	-	46.2	48.3	78.3	153.3	125.6	11.7#
Madagascar[b]	61.4	82.4	63.9	37.7	103.3	71.1	63.9	10.6*	

= First half of year; * = figures for five months only; - = no information;

a = source Bureau de Recette des Douanes de Toliara; Service Provincial de Commerce de Toliara

b = source Institut National de la Statistique et de la Recherche Economique (I.N.S.R.E.)

TABLE 10. EXPORTS OF SHELLS FROM TOLIARA, 1979 AND 1980 (KG)

Species	1979	1980
Cypraea spp.	1000	2950
Cypraea caputserpentis	125	-
Cypraea histrio	130	110
Cypraea scurra	622	
Cypraea tigris	480	200
Conus spp.	412	100
Charonia tritonis	169	101
Lambis lambis	791	448
Lambis truncata	558	766
Oliva spp.	300	
Terebra spp.	2040	1000
Polynices spp.	570	500
Vasum ceramicum	100	
Cypraeacassis rufa	750	2100
Murex ramosus	8660	13087
Turbo bruneus	520	200
Turbo marmoratus	1050	2600
Bursa lampas	252	
Bursa bubo	591	295
Strombus lentiginosus		250
Clanculus pharaonius	20	-
Pleuroploca trapezium	600	500
Atrina vexillum	76	215
Macrocallista nimbosa	100	
Tridacna elongata/gigas	710	500

Source Bureau de Recette des Douanes de Toliara; Service Provincial de Commerce de Toliara

Taken from Rabesandratana (1985).

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V.9. NON-MARINE CRUSTACEANS

The non-marine crustacea of Madagascar remains little studied, although there are known to be many endemic species. Details of some of the more interesting groups are given in Appendix 2. Several species are restricted to phreatic (groundwater) habitats including copepods (Cyclopidae, Harpactidae), ostracods and syncarids. Since rough substrates are most favourable for these species, they tend to be found mainly in the fine gravel of mountain torrents (Paulian, 1961).

Fisheries

Freshwater crustacea in the order Decapoda are often harvested for food; the most important families taken are the Palaemonidae (freshwater shrimps) and the Parastacidae (freshwater crayfish), although freshwater crabs (family Potamonidae) and shrimps of the family Atyidae are also taken.

a. Family Palaemonidae

The larger freshwater shrimps are a very popular food and are known locally as 'patsa', 'makamba' and 'tsivakiny' (Decary, 1950; Griveaud, 1981) (prawns are 'tsitsika' (Kiener, 1963)); some of the *Macrobrachium* prawns are known as 'orana' or 'camaron' such as *Macrobrachium australe*, *M. idae* (said to be much appreciated by Europeans; with *Metapenaeus monoceros* and *Palaemon concinnus* it dominates the fishery in the Pangalanes), and *M. lepidactylus* (Madagascar scale prawn, Bouquet malgache, also referred to as *Palaemon hilgendorfi*) (Louvel, 1930; Moulherat and Vincke, 1968). In the past, freshwater shrimps were brought as gifts to women in confinement; nowadays visitors bring a small sum of money called 'vola amidy patsa' or 'money to buy shrimps' (Decary, 1950). Shrimp are caught in the lakes and marshes of the west and in the Pangalanes-Est. Prawns are mainly found in rocky parts of rivers at medium and low altitudes, and are caught by women using molluscs as bait. A particularly large species (scientific name not identified) found in forest streams with long claws and bright blue, green and pink in colour is called 'rangaza', 'rakaho' or 'rafitrako' (Kiener, 1963).

b. Family Parastacidae

Astacoides madagascariensis is the only representative of the family Parastacidae in Africa, and is in a monotypic genus endemic to Madagascar, apparently most closely related to Australian and South American forms (Griveaud, 1981). It is absent from the west of the country (Decary, 1950). All subspecies of *Astacoides* are of a size that makes them valuable food items. In the 1950s, they were collected quite intensively to the east of Fianarantsoa and around Antananarivo but already seemed to be becoming rarer. They were either brought to the town alive for sale in the markets or cooked and sold to travellers on the railway stations on the line from Antananarivo to Toamasina. A variety of collecting methods are used (Decary, 1950). They are considered to be declining due to progressive deforestation, although at the beginning of the 1960s some areas, especially the rivers flowing down the easten scarp of the island, e.g. Mandraka (Ambatolaona) and Ankaratra (Ambatolampy), had large populations (Kiener, 1963). Known as 'oram-bokoka' or 'orambato' (Kiener, 1963), they are forest stream dwellers and would probably not lend themselves to artificial culture (Hobbs, 1983). However, experiments on crayfish culture using a variety of species suggest that it might be worth attempting to raise them artificially (Brinck, 1983).

Threats

The IUCN Invertebrate Red Data Book (Wells *et al.*, 1983) discusses the types of human activities which may threaten freshwater crustaceans, and gives several examples. Habitat alteration and pollution are probably the major threats. The species which may be most vulnerable in Madagascar are those of interstitial, subterranean and brackish water habitats (Dussart, 1983). Interstitial and subterranean forms may be threatened by pollution. There are a number of interesting endemic taxa (e.g. *Anopsilana, Caridina troglophila, Parisia edentata, P. macrophthalma, P. microphthalma* and *Typhlopatsa pauliani*) restricted to small, and therefore particularly vulnerable, caves (Paulian 1983). Moss and epiphytic lichens also seems to be important habitats for crustaceans, presumably because they provide a high level of humidity during the day (Paulian, 1961). Burrowing and cave crustaceans are threatened in many parts of the world, and examples are given in the IUCN Invertebrate Red Data Book.

In many countries, native crayfish are coming under increasing threat through a combination of factors including overexploitation, pollution and competition with introduced species. Since there is evidence that the native Madagascan species are a valuable resource, efforts should be made to ensure that stocks are properly managed. Fishing pressure on the native species is already heavy, and certainly destructive. Regulations should be introduced to limit catches and to protect the reproductive stages, possibly through closed seasons and minimum sizes (Paulian, 1983b).

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V.10. MARINE CRUSTACEANS

Like most other Madagascan marine invertebrates, the marine crustaceans are mainly typical of the Indo-Pacific fauna; some groups have been fairly well studied but there is still much work to be done. Many of the publications up to 1974 are listed in ORSTOM (1973) and ORSTOM (1975). It has not been possible to review all the studies that have been carried out on marine crustaceans but a few examples are given below, and the main commercial crustacean fisheries are discussed.

Seventy-three species of crabs in the family Portunidae have been described (Crosnier, 1962), collected in the course of studies on peneids. Collecting was carried out on all coasts except the east; 23 of the species found occur in South African waters, 33 in Australasian waters, 18 in Hawaii, and 33 in Japan. Five species new to science were described. The study confirmed the fact that the marine fauna of the north-west and west coasts of Madagascar and the Comoros is very rich in species and homogeneous; in the south and south-east, the waters are colder and there is a rather different and less diverse fauna.

Forty-one species of crab in the family Grapsidae and 19 in the family Ocypodidae (which includes the ghost crabs *Ocypode* and the fiddler crabs *Uca*) have been described (Crosnier, 1965), but these lists are almost certainly incomplete, particularly for the smaller forms. Six new species were described. All except three species were intertidal. This study illustrated that most Madagascan marine species fall into three groups:

1. Species with Indo-Pacific distributions
2. Species with distributions extending as far as South-East Asia or India.
3. Species limited to Madagascar and the East African region.

Species which are apparently endemic may only be so through lack of collection in other places. Rare exceptions concern some of the species from the region of Taolanaro and St. Lucia in the south-east; it is possible that some of these, such as *Ocypode madagascariensis*, are true endemics (Crosnier, 1983). Studies on the families Xanthidae, Trapeziidae, Carpiliidae and Menippidae have been carried out and will shortly be published; more than 200 species have been recorded (Serène, in press). There are also a number of endemic marine phreatic species, revealed by samples taken from the lagoon across the 'cordon littoral' at Maroantsetra. These may have extremely restricted distributions if they are comparable to endemic species found in similar habitats on Réunion (Paulian, 1961).

The Coconut crab *Birgus latro* has been recorded from the Comoros (Fourmanoir 1953) and may possibly occur on some of the smaller islands off the Madagascar coast. It is listed in the IUCN Invertebrate Red Data Book as Rare, and there is evidence that it is declining in some parts of its range. Information on its presence in Madagascar is required.

Lobster fishery

Three reports on the lobster fishery are available (Charbonnier and Crosnier, 1961; Pichon 1964; Fourmanoir *et al.*, 1960). In the east, north-west and west, where the coast is mainly coralline, the following species predominate: *Panulirus versicolor* (Latr.) Painted Crayfish (Indo-Pacific); *P. ornatus* (Fabr.), the largest species, weighing up to 3 kg.); *P. japonicus* (Siebold) Japanese Spiny Lobster, Langouste Japonaise; in addition *P. penicillatus* was found to be rare on Nosy Bé (Pichon, 1964).

These species are usually found at depths of less than 4 m. Their reef habitat precludes the use of nets and traps and they are taken only by divers and spear fishermen, although this is said to be illegal (see below). There is no substantial fishery.

On the rocky coasts of the south and south-east, *Panilurus hommarus* (L.) (= *P. burgeri*) and *P. penicillatus* are found (Charbonnier and Crosnier, 1961).

These two species are caught easily and an artisanal fishery has developed along the coast between Cap Ranavalona and Manantenina. *P. penicillatus* is quite rare and constitutes more than 1% of the fishery. The principal fishing centres are the bay of Itaperina and Sainte Luce. Lobsters are caught using traps placed either by wading out or using canoes made from tree trunks. Most fishing is carried out at depths of less than 8 m; attempts at depths of 25-50 m were unsuccessful (Fourmanoir *et al.*, 1960). Mussels are the most suitable bait, but in the more populated areas these have been depleted, and limpets (*Patella* sp.) and acorn barnacles (*Balanus* sp.) are used instead. Mussels are still abundant in areas offshore but are inaccessible here because of the sea swell. The number of fishing days per year is very small on account of winds, heavy swell and the instability of the canoes; in general, only sheltered sites are exploited. In 1958, 24.5 tonnes were produced; in 1959, 21.5 tonnes. At the beginning of the 1960s the 'Division des Pêches maritimes du Service de l'élevage et l'Institut de recherches scientifiques à Madagascar' carried out a survey of the Taolanoro and Sainte Luce areas to see if an extension of the fishing zone would be feasible. However it was found that the range of the lobsters is restricted to a very narrow coastal band. An increase in harvest could have been achieved by using motor boats to get to the more inaccessible sites, but in the 1960s the local markets in Madagascar were already saturated. A freezer plant would have to be installed if an export trade were to develop; this would necessitate a minimum production of 10 tonnes per month, which would be difficult to achieve. Furthermore, an increase in fishing intensity would lead to even greater depletion of the bait species. It was therefore concluded that further intensification of the lobster fishery would not be a viable proposition (Charbonnier and Crosnier, 1961). Attempts were made to improve yields using artificial shelters, but these were not successful (Pichon, 1964). Frozen tails and living lobsters have been exported to France on occasions, but quantities are not available and it is not known if exports continue. The decree of 27 December 1962 prohibits the fishing, sale, transport and processing of lobsters from 1-30 April each year (Randrianarijaona and Razafimbelo, 1983). Throughout the year it is forbidden to sell, transport or sell ovaried female lobsters and any lobsters less than 20 cm in length (measured from the end of the telson to the end of the rostrum excluding the antennae). The decree of January 1921 prohibits the use of all collecting methods apart from traps and nets. These methods permit the release of ovaried females, unlike harpooning. There is no comment on the fact that harpooning is the method used in the east, north-west and west. Studies on deep-sea *Palinurus* have been carried out by Plante and Moal.

Crab fishery

Crabs are known locally as 'foza'. *Scylla serrata*, the mud crab (crabe de mangrove), which has a range throughout the Indo-Pacific, has long been fished in Madagascar but a commercial fishery for export has only recently developed, mainly as a sideline by the shrimp companies. The fishery at Antseranana was studied in 1976 by Le Reste, Feno and Rameloson. Adults and very young juveniles and larvae live in shallow open water, juveniles are found in brackish estuaries and subadults in the mangroves. These habitats are found primarily on the west coast (98% of Madagascan mangroves are found here) and crab fisheries have developed at Toliara, Mahajanga and Antseranana. Young crabs move into estuarine waters at a size of 2-8 cm (cephalothorax width). On attaining a size of 10 cm they move to the mangroves where mating occurs, and then into the sea where the larvae are released. There appear to be two breeding seasons, one in the dry season and one in the wet season. Crabs feed on shrimps, crabs, fish and bivalves, and although occasionally found on mud, they usually inhabit burrows in the mangroves.

Crabs are caught while they are in the mangroves, probably aged about 5 months; since the females move into the mangroves later than the males, a higher percentage of male crabs are caught. They are caught in their burrows, a method known as 'pêche au trou' which has been shown to be most efficient. In some areas, however, they are reported to be caught in sea grass beds. At Antseranana they are caught mainly in the warm and wet season (i.e. October to April, with a peak in December/January) when they are most abundant, unless rainfall is sparse when they are more abundant in the dry season and caught then. At Toliara the maximum catch is taken in April; at Mahajanga the fishing season runs from March to July. The significance of these differences is not known. At Antseranana the crabs show two peaks of abundance, one in the wet season and one in the dry, which are considered to be linked to the two peaks in primary production, typical of tropical waters. Prior to export, the crabs are kept in mud but studies have shown the mortality to be fairly high. Males give the best yield of flesh and are particularly valuable on account of their large claws which are considered a delicacy. Crabs for export are cooked and their shells removed.

Total production in the early 1970s was as follows:

1970	182 tonnes
1971	258 "
1972	161 "
1973	111 "

Exports have probably ceased altogether now. The decline between 1971 and 1973 was considered to be due to a decrease in fishing effort rather than overexploitation, as crabs are relatively expensive and both foreign and local markets had declined. FAO statistics do not record Madagascar as a producer for the years 1977-1980. The 1976 survey recommended that studies should be carried out on the Toliara and Mahajanga fisheries and suggested that culture of this species might be possible but would require considerable further research, and would probably present many problems (see below). It was concluded that the traditional fishing methods used would be difficult to better, that there was little likelihood of overexploitation since the crabs grow fast and are only exploited in the mangroves where there are a higher percentage of males, and that the large males are the most profitable specimens to take.

In other countries, the mangrove crab is cultured as a subsidiary crop to milkfish in brackish ponds. The ponds are seeded with small crabs which reach marketable size within six months (Warner, 1977; Bardach *et al.*, 1972).

Shrimp fishery

This is the largest crustacean fishery, and is of major economic importance; shrimp are the fifth most important export commodity. Most exports go to Japan and the USA which are the main shrimp consumers. The fishery began commercially in 1967 off the north-west coast and developed rapidly until there were more than 40 vessels involved in 1975 (Marcille 1978). Numerous publications are available on this subject as the fishery has been well studied by ORSTOM; some of these are listed in the bibliography.

The following species are the most important (details from Holthuis (1980) and further details on these species are given in Marcille (1978)):

Penaeus indicus Milne Edwards 1837. The Indian White Prawn, Crevette Royale Blanche, 'makamba' (Sakalava language), 'patsa' (Hova language). Occurs thoughout Indo-West Pacific. Makes up 67% of the total shrimp catch in Madagascar, equivalent in 1974 to 3000 tonnes.

P. semisulcatus De Haan, 1844. The Green Tiger Prawn, Crevette Tigrée Verte. Indo-West Pacific, and has reached eastern Mediterranean through the Suez canal. 11% of Madagascar shrimp catch.

P. monodon Fabricius, 1798. The Giant Tiger Prawn, Crevette Giante Tigrée. Indo-West Pacific. 3% of shrimp catch.

Metapenaeus monoceros (Fabricius, 1798). The Speckled Shrimp, Crevette Mouchetée, 'patsanorana' (name used also for other species). Indo-West Pacific and eastern Mediterranean. 19% of catch.

P. japonicus (Bate) is fished in very small quantities.

Fishing is coastal and carried out at depths of 5-25 m in sandy and muddy areas. The continental shelf of Madagascar is poorly developed except in the region of Taolanaro and on the west coast where the fisheries are concentrated. The commercial fisheries are concentrated between the Mangoky estuary and cap Saint Sebastien (see map in Marcille, 1978). Two kinds of fishery have developed:

An artisanal fishery consisting of shore barriers, which catches mainly immature shrimps in estuaries near mangroves in the intertidal zone.

An industrial fishery operating with a trawler fleet and freezer plant which catches adult shrimps in depths of 3-10 m. The products are processed in four factories. Research has been carried out on the production of edible products using waste from the shrimp industry (Frontier Albon, 1972).

The ORSTOM centre at Nosy Bé has collected statistics since the beginning of the fishery. This has permitted a study of the evolution of stocks over this period, during which there was considerable intensification of the fishery. The results are given in Marcille (1978), where models have been produced which could be used to help determine the maximum fishing effort that shrimp stocks could support. The study concludes that some form of fishery management is required, since in 1974 the catch declined despite increased fishing effort (in 1975 catches increased slightly - see figures in Marcille, 1978). The following recommendations were made:

For the artisanal fishery, the size of the gaps between the lattices in the shore barriers should be increased from 7.5 mm to 11 mm to increase selectivity.

For the industrial fishery, a closed season should be introduced throughout the fishing area for a short period (1-2 months) in January/February in order to protect the young. A closed season was implemented on part of the north-west coast near Mahajanga, for two months (December/February). This proved to be beneficial to fishermen and the stock and has been retained (Veillon, 1973). The closed season at the beginning of the year protects the shrimps when they are particularly small. The shore barriers are known locally as 'valakira'. Randrianarijaona and Razafimbelo (1983) report that their use is, in fact, illegal but that it has proved difficult to prohibit them since many people gain their living in this way. Fishing effort should also be limited; two methods are proposed, details of which are given in Marcille (1978).

Le Reste (1978) also recommends that the minimum size limit for the commercial fishery should be 10 cm, which is anyway the smallest size of economic value.

Current legislations are described under the decree of 18 May 1971 (Randrianarijoana and Razafimbelo, 1983). Shrimp boats must be licensed; fishing is prohibited from 15 December to 15 February; the mesh-size of nets is controlled; and boats with motors larger than 25 hp may not trawl within two miles of the coast.

Le Reste (1978) describes the *P. indicus* fishery in the Baie d'Ambaron in the north-west between Cap d'Ambre and Cap St. André in detail. The larvae are shed at sea; juveniles move to the estuaries and at a size of about 4.5 cm move into the intertidal zone where they remain until they reach a size of about 6.5 cm. The annual cycle involves two generations. From October to November, a small number of eggs are spawned since the percentage of females in the population is low. High temperatures result in favourable conditions for juvenile growth. As a result, both the artisanal and commercial fisheries take large catches of this generation A between March and June. At this time of year, conditions are less favourable for juvenile growth, although there are large numbers of females in the population laying eggs, and so the catches of generation B in July and August, taken only by the artisanal fishery north of Nosy Bé, are small. It is suggested that this fishery could be extended further along the coast. It is also recommended that the fishery for generation A would ultimately need to be protected from overexploitation although at the time this study was carried out (presumably c. 1972), this was thought to be an unlikely occurrence.

All coastal stocks have been discovered and in 1973 the majority were already maximally exploited, and it was considered that the rest soon would be. About 5000 tonnes were produced a year and it was thought that this would increase to 8000 tonnes, but that stocks would be unlikely to sustain a higher harvest (Anon., 1973; Marcille and Veillon, 1973a). Studies made by the ORSTOM centre at Nosy Bé during the 18 years preceding 1973 showed that there was no hope of developing deep-water trawling on the continental shelf as either stocks are poor or the bottom type such as coral makes dredging impossible. Further development of the fishery will therefore necessitate the discovery of new stocks, possibly on the continental slope. In 1971, ORSTOM therefore started a programme to look at the slope between 100-1000 m depth. Details of this study are given in Crosnier and Jouannic (1973) and the species are described in Crosnier (1978).

More than 250 decapod species were caught but probably only a few are of commercial value. The following were considered to be of the greatest potential value on account of their size and abundance:

Hymenopenaeus sibogae = Haliporoides sibogae (De Man, 1907). The Jack-knife Shrimp, Salicoque Canif; of importance in Japanese fisheries.

Plesiopenaeus edwardsianus (Johnson, 1868). The Scarlet Shrimp, Gambon Ecarlat; Eastern Atlantic where it is fished commercially by Spanish trawlers; the Madagascan form may not be the same species.

Aristaeomorpha foliacea (Risso, 1827). The Giant Red Shrimp, Gambon Rouge. Eastern Atlantic, fished by commercial deep sea trawlers off Mediterranean coasts; the taxonomic status of the Indo-West Pacific form is not yet clear, and it is not yet fished commercially in this area.

Aristeus virilis (Bate, 1881). The Stout Red Shrimp, Gambon Gaillard. Indo-West Pacific; does not yet appear to be fished commercially anywhere

Aristeus mabahissae Ramadan, 1938. Not yet fished commercially.

The langoustine *Nephrops andamanicus* was also considered potentially commercially valuable.

The survey showed that the only suitable area for such a fishery was in the Toliara region where stocks were reasonably abundant. *Hymenopenaeus sibogae madagascarinum* and *Nephrops andamanicus* were found at depths of 425-475 m, and the other species were found at depths of 700-800 m. It was recommended that further research should be carried out in the Toliara region using a commercial deep-sea fishery vessel rather than a research vessel.

Another small freshwater shrimp species known locally as 'tsivakihiny', *Acetes erythraeus* (Sergestidae), which is widespread from the Red Sea down to South Africa, is fished in the muddy, shallow estuaries of the north and north-west coasts by women. The shrimps are dried and eaten in coastal villages. The quantities collected are unknown but are reported to be large (Crosnier *et al.*, 1962; Le Reste, 1971).

We are very grateful to Dr Alain Crosnier who provided the information for this section.

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V.11. OTHER INVERTEBRATES

Marine

The marine fauna in general has few endemics since the position of Madagascar in the south-west Indian ocean means that most of its fauna is common to the Indo-Pacific with, in the south, species from temperate seas (Magnier, 1981). No information is available on the conservation status of the following groups.

a. Corals and other coelenterates

Two hundred and twenty-two species of octocoralliens have been described from the waters around Madagascar, Seychelles, Réunion, Mauritius and Aldabra. Most are common to the whole Indo-Pacific; 62 species were known only from the waters of Madagascar and neighbouring islands (Tixier-Durivault, 1966). Coral reefs are discussed in detail in Part IV.

b. Echinoderms

Thirty species of sea urchin are known but these are rarely eaten by the local people, although *Heterocentrotus* is eaten in the north and *Tripneustes gratilla* in the south-west. Urchins are, however, often used as bait.

Sea cucumbers are fished for sale and export to the Far East. At the beginning of the 1950s, 50-70 tonnes were being collected a year (Decary, 1950). Minimum sizes have been established for their capture and sale: 11 cm for fresh specimens and 8 cm for dried specimens (Randrianarijaona and Razafimbelo, 1983). They are collected mainly from the region between Androka and the Baie de Mangoky. Recently, it has become apparent that sea cucumbers are being over-collected in certain areas, particularly on the south-west coast (Randrianarijaona and Razafimbelo, 1983).

A rich fauna of ophiuroids has been described (Charbonnier and Guille, 1978). 112 species are known, including 24 new species and 1 new genus. Most species were found in the littoral.

c. Ascidians

Plante and Vasseur (1966) describe three new species but there is no indication that these are necessarily endemic.

Non-marine

Previously unknown species of hydrozoans, bryozoans and sponges have been found in freshwaters but have not yet been fully studied. Rotifers appear to be numerous but have also not been studied (Paulian, 1961).

a. Flatworms

Large, brightly coloured, black and red flatworms are found in the soil of the rain forests in the east (Griveaud 1981). Apart from parasitic forms of Platyhelminthes, two aquatic planarians have been described and at least 31 terrestrial planarians, 23 in the genus *Bipalium*, two in *Pelmatoplana*, six in Rhynchodemidae. An unpigmented planarian was found in the important cave of Andranoboka, but in general planarian diversity seems to be low (Paulian, 1961).

b. Nemertines

At least one species is known (Paulian, 1961).

c. Annelida

Earthworms (Hakatany or Kankana) can reach large sizes, up to 75 cm long (Decary, 1950). Leeches are known as 'linta', 'dinta' or 'ditamaka' (Decary, 1950). Small forest leeches are abundant in the soil and foliage in the rain forests in the east (Griveaud, 1981). A species of *Philaemon* and three species in the genus *Haemadipsa* are known, from the rain forests of the east (Paulian, 1961).

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PART VI. PROTECTED AREAS

VI.1. INTRODUCTION

Legislation

Five different categories of protected area are recognised:

a. Réserves Naturelles Intégrales (Strict Nature Reserves).
b. Parcs Nationaux (National Parks).
c. Réserves Speciales (Special Reserves)
d. Forêts Classées (Classified Forests).
e. Perimètres de Reboisement et de Restauration (Reafforestation Zones).

a. Legislation for the Strict Nature Reserves is chiefly contained in Decree 66-242 (01.06.66); the network of reserves was originally set up in 1927. These reserves are part of the national forest domain; access is strictly forbidden, other than for scientific research purposes (which in each case must be authorised by the Ministry in charge of the Direction des Eaux et Forêts). Each reserve comprises a station for a deputy forester and each station is divided into two or three sectors under the responsibility of auxiliaries. At present there are 11 Strict Nature Reserves; a twelfth, R.N.I. No 2 on the Masoala Peninsula, was de-gazetted by Decret 64-381 of 16.09.64. and is now a Classified Forest.

b. National Parks legislation is contained in Decrees 58-07 (28.10.58) and 62-371 (19.07.62). Access to the Parks is controlled. Rights are accorded to neighbouring villagers for the exploitation of certain forest products; these rights are tied to duties incumbent on the beneficiaries. There are two national parks at present.

c. Special Reserves have been set up by a series of decrees and are designed to protect certain animal or plant species. Access to such reserves is free, but hunting, fishing, pasturing of livestock, collection of natural products and introduction of vegetation or animal species are all forbidden; however, these areas do not generally have supervisory personnel. There are 23 Special Reserves, of which the most recently created (November 1985) is Beza Mahafaly in Toliara Province.

d. Classified Forests are the subject of individual ministerial decrees; points in common are:
- all forest exploitation is forbidden;
- they are intended to constitute 'forest reserves' in the economic sense of the term;
- local inhabitants can exercise certain traditional rights of usage (limited to the collection of minor forest products such as honey and raffia);
- classified forests are created under an initiative from the Minister in charge of the Direction des Eaux et Forêts on the advice of a commission composed of representatives of the administration and local inhabitants; protection is not necessarily permanent.

e. Reafforestation and Restoration Zones are set up following the same procedure as for Classified Forests above. Their aim is principally stabilisation and protection of watersheds, and prevention of erosion. Land-use is regulated within these regions, and they benefit from management practices such as reafforestation, management of pasture and use of antierosion measures and devices.

The original definitions for parks and reserves were based on the 1933 London Convention (which was accepted in Malagasy law on 25 January 1937), and the African Convention for the Conservation of Nature and Natural Resources (1968) is invoked for the protection and conservation of all protected areas.

Administration

This is the responsibility of the Administration Forestière within the Direction des Eaux et Forêts which at the present time comes under the Ministère de la Production Animale (Elevage et Pêche) et des Eaux et Forêts. The Direction des Eaux et Forêts is also responsible for forests and freshwater fisheries, while other departments within the same Ministry deal with marine fisheries and agriculture.

Total area under protection

	(hectares)
National Parks	
Isalo (No.2)	81 540
Montagne d'Ambre (No.1)	18 200
Total	99 740
Nature Reserves	
Tsingy de Bemaraha (No.9)	152 000
Andohahela (No.11)	76 020
Zahamena (No.3)	73 160
Ankarafantsika (No.7)	60 520
Marojejy (No.12)	60 150
Tsaratanana (No.4)	48 622
Tsimanampetsotsa (No.10)	43 200
Andringitra (No.5)	31 160
Tsingy de Namoroka (No.8)	21 742
Betampona (No.1)	2 228
Lokobe (on Nosy Bé) (No.6)	740
Total	569 542
Special Reserves	
Ambatovaky (Toamasina Province)	60 050
Marotandrano (Mahajanga)	42 200
Manongarivo (Antseranana)	35 250
Analamerana (Antseranana)	34 700
Anjanaharibe-Sud (Antseranana)	32 100
Kalambatritra (Fianarantsoa)	28 250
Ambohijanahary (Mahajanga)	24 750
Kasijy (Mahajanga)	18 800
Ankara (Antseranana)	18 220
Tampoketsa d'Analamaitso (Mahajanga)	17 150
Bemarivo (Mahajanga)	11 570
Maningozo (Antseranana)	7 900
Andranomena (Toliara)	6 420
Ambohitantely (Antananarivo)	5 600
Manombo (Fianarantsoa)	5 020
Forêt d'Ambre (Antseranana)	4 810
Bora (Mahajanga)	4 780
Pic d'Ivohibe (Fianarantsoa)	3 450
Cap Sainte Marie (Toliara)	1 750
Périnet-Analamazoatra (Toamasina)	810
Mangerivola (Toamasina)	800
Beza Mahafaly (Toliara)	600
Nosy Mangabe (Toamasina)	520
Total	365 500
Classified forests	
There are 158 of these with total area	ca 2 671 000
Reafforestation areas	
There are 77 of these covering	ca 823 978

Finally, a decree of 23 May 1923 declared the following as protected areas for the turtles *Chelonia mydas* and *'Chelonia imbricata'* (*=Eretmochelys imbricata*): Nosy Ovambo; Nosy Iranja, Chesterfield Island, Nosy Trozona, Nosy Ve and Europa (this last is now under French control).

Information sheets

The following section provides information on the two national parks, the eleven existing natural reserves, four special reserves (Ambohitantely, Beza Mahafaly, Nosy Mangabe and Périnet-Analamazoatra) and the private reserves at Berenty and Analabe. Format and contents are modified versions of those provided in the forthcoming IUCN Directory of Afrotropical Protected Areas.

A *preliminary* faunal list for each protected area is provided. It should be stressed that these lists are in large part incomplete, and are more a reflection of the available information for different faunal groups in each of the areas than of their relative faunal diversity. In general the birds and primates are the best-known components of the fauna, although for some areas (e.g. R.N.I. de Tsingy de Bemaraha (No.9), the largest reserve in Madagascar) information is still very incomplete even for these. For other groups, good information is available for only a very few protected areas. For some sites, records have been included if these refer to the general area of the reserve (e.g. Massif d'Andringitra (R.N.I. No.5), Montagne d'Ambre (Parc National No.1), Massif de Tsaratanana (R.N.I. No.4)), though it is possible that in some of these cases the records are from outside the reserves themselves. For a few cases, notably Lokobé (R.N.I. No.6) and Andohahela (R.N.I. No.11), some records have been included if they refer to the more extensive areas in which the reserves are situated (Nosy Bé island and the Anosyennes hills respectively), though this is made clear in each case.

In general, only endemic species have been included; where exceptions have been made these are clearly indicated (birds endemic to the Malagasy region but not confined to Madagascar are denoted *(R)*).

Species which are believed on current knowledge to be restricted to a given reserve or reserve area (see above) are marked *; doubtful records are indicated with '?'.

Much of the information quoted has been provided by recent observers; in particular we are extremely grateful to O. Langrand, M. Nicoll, S. O'Connor and M. Pidgeon for access to their extensive unpublished data, mainly on birds and mammals, and to Q Bloxam, D. Curl and C. Raxworthy for providing information on the herpetofauna of several of the protected areas. Most of the remaining records are derived from previously published data; further information and references for these are provided in Part V and Appendices 2 and 3. It should be noted that many of the published records, particularly those for the rarer bird species, are relatively old and may not have been re-confirmed more recently.

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NAME Parc National de la **MONTAGNE D'AMBRE** (No.1)

MANAGEMENT CATEGORY II (National Park).

LEGAL PROTECTION Total.

DATE ESTABLISHED 28 October 1958 by Decree No. 58-07.

GEOGRAPHICAL LOCATION 12°28'-44'S, 49°04'-13'E. At the northern point of Madagascar near the town of Antseranana.

ALTITUDE 850-1474 m.

AREA 18 200 ha.

LAND TENURE Government land.

PHYSICAL FEATURES The park lies within a volcanic massif which is composed essentially of basaltic rock of origin ca 14 myBP., and consists of a line of summits some 30 km long, oriented north-south, the tallest being the Pic d'Ambre (1475 m). The park contains a crater lake and cascades, and is a place of great beauty. The region of Antseranana has a tropical climate with a marked dry season from May to December during which a strong south-east trade wind blows (the 'Varatraza') and a wet season from January to April with less than 1000 mm rainfall. The Montagne d'Ambre, however, has a microclimate characteristic of the eastern rainforest with very high rainfall (3585 mm per year has been measured) throughout the year, with a maximum in January - February. The area thus serves as an important rain catchment area for Antseranana.

VEGETATION Vegetation is principally upland tropical moist forest, with trees reaching 30 m height and including species such as *Canarium madagascariense, Gluta tourtour, Terminalia mantali* and *Dalbergia* sp.; palms (e.g. *Neodypsis* and *Chrysalidocarpus* spp.) and tree-ferns (*Cyathea* spp.) are abundant in the understorey and there is a very diverse epiphytic flora, including ferns (e.g. *Platycerium, Drynaria* and *Asplenium*) orchids (e.g. *Bulbophyllum, Angraecum* and *Aëranthes*) and lichens. Around the Station Forestière des Roussettes there are plantations of introduced species including pines, *Eucalyptus* and *Araucaria.*

ZONING None.

CONSERVATION MANAGEMENT The management of the park is the responsibility of the Circonscription Forestière at Antseranana. In 1985, 23 km of the park boundary were re-cleared - previously the park's limits had been badly marked on the ground; the path giving access to the park was renovated, as was the 'gîte d'étape' which provides accommodation at the Station Forestière des Roussettes situated on the northern boundary of the park (Langrand and Lenormand, 1985). Reafforestation work has been undertaken at the park's boundaries by an association for nature conservation set up be teachers in Antseranana in 1983 (ASSE), in collaboration with Eaux et Forêts agents based at the Station Forestière des Roussettes.

DISTURBANCES OR DEFICIENCIES In general the park is inadequately guarded - there is only one agent who lives too far from the park (in Antseranana) to be able to carry out effective surveillance. Bush fires threaten the edges of the national park every year, and destroy eucalyptus plantations growing at the boundaries; such fires are usually the result of uncontrolled pasture burning. Illegal forest exploitation takes place in areas where access by Eaux et Forêts agents is difficult, particularly in the south. Collection of ornamental plants such as orchids, palms, and arborescent ferns for sale in Antseranana is a problem as is poaching, particularly of lemurs (*Lemur coronatus, L. fulvus*) and the Crested Ibis *Lophotibis cristata*; such poaching was said in 1986 to be widespread and increasing. Livestock range freely, though in relatively small numbers, through the park.

SCIENTIFIC RESEARCH There have been numerous collecting trips to the area since 1893.

VISITOR AND SCIENTIFIC FACILITIES Access is relatively easy from Antseranana (50 km north of the park) along an asphalt road. There are some 30 km of paths within the park, but their state of repair varies greatly from year to year. The 'jardin botanique' path passes numerous different trees that have been identified and labelled for visitors. There is accomodation in the form of a 'gîte d'étape' at the Station Forestière des Roussettes (Langrand and Lenormand, 1985).

PRINCIPAL REFERENCE MATERIAL

Langrand, O. and Lenormand, B. (1985). Presentation sommaire du Parc National de la Montagne d'Ambre. Unpd. report, 9 pp.

Nicoll, M.E. and Langrand, O. (1987). Report on the first phase of WWF - Protected areas programme in Madagascar. Unpd. report, 62 pp.

STAFF One Eaux et Forêts agent.

BUDGET Salaries paid by the government. WWF Direction à Madagascar has provided material and financial support for the park.

LOCAL PARK OR RESERVE ADMINISTRATION Headquarters is at Roussettes.

FAUNA

Birds

Tachybaptus pelzelnii
Ardeola idae (R)
Lophotibis cristata
Anas bernieri
Haliaeetus vociferoides
Aviceda madagascariensis
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Margaroperdix madagarensis
Turnix nigricollis
Dryolimnas cuvieri
Sarothrura insularis
Streptopelia picturata (R)
Treron australis (R)
Alectroenas madagascariensis
Coracopsis vasa (R)
Coracopsis nigra (R)
Coua cristata
Cuculus rochii (R)
Centropus toulou (R)
Otus rutilus (R)
Asio madagascariensis
Caprimulgus madagascariensis (R)
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Ipsidina madagascariensis
Eurystomus glaucurus (R)
Atelornis pittoides
Leptosomus discolor (R)
Mirafra hova
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus madagascariensis
Phyllastrephus zosterops
Hypsipetes madagascariensis (R)
Calicalicus madagascariensis
Vanga curvirostris
Leptopterus viridis
Leptopterus chabert
Leptopterus madagascarinus (R)
Copsychus albospecularis
Monticola sharpei
Neomixis tenella
Nesillas typica
Cisticola cherina
Newtonia amphichroa
Newtonia brunneicauda

Terpsiphone mutata (R)
Oxylabes madagascariensis
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Lonchura nana (R)
Ploceus nelicourvi
Foudia madagascariensis (R)
Foudia omissa
Saroglossa aurata
Dicrurus forficatus (R)

Mammals

Lemur coronatus
Lemur fulvus
Lepilemur septentrionalis
Phaner furcifer
Cheirogaleus major
Microcebus rufus
Cryptoprocta ferox
Galidia elegans
Tenrec ecaudatus
Setifer setosus
Pteropus rufus

In addition *Microgale prolixacaudata, M. parvula* and *M. drouhardi* have locality records of 'Antseranana' and probably occur in the national park.

Amphibians

Cophyla phyllodactyla
Mantidactylus femoralis
Mantidactylus granulatus
Mantidactylus ulcerosus
**Mantipus laevipes*
Mantidactylus flavicrus
Mantidactylus lugubris

Reptiles

Homopholis boivini?
**Uroplatus alluaudi*
**Brookesia tuberculata*
Amphiglossus ardouini
**Paracontias brocchi*
**Pseudoxyrhopus ambreensis*
Acrantophis madagascariensis
Sanzinia madagascariensis
Lygodactylus madagascariense
Uroplatus ebenaui
Chamaeleo pardalis
**Androngo allaudi*
Alluaudina bellyi
Leioheterodon madagascariensis
Ithycyphus miniatus
Liophidium rhodogaster

Nonmarine Molluscs

Tropidophora alluaudi
Tropidophora deliciosa
**Tropidophora propeconsocia*
Tropidophora surda
Tropidophora vignali
Tropidophora winckworthi
**Kalidos anceyanus*
Kalidos andapaensis
**Kalidos dautzenbergianus*
**Kalidos fallax*
**Kalidos glessi*
Kalidos humbloti
**Kalidos tenebricus*
**Ampelita alluaudi*
Ampelita atropos (forêt des Rousettes)
Ampelita dingeoni
**Ampelita lamothei*
**Ampelita subatropos* (forêt des Rousettes)
Clavator moreleti
Edentulina alluaudi (forêt des Rousettes)
Edentulina nitens
Macrochlamys stumpfii
Edouardia rufoniger

Nonmarine Crustacea

Isopoda:
Suarezia heterodoxa

Decapoda:
Hydrothelphusa agilis madagascariensis

Lepidoptera

Papilionidae
Graphium endochus

Danaidae
Amauris nossima dijuncta

Nymphalidae
Charaxes andranodorus
Hypolimnas dexithea
Cymothoe lembertoni

NAME Parc National de l'ISALO (No.2)

MANAGEMENT CATEGORY II (National Park).

LEGAL PROTECTION Total, except that inhabitants of Ranohira are authorized to harvest silkworm cocoons (*Bocerus* sp.) and Tapia *Uapaca bojeri.*

DATE ESTABLISHED 19 July 1962 by Decree No. 62-371.

GEOGRAPHICAL LOCATION West of Ihosy, in the province of Fianarantsoa. 22°10'-41'S, 49°10'-21'E.

ALTITUDE 514-1268 m.

AREA 81 540 ha.

LAND TENURE Central Government.

PHYSICAL FEATURES The park encompasses the whole of the sandstone Isalo Massif and has very varied relief. The south and east of the massif has characteristically ruiniform relief ranging in altitude from 820 to 1240 m above sea level, comprising 100-200 m deep, narrow-floored canyons extending for several kilometres. These have temporary or permanent watercourses. The northern and western parts of the massif are not ruiniform but also have 200-300 m high cliffs enclosing narrow, deep gorges. There are clear, fast-flowing streams which join the Malio River to the west and the Menamaty in the east, both these being tributaries of the Mangoky. Climate is dry and tropical, with a rainfall of ca 850 mm. A marked dry season occurs between June and August; the wet season runs from October to March with highest rainfall recorded in November and December. Average monthly temperatures are lowest in June (17.1°C) and highest in February (25.1°C). Winds (velocity 6-12 m/s) blow throughout the year.

VEGETATION Much of the vegetation is very degraded. A dry deciduous forest covers ca 20% of park, largely in the north and west (Sahanafo, Ankikiky and Angodongodona). In some areas the fire-resistant *Uapaca bojeri* is the only canopy species. Canyon floors with watercourses support evergreen forest with *Eugenia, Pandanus, Chrysalidocarpus* and two fern species predominating. Rock-dwelling vegetation is very abundant and principally consists of m*Pachypodium rosulatum* and *Aloe isaloensis*, both endemic to the massif.

ZONING None.

CONSERVATION MANAGEMENT None at present.

DISTURBANCES OR DEFICIENCIES Bush fires consitute the most serious threat to the park: the pastures bordering the park are subject to annual uncontrolled burning which spreads into the surviving wooded areas. Only isolated areas such as canyons are protected from fire. The ranging of Zebus within the park has been a problem, though in 1986 was noted to have considerably decreased over the past few years owing to the extent of cattle-rustling in the region. People living around the park often enter to collect fuel wood (*Uapaca*) and building wood (e.g. *Weinmannia*), and to hunt. Poaching principally involves lemurs (*Lemur catta*), the bush pig *Potamochoerus larvatus*, guinea fowl *Numida meleagris*, fruit bats (*Pteropus rufus* or *Eidolon helvum*) and eels. Honey is also collected within the park.

SCIENTIFIC RESEARCH A historical study of the rock shelter known as the 'Grotte des portugais' at Tenika was carried out in 1960-62; despite its name, it is believed likely to be of 11th century Arab origin.

VISITOR AND SCIENTIFIC FACILITIES None, although the park is run as a tourist attraction by the agents of the Direction des Eaux et Forêts. Visitors (82 in 1985, 67 in 1986) pay an entrance fee of 1500 F.M.G. (which goes direct to the local community, not to the Direction des Eaux et Forêts) and are guided by the Eaux et Forêts agents or other local guides. Ranohira, the main town bordering the reserve, lies on the Route Nationale linking Toliara to Fianarantsoa; it has shops and a hotel.

PRINCIPAL REFERENCE MATERIAL

Nicoll, M.E. and Langrand, O. (1987). Report on the first phase of WWF - Protected areas programme in Madagascar. Unpd. report, 62 pp.

Revue de l'Office du Tourisme de Madagascar No. 33 (La Grotte des Portugais by P. Ginther and V.C. Herbert).

STAFF One agent and one auxiliary.

BUDGET Salaries paid by the government.

LOCAL PARK OR RESERVE ADMINISTRATION Administration is at Ranohira.

FAUNA

Birds

The following species have been recorded by O. Langrand (unpublished data, *in litt.*, 22.12.86).

Tachybaptus pelzelnii
Buteo brachypterus
Falco newtoni (R)
Margaroperdix madagarensis
Turnix nigricollis
Pterocles personatus
Streptopelia picturata (R)
Coracopsis nigra (R)
Agapornis cana
Cuculus rochii (R)
Centropus toulou (R)
Ninox superciliaris
Caprimulgus madagascariensis (R)
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Eurystomus glaucurus (R)
Leptosomus discolor (R)
Mirafra hova
Phedina borbonica (R)
Motacilla flaviventris
Coracina cinerea (R)
Leptopterus viridis
Copsychus albospecularis
Monticola bensoni
Nesillas typica
Cisticola cherina
Newtonia brunneicauda
Neomixis tenella
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Foudia madagascariensis (R)
Dicrurus forficatus (R)

Mammalia

Propithecus verreauxi
Lemur catta
Lemur fulvus
Cryptoprocta ferox
Tenrec ecaudatus
Tenrec setifer

Reptiles

Acrantophis dumerilii
Oplurus sp.

NAME Réserve Naturelle Intégrale de **BETAMPONA** (No.1).

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 31 December 1927. The area of the reserve was fixed by Decree 66-242 of June 1966.

GEOGRAPHICAL LOCATION 17°51'-55'S, 49°12'-15'E. The reserve is situated 40 km to the north-west of Toamasina in Toamasina Province.

ALTITUDE 275-650 m.

AREA 2228 ha.

LAND TENURE State land.

PHYSICAL FEATURES The reserve occupies a rocky spur which dominates the coastal plain and consists of a family of ridges varying in height from 320 m to 650 m above sea level. It is a rugged zone where numerous streams have their sources. Climate is humid tropical with precipitation over 2000 mm a year and no dry months. Mean annual temperature is between 21° and 24°C, though in the colder months mean temperature can be as low as 12°C. The reserve is an example of the natural low altitude biotope of the eastern region of Madagascar.

VEGETATION Betampona is the sole forested massif in a vast deforested area, and although the sides of the massif have been deforested, the vegetation has re-established itself to some degree (see below). The undegraded vegetation is low altitude dense evergreen rain forest which is extremely rich floristically and is the type locality for many species. It is characterised by species of Myristicaceae and *Anthostema* (Euphorbiaceae); other notable species are *Canarium madagascariensis* (Burseraceae), *Sideroxylon* sp., *Faucherea ursii* (both Sapotaceae), *Rhopalocarpus*

sp. (Sphaerosepalaceae), *Hirtella* sp. (Chrysobalanaceae). Also present are members of the tribe Areceae (Palmae) and the families Rubiaceae, Araliaceae, Ebenaceae, Sapindaceae, Loraceae, Myrtaceae, Flacourtiaceae and Leguminosae. Local dominance of *Uapaca thouarsii* and glades of the bamboo *Cephalostachyum madagascariensis* occur. Much of the central southern edge of the reserve, notably along the Fontsiamavo River and its tributaries, is composed of the colonising *Eugenia jambos*. Secondary forest has considerably advanced, especially along the central track from Sorintsandry to Marovato, an area which had not been cleared in 1947.

ZONING There was formerly a 200 m protective zone around the reserve, set up in 1935; Pollock reported in 1985 that it had recently been reclaimed by local villagers for residential and exploitative purposes.

CONSERVATION MANAGEMENT The reserve is clearly delimited by a 3-metre wide band cleared around the perimeter and has a good internal path network. Insufficient funds and staff are available at present for further management.

DISTURBANCES OR DEFICIENCIES A degraded zone some 1000-1500 m wide lies within the reserve boundaries, consisting largely of 20-25 year old growth of *Ravenala madagascariensis* and other 'savoka' species. This represents an area of regeneration following cultivation: the existence of tavy cultivation and the corresponding threat to the forest edges was first remarked in 1908. The situation had not markedly improved in 1931 and although the Reserve Intégrale was first declared in 1932 and the protective zone in 1935, real protection was not initiated until 1949; the regeneration presumably dates from then. Forest cover within the reserve thus totals some 1000 ha. It is surrounded by numerous villages, situated within 1 km of the reserve and often less, and there are incursions into the reserve: Pollock noted in 1984 that there were clear signs of crayfish catching in the upper Fontsiamavo River within the reserve, and that a local merchant had recently been arrested for shooting lemurs in the central part of the reserve.

SCIENTIFIC RESEARCH None appears to have been carried out recently.

VISITOR AND SCIENTIFIC FACILITIES Access to the reserve is on foot (90 minutes walk) from the village of Fontsimavo, which is 90 minutes by car from Toamasina (Pollock, 1985).

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

Pollock, J.I. (1985). Preliminary report on a mission to Madagascar by Dr. J.I. Pollock in August and September 1984. Unpublished report, 10 pp.

STAFF One agent and two auxiliaries, full-time.

BUDGET Salaries paid by the government.

LOCAL PARK OR RESERVE ADMINISTRATION Headquarters at Rendrirendry. This village consists of the dwelling quarters of two families, the local office of the Direction des Eaux et Forêts and a 'gite d'étape' or rest-post for the guardian of the reserve, who lives in Toamasina.

FAUNA

Birds

Lophotibis cristata
Treron australis
Alectroenas madagascariensis
Ipsidina madagascariensis
Leptosomus discolor
Philepitta castanea
Vanga curvirostris
Terpsiphone mutata
Zosterops maderaspatana

Mammals

Avahi laniger
Hapalemur griseus
Cheirogaleus major
Lemur fulvus
Lepilemur mustelinus
Phaner furcifer
Cryprotprocta ferox
Eupleres goudotii
Varecia variegata
Microcebus rufus
Indri indri
Propithecus diadema (possibly)
Daubentonia madagascariensis
Galidia elegans
Fossa fossa
Galidictis striata (reported)

Amphibians

**Plethodontohyla coudreaui*

Reptiles

Ebenavia inunguis

Nonmarine Molluscs

Ampelita lanx
A. sepulchralis
Tropidophora tricarinata
Helicophanta magnifica
Macrochlamys stumpfii
Kalidos bournei

Nonmarine Crustacea

Decapoda:

Hydrothelphusa agilis madagascariensis

NAME Réserve Naturelle Intégrale de **ZAHAMENA** (No.3).

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 31 December 1927.

GEOGRAPHICAL LOCATION 17°26'-44'S, 48°56'-49°00'E; east of Ambatondrazaka in Toamasina Province, bordered to the south by the Onibe, to the east by the Ihofika River, to the west by the Vohimahery and to the north by the track from Sahatavy to Imerimandroso.

ALTITUDE 500-1500 m.

AREA 73 160 ha, essentially divided into two blocks.

LAND TENURE State land.

PHYSICAL FEATURES The reserve consists of two zones well separated by a large piece of enclosed land. Relief is very uneven with steep-sided valleys; large landslides were recorded in the 1950s. Climate varies with altitude from an equatorial or tropical humid type, to one with a two or three month dry season (August to October). Mean annual rainfall is 1500-2000 mm but may be considerably higher in the east. Average temperature of the coolest month is between 10° and 15°C at higher altitudes.

VEGETATION Generally characteristic of the eastern escarpment, with primary and secondary tropical evergreen forest, changing from forest with Myristicaceae and *Anthostema* typical at low altitude to forest with *Tambourissa* and *Weissmannia* between 800 and 1300 m. With increasing altitude, plants with temperate affinities appear, and there are notable deciduous species and belts of bamboo; the higher altitude forest when degraded transforms into ericaceous scrub with *Philippia*, *Agauria* and *Helichrysum*.

ZONING None.

CONSERVATION MANAGEMENT Relatively little at present as the reserve is undermanned; the 1985 University of London Expedition financed the construction of a 2 km firebreak along the western edge of the reserve.

DISTURBANCES OR DEFICIENCIES Most of the western half and south-eastern parts of the reserve were noted in 1985 as having an unbroken canopy of good forest; a trail through the the south-centre of the reserve passed through an abandoned clearing which was reverting to forest. Other than this, only a few trees had been selectively felled. However, the north-eastern corner of the reserve (near the enclave - see below) was under greater threat: the trail there was heavily used, an area of ca 1 sq. km had been cleared for tavy and three lemur traps were found. The western edge of the reserve adjoined eucalyptus plantations and cultivated land, and faced threats from logging and fire. The central enclave was part of the reserve as it was originally gazetted; the continued presence of several villages there led to the area being degazetted in 1966 (Decree 66-242). These villages were reported in 1971 as growing in size and representing a long-term threat to the integrity of the reserve; cultivation (by tavy), livestock grazing and poaching apparently occurred around the edges of the enclave (in the north-east corner of the reserve). In 1985, it was noted that the enclave had been cleared for agriculture except for some secondary scrub and a tiny area of relict forest.

SCIENTIFIC RESEARCH Important entomological work has been conducted in the area. In 1985 a five person expedition from the University of London spent 32 days in the reserve, primarily surveying the avifauna, though also collecting amphibians and making observations on mammals and plants (particularly pteridophytes) (Thompson *et al.*, in press).

VISITOR AND SCIENTIFIC FACILITIES None. Much of the reserve is virtually impenetrable and lacks trails.

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

Thompson, P.M., Raxworthy, C.J., Murdoch, D.A., Quansah, N. and Stephenson, P.J. (in press). Zahamena Forest (Madagascar) Expedition, 1985. ICBP Study Report. ICBP, Cambridge.

STAFF One agent and two auxiliaries full-time.

BUDGET Salaries paid by the government.

LOCAL PARK OR RESERVE ADMINISTRATION Headquarters at Manakambahiny Est.

FAUNA

Birds

The 1985 University of London expedition to Zahamena recorded the following endemic birds. Those in parentheses were only recorded in the enclave, not in the reserve proper, but many, if not all, are thought likely to occur in the reserve.

Polyboroides radiatus
Accipiter madagascariensis
(Accipiter francesii (R))
Buteo brachypterus
Falco newtoni (R)
Dryolimnas cuvieri
Streptopelia picturata (R)
Alectroenas madagascariensis
Coracopsis nigra (R)
Coracopsis vasa (R)
Coua serriana
Coua reynaudii
Coua caerulea
Centropus toulou (R)
Otus rutilus (R)
(Caprimulgus madagascariensis (R))
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Ipsidina madagascariensis
Brachypteracias leptosomus
Leptosomus discolor (R)
Philepitta castanea
Neodrepanis coruscans
Phedina borbonica (R)
Coracina cinerea (R)
Phyllastrephus madagascariensis
Phyllastrephus zosterops
Hypsipetes madagascariensis (R)
Tylas eduardi
Calicalicus madagascariensis
Leptopterus chabert
Leptopterus viridis
Leptopterus madagascarinus (R)
Oriolia bernieri
Euryceros prevostii
Hypositta corallirostris
Copsychus albospecularis
Neomixis tenella
Neomixis viridis
Neomixis striatigula
Hartertula flavoviridis
Oxylabes madagascariensis
Nesillas typica
Cisticola cherina
Randia pseudozosterops
Newtonia amphichroa
Newtonia brunneicauda
Pseudobias wardi
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Lonchura nana (R)
Ploceus nelicourvi
(Foudia madagascariensis (R))
Foudia omissa
(Saroglossa aurata)
Dicrurus forficatus (R)

Lophotibis cristata has been reported to occur in the reserve but was not observed by the 1985 expedition.

Mammals

Microcebus rufus
Cheirogaleus major
Avahi laniger
Indri indri
Propithecus diadema
Daubentonia madagascariensis
Hapalemur griseus
Lemur fulvus
Lemur rubriventer
Lepilemur mustelinus
Varecia variegata
Galidia elegans

Amphibians

The following species were collected by the 1985 University of London Expedition.

Ptychadena mascariensis
Aglyptodactylus madagascariensis
Mantidactylus guttulatus
Mantidactylus majori
Mantidactylus wittei
Mantidactylus pliciferus?
Mantidactylus aerumnalis
Mantidactylus betsileanus
Boophis viridis?
Mantella cowani

Mantidactylus femoralis
Mantidactylus luteus
Mantipus laevipes
Platypelis pollicaris

Reptiles
Phelsuma bimaculata
Phelsuma madagascariensis
Ebenavia inunguis
Zonosaurus aeneus
Mabuya gravenhorsti
Amphiglossus melanopleura
Chamaeleo nasutus
Sanzinia madagascariensis

Non-marine molluscs
Macrochlamys stumpfii
Tropidophora tricarinata
Ampelita xystera
Kalidos oleatus
Helicophanta magnifica

NAME Réserve Naturelle Intégrale de **TSARATANANA** (No.4).

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 31 December 1927.

GEOGRAPHICAL LOCATION 13°49'-14°05'S, 48°44'-59'E. To the south-east of Ambanja in the province of Antseranana.

ALTITUDE 700-2876 m (Mt. Maromokotra, the highest summit in Madagascar).

AREA 48 622 ha.

LAND TENURE Government land.

PHYSICAL FEATURES Large mountain group of crystalline rocks and volcanic formations of the Miocene. Mont Maromokotra, the highest mountain in Madagascar, is found in this reserve. The climate has the same characteristics as the Malagasy rain forest and is extremely wet. During summer, especially the monsoon season (end of November to the beginning of May), there are virtually daily torrential rainstorms. From May to October, the summits are covered with fog accompanied by drizzle and fine rain. October and November are relatively dry.

VEGETATION In general, the vegetation consists of primary and secondary tropical evergreen forests of both high and low altitude with both lichens and ericaceous species common. The flora is rich in endemics especially at high altitude. From 1000 to 2200 m, the principal plants found are: *Podocarpus madagascariensis, Canarium, Aphloia theiformis, Ravensara, Ocotea, Beilschmiedia oppositifolia, Malleastrum, Noronhia, Erythroxylum corybosum, Dichaetanthera, Eleacarpus, Coffea tsaratananae, Gardenia, Peddiea involucrata, Buddleia, Senecio, Vernonia, Oncostemum, Panicum uvulatum, Poecilostachys tsaratananensis, Oplismenus, Leptaspis cochleata* and various members of the families Acanthaceae, Labiaceae, especially *Coleus*, and Urticaceae, notably *Pilea*. Tree ferns of the family Cyatheaceae do not seem to be very abundant; however this appears to be optimum habitat for epiphytes such as *Peperomia, Kalanchoe, Medinilla, Viscum, Rhipsalis* and numerous ferns and orchids. From 2000 to 2200 m there is a belt of virtually pure giant bamboo. Above 2200 m there is moss forest with Araliaceae, Cunoniaceae (*Weinmannia*), Compositae, Ericaceae (*Agauria, Philippia*), Sterculiaceae (*Dombeya*), and Taxaceae (*Podocarpus rostratus* and *P. madagascariensis*). *Chrysalidocarpus* (Palmae) is also found. Ephiphytes are very common. Understorey, when it exists, is composed of small trees: *Schismatoclada, Helichrysum, Philippia*. Around 2600 m there is a second band of bamboos, then shrubby and herbaceous vegetation on the summits, secondary and depauperate through fire, of blackened *Philippia* in a grassy lawn (*Danthonia, Bromus, Anthoxanthum,* with scattered *Helichrysum*).

DISTURBANCES OR DEFICIENCIES Some illicit cultivation; however, apart from the burned summits, the reserve is largely intact, as the very cold winter temperatures and the steepness of the terrain limit attempts at planting. Formerly, parts of the reserve were adversely affected by illicit plantations of tobacco and indian hemp. In 1968 and 1969, a police operation was organised to destroy the plantations and arrest the miscreants. These people were sufficiently well organized to make entry to the reserve dangerous if unarmed and unaccompanied. Outside the plantations were found herds of zebu cattle belonging to the same people. It is not known if this has been a problem more recently.

SCIENTIFIC RESEARCH Numerous collecting trips have been carried out.

VISITOR AND SCIENTIFIC FACILITIES None.

PRINCIPAL REFERENCE MATERIAL

Albignac, R. (1970). Mammifères et oiseaux du Massif de Tsaratanana. *Mém. ORSTOM* 37: 223-229.

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

Milon, P. (1957). Etude d'une petite collection d'oiseaux du Tsaratanana. *Naturaliste Malgache* 3(2): 167-183.

STAFF Two full-time forest agents.

BUDGET Salaries paid by the government.

LOCAL PARK OR RESERVE ADMINISTRATION Headquarters are at Ambanja with a guard post at Mangindrano.

FAUNA

Birds

Lophotibis cristata
Buteo brachypterus
Margaroperdix madagarensis
Turnix nigricollis
Dryolimnas cuvieri
Sarothrura insularis
Gallinago macrodactyla
Streptopelia picturata (R)
Alectroenas madagascariensis
Coracopsis nigra (R)
Coua reynaudii
Coua caerulea
Cuculus rochii (R)
Caprimulgus ennaratus
Alcedo vintsioides (R)
Ipsidina madagascariensis
Atelornis crossleyi
Leptosomus discolor (R)
Philepitta castanea
Neodrepanis coruscans
Mirafra hova
Phedina borbonica (R)
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus zosterops
Phyllastrephus cinereiceps
Hypsipetes madagascariensis (R)
Tylas eduardi
Calicalicus madagascariensis
Leptopterus viridis
Copsychus albospecularis
Monticola sharpei
Neomixis viridis
Hartertula flavoriridis
Crossleyia xanthophrys
Nesillas typica
Dromaeocercus brunneus
Dromaeocercus seebohmii
Newtonia brunneicauda
Pseudobias wardi
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Lonchura nana (R)
Ploceus nelicourvi
Foudia madagascariensis (R)
Dicrurus forficatus (R)

Mammals

Lemur macaco
Lemur rubriventer
Cheirogaleus major
Lepilemur sp.
Microgale sp.
Hapalemur griseus
Lemur fulvus
Phaner furcifer
Microgale talazaci
Nesomys cf *N. rufus*

Amphibians

**Mantipus guentherpetersi*
Platypelis pollicaris
Stumpffia psologlossa
Mantidactylus elegans
**Platyhyla alticola*
**Platypelis tsaratananaensis*
Mantidactylus asper
Mantidactylus granulatus

Reptiles

Lygodactylus rarus
**Chamaeleo tsaratananensis*
Chamaeleo guibe
**Amphiglossus tsaratananensis*

Nonmarine Molluscs

This reserve is undoubtedly the most important area in Madagascar for molluscs.

**Acroptychia culminans*
**Acroptychia pauliani*
**Acropytchia pauper*
**Tropidophora dingeoni*
**Tropidophora puerilis*
Tropidophora tricarinata
**Tropidophora vuillemini*
**Clavator dingeoni*
Clavator moreleti
**Clavator pauliani*
**Kalidos amicus*
Kalidos andapaensis
**Ampelita caduca*
**Ampelita culminans*
Ampelita futura
Ampelita gaudens
Ampelita lamarei
Ampelita lanxava
**Ampelita parva*
**Ampelita pauliani*
Ampelita perampla
**Sitala acuta*
**Sitala culminis*
Kalidos cleamesi
**Kalidos decaryi*
Kalidos humbloti
**Kalidos merschardti*
**Kalidos milloti*
**Kalidos montis*
Kalidos oleatus
**Kalidos secans*
**Kalidos tsaratananensis*
**Cyathopoma pauliani* (Andamy)
Macrochlamys stumpfii
**Ampelita bathiei*
**Sitala delaportei*
Sitala elevata
**Sitala roedereri*
**Microcystis madecassina*
**Microcystis nitelloides*
**Microcystis tangens*
Vitrina madagascariensis
Edentulina metula
**Pilula excavata*
**Pilula madecassina*

NAME Réserve Naturelle Intégrale de **L'ANDRINGITRA** (No.5).

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 31 December 1927; the present boundaries were fixed by Classement 66-242, June 1st, 1966.

GEOGRAPHICAL LOCATION 22°07'-21'S, 46°47'-47°02'E. South of Ambalava in the Province of Fianarantsoa. The village of Antanifotsy is situated on the edge of the reserve.

ALTITUDE 1200-2658 m.

AREA 31 160 ha.

LAND TENURE Government land.

PHYSICAL FEATURES The Andringitra mountain chain which constitutes the reserve is a very hilly, granitic massif in the form of a V with unequal length branches; where these meet the massif forms a plateau at about 2500 m with very uneven relief. The massif contain the sources of many streams and has the coldest climate of any of the Madagascan mountains, with severe frosts recorded at high altitude and several snowfalls at above 2500 m in the last 40 years; lower altitudes in the reserve generally have the characteristic cool climate of the high plateaux with 3 or 4 dry months. Annual rainfall is 1500-2000 mm. On the eastern slopes, the climate is rather more equable.

VEGETATION Several vegetation types occur within the reserve, varying principally with altitude, but also from east to west. The non-degraded vegetation is classified as follows: from 700 to 800 m are areas of eastern lowland rain forest, characterised by *Dalbergia baroni*; from 800-1600 m is found mid-altitude rain forest, with *Eugenia, Tambourissa* and *Allocarpus*; above this, from 1500-2000 m., is montane sclerophyll and lichen forest, characterised by *Schefflera, Weinmannia* and *Brachylaena*, and ericoid scrub with *Philippia* which can reach 4-5 m in height. At these altitudes there are also scattered peaty depressions (notably carrying the remarkable *Restio madagascariensis*) and 'xerophytic lawn'. On the crags is a xerophytic flora with *Aloe, Kalanchoe* and *Helichrysum*. The whole area is rich in endemics: 80% of the flora of the humid depressions and the rocks is endemic to the massif. Much of the natural vegetation in the western part of the reserve has been destroyed by fire, but that which survives is characteristic of the western Madagascan domain.

ZONING None.

CONSERVATION MANAGEMENT The boundary is marked by 33 permanent marker stones, although these are not clearly visible; the reserve is patrolled on foot by three agents of the Direction des Eaux et Forêts. There is a 30 km fire break along the western boundary of the reserve near the village of Ankazomby, although this has apparently only been partially effective.

DISTURBANCES OR DEFICIENCIES Fire is the principal threat to the reserve; most burning within the reserve is the result of spread of uncontrolled fires started on pasture land outside the reserve, although some are deliberately started to cause damage and others may be caused by lightning. Around 500 ha of the summit zone was burnt in 1983 as was some 44 ha on the Andohariana Plateau; in 1982 around 1250 ha in the Antombohobe area was burnt. Cattle are present within the reserve and cause damage to the natural vegetation, particularly the rock-dwelling communities. The Riantahy and Rianvavy waterfalls, two areas reportedly of great beauty and historical interest, have been damaged by watercourse management under the Mamoly management project, designed to improve irrigation and rice production in the Antanifotsy village region. Management involves regulating the water flow at the Riantahy waterfall. To this end a dam and reinforced conduit have been built, and construction of a 3 km long canal, scheduled to be completed in 1987, has begun; all this work has been carried out within the reserve. The agents of the Direction des Eaux et Forêts lack camping equipment and transport and are thus prevented from effectively patrolling the reserve. Ring-tailed Lemurs *Lemur catta* are captured alive to sell to people passing through the area.

SCIENTIFIC RESEARCH Study of highland ecosystems in 1970 for RCP 225 (Paulian *et al.*, 1971).

VISITOR AND SCIENTIFIC FACILITIES Access is difficult: there is a 50 km track from Ambalavao to Antanifotsy which is in bad condition and is damaged each wet season and a 40 km dry-season track to Ambaratra Antambohobe. There are several foot paths within the reserve, including one running 25 km from Antanifotsy to Pic Boby.

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

Nicoll, M.E. and Langrand, O. (1987). Report on the first phase of WWF - Protected areas programme in Madagascar. Unpd. report, 62 pp.

Paulian, R., Betsch, J-M., Guillaumet, J-L., Blanc, C. and Griveaud, P. (1971). RCP 225. Etude des écosystèms montagnards dans la région malgache. I. Le massif de l'Andringitra. 1970-1971. Géomorphologie, climatologie et groupements végéteaux. *Bulletin de la Société d'Ecologie* II (2-3): 189-266.

STAFF 1 agent and 2 full-time auxiliaries.

BUDGET Salaries paid by the government.

LOCAL PARK OR RESERVE ADMINISTRATION Headquarters at Ambalavo and a guardpost at Ivohibe.

FAUNA

Birds

Tachybaptus pelzelnii
Anas melleri
Polyboroides radiatus
Buteo brachypterus
Falco newtoni (R)
Sarothrura insularis
Streptopelia picturata (R)
Cuculus rochii (R)
Leptosomus discolor (R)
Atelornis pitt ides
Phedina borbonica (R)
Motacilla flaviventris
Hypsipetes madagascariensis (R)
Copsychus albospecularis
Monticola sharpei
Acrocephalus newtoni
Nesillas typica
Cisticola cherina
Dromaeocercus brunneus
Neomixis tenella
Nectarinia souimanga (R)
Zosterops maderaspatana
Foudia madagascariensis (R)

Mammals

Microcebus rufus
Avahi laniger
Lepilemur microdon
Lemur catta
Lemur fulvus
Varecia variegata
Cryptoprocta ferox
Tenrec ecaudatus
Setifer setosus
Microgale dobsoni
Microgale drouhardi
Leptogale gracilis
Oryzorictes tetradactylus
Brachyuromys betsiloensis
Brachyuromys ramirohitra
Eliurus myoxinus

Amphibians

**Anodonthyla montana*
Mantipus inguinalis
Plethodontohyla tuberata
Mantidactylus aerumnalis
Mantidactylus argenteus
**Mantidactylus blanci*
Mantidactylus decaryi
**Mantipus bipunctatus*
Plethodontohyla notosticta
Pseudohemisus madagascariensis
Mantidactylus aglavei
Mantidactylus asper
**Mantidactylus bourgati*
Mantidactylus domerguei

Mantidactylus elegans
**Mantidactylus madecassus*
Mantidactylus redimitus
**Boophis brygooi*
Boophis microtympanum
Mantidactylus lugubris
Mantidactylus microtympanum
Mantidactylus tricinctus
**Boophis laurenti*

Reptiles
Leioheterodon madagascariensis

Nonmarine Molluscs
Ampelita covani
Ampelita petiti
**Imerinia fischeri*
**Tachyphasis milloti*
Macrochlamys stumpfii
Helicophanta gloriosa (forêt d'Fivanona)

Amphipoda:
Austroniphargus bryophilus (Pic Boby)

NAME Réserve Naturelle Intégrale de **LOKOBE** (No.6).

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 31 December 1927, though the Forêt de Lokobe was constituted as a reserve as early as 1913.

GEOGRAPHICAL LOCATION On the south-eastern side of the island of Nosy Bé, with the coast forming the southern edge of the reserve. 13°23'-25'S, 48°18'-20'E.

ALTITUDE 0-430 m (the highest point on the island).

AREA 740 ha.

LAND TENURE Government land.

PHYSICAL FEATURES The island of Nosy Bé is formed of a neogenous basaltic block and marine sediments of the upper Lias. The relief is fairly tortuous in places. The reserve has an important role in the local water network. Climate is characteristic of the 'Sambirano' Domain, with a relatively well-marked dry season of 3 to 4 months, lower annual rainfall than on the east coast and fairly high temperatures (mean of over 15°C in the coldest month).

VEGETATION The reserve contains much of the remaining forest on the island. This is a dense, humid forest characterised by species of the families Chlaenaceae (endemic to Madagascar), Myristicaceae and the genus *Anthostema*. Biologically and physionomically, it resembles the eastern rain forest but is distinguished by the presence of numerous endemics.

ZONING The reserve boundaries are clearly delimited, and obviously marked.

CONSERVATION MANAGEMENT There are proposals to increase the effectiveness of the reserve both by increasing its size, and by providing vehicles for the staff. Use of surrounding areas for tourism could be a valuable source of income.

DISTURBANCES OR DEFICIENCIES The reserve is very vulnerable because of its small size. The proposed buffer zone, which is not formally protected, is being cut down for cultivation of rice and manioc. In 1972 it was reported that poaching of lemurs was a problem, incursions being made into the reserve by boat.

SCIENTIFIC RESEARCH Numerous collecting expeditions have been carried out.

VISITOR AND SCIENTIFIC FACILITIES The Centre National de Recherches Océanographiques owns a laboratory close to the reserve, but the work has always been orientated towards the marine fauna.

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

STAFF Only one agent.

BUDGET Salaries paid by the government. In 1982, a WWF Tropical Forest Campaign grant of US$ 22 000 over 2 years was allocated to buy essential equipment and assist in the protection of 150-200 ha of the planned buffer zone in the northern part of the reserve.

LOCAL PARK OR RESERVE ADMINISTRATION At Hell-ville on Nosy Bé.

FAUNA

Birds

The following species have been recorded by O. Langrand (*in litt.*, 28.10.86).

Aviceda madagascariensis
Haliaeetus vociferoides
Polyboroides radiatus
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Margaroperdix madagarensis
Turnix nigricollis
Streptopelia picturata (R)
Treron australis (R)
Alectroenas madagascariensis
Coracopsis nigra (R)
Agapornis cana
Cuculus rochii
Coua cristata
Centropus toulou (R)
Otus rutilus (R)
Caprimulgus madagascariensis (R)
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Eurystomus glaucurus (R)
Leptosomus discolor (R)
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus madagascariensis
Hypsipetes madagascariensis (R)
Calicalicus madagascariensis
Vanga curvirostris
Leptopterus viridis
Leptopterus chabert
Leptopterus madagascarinus (R)
Copsychus albospecularis
Nesillas typica
Newtonia brunneicauda
Neomixis tenella
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Lonchura nana (R)
Foudia madagascariensis (R)
Dicrurus forficatus (R)

Mammals

Lepilemur dorsalis
Microcebus rufus
Lemur macaco
Microcebus murinus

Amphibians

The following taxa are listed for Nosy Bé in general, no data are available on the herpetofauna of Lokobe in particular. *Platypelis milloti* is an exception; it has been recorded only in the Lokobe Reserve.

Cophyla phyllodactylus
Rhombophryne testudo
Laurentomantis horrida
Boophis madagascariensis
**Platypelis milloti*
Stumffia psologlossa
Mantidactylus granulatus
'Hyperolius' nossibeensis

Reptiles

The following taxa are listed for Nosy Bé in general, no data are available on the herpetofauna of Lokobe in particular.

Ebenavia inunguis
**Lygodactylus heterurus*
Phelsuma laticauda
**Paroedura oviceps*
Uroplatus fimbriatus
Brookesia ebenaui
**Brookesia minima*
Brookesia superciliaris
Chamaeleo parsoni
**Amphiglossus stumpffi*
Zonosaurus boettgeri
Zonosaurus rufipes
**Typhlops madagascariensis*
Acrantophis madagascariensis
Langaha nasuta
Lycodryas arctifasciatus
Micropisthodon ochraceus
Liopholidophis stumpffi
Geckolepis maculata .
Phelsuma dubia
Phelsuma madagascariensis
Paroedura stumpffi
Uroplatus ebenaui
**Brookesia legendrei*
Brookesia stumpffia
Chamaeleo boettgeri
Amphiglossus polleni
Paracontias hildebrandti
Zonosaurus madagascariensis
Ramphotyphlops braminus
**Typhlops reuteri*
Ithycyphus miniatus
Liophidium rhodogaster
Lycodryas gaimardi
Pararhadinea melanogaster

Nonmarine Molluscs

Some of these species are recorded from 'Nosy Bé' and may not occur in Lokobe.

Tropidophora aspera
Tropidophora cuvieriana
Tropidophora deshayesiana
**Tropidophora felicis*
Tropidophora fuscula (Lokobe)
Tropidophora ligata non endemic
Tropidophora milloti
Tropidophora tricarinata
Tropidophora vittata
Clavator moreleti
Helicophanta amphibulima (Lokobe)
Helicophanta oviformis (Lokobe)
Kalidos lamyi (Lokobe)
**Sitala brancsiki* (Lokobe)
**Sitala filomarginata* (Lokobe)
Edentulina stumpfii
Macrochlamys stumpfii
Acmella parvula
Cleopatra colbeaui
Truncatella guerini
Gastrocopta seignaciana
Nesopupa minutalis
Cecilioides mariei
Ampelita galactostoma
Ampelita gaudens
Ampelita omphalodes (Lokobe)
**Ampelita stumpfii* (Lokobe)
Desmocaulis subaspera
Drepanocaulis plateia
Drepanocaulis tetragonalis
Euconulus micra
Opeas soulaianus
Elisolimax bella
Imerinia grandidieri
Imerinia sulfurea
Imerinia verrucosa
Clithon spiniperda

NAME Réserve Naturelle Intégrale de **L'ANKARAFANTSIKA** (No.7)

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED The integral reserve was established by a decree of 31 December 1927, and updated by decree 66-242 of 30 June 1966.

GEOGRAPHICAL LOCATION In Mahajanga Province 40 km north-west of Ambato-Boéni. 15°59'-16°22'S, 45°56'-47°12'E.

ALTITUDE 75-390 m.

AREA 60 520 ha, bordering the Ampijoroa Forest Station to the west which covers ca 20 000 ha.

LAND TENURE Government land.

PHYSICAL FEATURES Very rugged relief to the east and south, forming cliffs in places. Towards the west and north, the plateau descends gently. The soils of the plateau are very sandy. Precipitation is between 1000 and 1500 mm a year with a marked dry season of 5-6 months (May-November). Mean annual temperature is ca 26°C, with maximum 35°C and minimum 17°C. The reserve protects a sample of habitats typical of the arenaceous soils of western Madagascar, and also protects the catchment of one of Madagascar's most important rice growing areas. Problems occur in the paddy fields downstream when sand eroded from cleared areas is carried by the rivers.

VEGETATION Still largely covered in the original forest vegetation. Forest is dense and dry of the series *Dalbergia-Commiphora-Hildegardia*. Numerous Leguminosae and Myrtaceae. Some species adapted to dry environments such as *Pachypodium*, and members of the families Ampelidaceae and Passifloraceae. Numerous lianes, but epiphytes are virtually absent. The forest is deciduous, and contains a wide variety of trees and shrubs at a high density (about 170 species of 35 families).

ZONING None, althuogh the reserve is bordered by six buffer zone areas.

CONSERVATION MANAGEMENT The reserve itself is not managed at present. The forestry station has a nursery and plant growth trials area; there is a good network of trails through the forest station and part of the area is used for research projects.

DISTURBANCES OR DEFICIENCIES The reserve and forest station are being encroached by clearance to create pastures, by charcoal burning, and, to a lesser extent, by clearance for crops in river valleys and slopes on the Antananarivo to Mahajanga road. The buffer zone areas have suffered forest loss and the forest edges are being pushed back into the reserve, particularly in the north and east. Fire affected the western quarter of the reserve in 1983. Poaching appears to be low-level at present (1986) although may become more of a problem in the future. There are feral cattle within both the reserve and the forest station. The reserve is undermanned.

SCIENTIFIC RESEARCH Some primate studies have been made in the reserve, particularly on range sizes and diet; the University of Madagascar also has study areas here. Entomological research has been carried out in the area.

VISITOR AND SCIENTIFIC FACILITIES The forestry station at Ampijoroa is used by research workers in the area.

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

IUCN/WWF Project 1911. Protection and development of the Ankarafantsika Nature Reserve.

Martin, C. (1982). Rapport de la mission technique WWF/IUCN à Madagascar 1981. IUCN/WWF, Gland, (contains a list of birds and mammals found within the reserve).

Nicoll, M.E. and Langrand, O. (1987). Report on the first phase of WWF - Protected areas programme in Madagascar. Unpd. report, 62 pp.

STAFF Two: a Chef de Station at Ampijoroa and a full-time auxilliary.

BUDGET Salaries paid by the government. WWF has provided funds for reserve management since 1980.

LOCAL PARK OR RESERVE ADMINISTRATION The headquarters is at Bevazaha.

FAUNA

N.B. Some of the species listed below have been recorded from Ampijoroa which lies immediately adjacent to the R.N.I.

Birds

Tachybaptus pelzelnii
Ardeola idae (R)
Lophotibis cristata
Anas melleri
Aviceda madagascariensis
Haliaeetus vociferoides
Polyboroides radiatus
Accipiter madagascariensis
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Margaroperdrix madagarensis
Mesitornis variegata
Turnix nigricollis
Dryolimnas cuvieri (R)
Pterocles personatus
Streptopelia picturata (R)
Treron australis
Agapornis cana
Coracopsis nigra (R)
Coracopsis vasa (R)
Coua gigas
Coua coquereli
Coua ruficeps
Coua cristata
Cuculus rochii (R)
Centropus toulou (R)
Otus rutilus (R)
Asio madagascariensis
Caprimulgus madagascariensis (R)
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Ipsidina madagascariensis
Eurystomus glaucurus (R)
Leptosomus discolor (R)
Philepitta castanea
Mirafra hova
Phedina borbonica (R)
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus madagascariensis
Hypsipetes madagascariensis
Calicalicus madagascariensis
Schetba rufa
Vanga curvirostris
Xenopirostris damii
Falculea palliata
Leptopterus chabert
Leptopterus viridis
Leptopterus madagascarinus (R)
Copsychus albospecularis
Acrocephalus newtoni
Nesillas typica
Cisticola cherina
Newtonia brunneicauda
Neomixis tenella
Terpsiphone mutata (R)
Nectarinia notata (R)
Nectarinia souimanga (R)
Zosterops maderaspatana
Lonchura nana (R)
Ploceus sakalava
Foudia madagascariensis (R)
Dicrurus forficatus (R)

Mammals

Avahi laniger
Lepilemur edwardsi
Cheirogaleus medius
Lemur fulvus
Macrotarsomys ingens
Tenrec ecaudatus
Pteropus rufus
Lemur mongoz
Microcebus murinus
Propithecus verreauxi
Cryptoprocta ferox
Macrotarsomys bastardi
Setifer setosus

Quoted records of *Lepilemur ruficaudatus* should almost certainly be ascribed to *L. edwardsi*

Amphibians

Dyscophus insularis
Mantidactylus wittei
Pseudohemisus granulosus

Reptiles

**Brookesia decaryi*
**Pygomeles petteri*
Phelsuma dubia
**Chamaeleo angeli*
Langaha nasuta

Nonmarine Molluscs

Ampelita omphalodes
Ampelita pfeifferi
Euconulus micra
Edentulina gaillardi
Helicophanta amphibulima (Bevahara)
Helicophanta oviformis (Bevaraha)
Acroptychia millotti

Nonmarine Crustacea

Isopoda:

Armadillo silvivagans (Tsaramandroso)

Lepidoptera

Papilionidae

Papilio morondavana
Papilio grosesmithi

NAME Réserve Naturelle Intégrale du **TSINGY DE NAMOROKA** (No.8).

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 31 December 1927.

GEOGRAPHICAL LOCATION To the south of Soalala in the province of Mahajanga. 16°19'-30'S, 45°16'-25'E.

ALTITUDE 180-370 m.

AREA 21 742 ha.

LAND TENURE Government land.

PHYSICAL FEATURES The area comprises a calcareous massif (karst) with many cliffs and numerous caves and springs. Average rainfall is between 1000 and 1500 mm a year, with a distinct dry season between May and November. Mean temperature in the coolest month is above 20°C.

VEGETATION Like the Tsingy de Bemaraha (R.N.I. No.9), the reserve is a mosaic of dense dry forest, savanna and vegetation adapted to the calcareous karsts, belonging to the *Dalbergia-Commiphora-Hildegardia* association. The mean height of the trees is 12-15 m. *Adansonia rubrostipa* is especially frequent. Many xerophytic and crassulacean plants. The area has a spring-fed stream with a remarkable aquatic flora. This reserve has lower species diversity than Tsingy de Bemaraha, whilst containing essentially the same biotopes.

ZONING None.

CONSERVATION MANAGEMENT Some 14 km of footpaths are delimited within the reserve as passable at all times of the year.

DISTURBANCES OR DEFICIENCIES Fires are frequent during the dry season. The human population around the reserve is fairly low and there is only one important village - Vilanandro. In 1972 it was noted that the local inhabitants were largely indifferent to the laws protecting the reserve, which was inadequately guarded; no fady (local taboo) protected the animals or plants of the region. Plantations of indian hemp have been found in the interior of the reserve and zebu cattle also occur within the reserve.

SCIENTIFIC RESEARCH No research appears to have been carried out recently.

VISITOR AND SCIENTIFIC FACILITIES None.

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

STAFF One agent and a full-time auxiliary.

BUDGET Salaries paid by the government.

LOCAL PARK OR RESERVE ADMINISTRATION Reserve headquarters at Vilanandro.

FAUNA

Birds

Dryolimnas cuvieri
Treron australis (R)
Alectroenas madagascariensis
Agapornis cana
Coua ruficeps
Coua coquereli
Otus rutilus
Coua cristata
Coua gigas
Otus rutilus (R)
Philepitta schlegeli
Motacilla flaviventris
Schetba rufa
Vanga curvirostris
Copsychus albospecularis
Neomixis tenella
Nesillas typica
Zosterops maderaspatana
Ploceus sakalava

Mammals

Lepilemur edwardsi
Propithecus verreauxi
Microcebus murinus
Lemur fulvus

Reptiles

**Brookesia bonsi*

Nonmarine Molluscs

Acroptychia grandidieri
Kalidos aequivocus
Kalidos bournei
Helicophanta oviformis
**Bathia madagascariensis*
Georissa aurata
Boucardicus petiti
Tropidophora semidecussata
Ampelita namerokensis

NAME Réserve Naturelle Intégrale du **TSINGY DE BEMARAHA** (No.9).

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 31 December 1927.

GEOGRAPHICAL LOCATION To the east of Antsalova in the region of Antsingy, 18°13'-19°07'S, 44°34'-57'E.

ALTITUDE 75-700 m.

AREA 152 000 ha, the largest natural reserve in Madagascar.

LAND TENURE Government land.

PHYSICAL FEATURES The reserve forms a part of the Antsingy region, a limestone karst area of very dissected relief with many caves and springs. Much of the eastern edge of the region is delimited by the Bemaraha cliff, several tens of kilometres long and 300 to 400 m high. To the east of the reserve there are three north-south flowing rivers separated by successive ridges, while the whole western region of the reserve forms a plateau with rounded hillocks which slopes away, with decreasing steepness, to the west. The climate is generally dry and there are 7 or 8 dry months. Temperatures decrease from north to south but are always above 20°C.

VEGETATION Vegetation is characteristic of the calcareous karst regions of the west, with many species unique to this formation, such as *Diospyros perrieri* (the ebony of the west coast), *Delonix regia*, and other species of the genus *Delonix*, and *Musa perrieri* (the only wild banana in Madagascar). Also baobabs *Adansonia*, and xerophytic plants such as *Aloe*. Other notable families include Flacourtiaceae, Orchidaceae, Leguminosae, Euphorbiaceae, Annonaceae, Bombacaceae and Moraceae. Climate and vegetation are very similar to that of the R.N.I. du Tsingy de Namoroka (No. 8), and the main vegetation types are dense, dry forest and savannah, but the much larger area and the greater height of the karst relief make the vegetation richer here.

ZONING None.

CONSERVATION MANAGEMENT There appears to be no active conservation management at present.

DISTURBANCES OR DEFICIENCIES Access to much of the reserve is very difficult, resulting in many areas being naturally protected. However, a track crosses the reserve from east to west and accessible valleys are populated with zebu cattle; there are also reportedly illegal settlements within the reserve. Poaching has occurred, though it is not known if this continues to be a problem.

SCIENTIFIC RESEARCH Very little. The area was apparently surveyed in the 1930s, though it is not known if the results have been published; in 1972 it was reported that a recent evaluation of the vegetation had been carried out, though further details are lacking. The reserve is of considerable archaeological interest, containing numerous ancient cemeteries.

VISITOR AND SCIENTIFIC FACILITIES None.

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

Leandri, J. (1938). La forêt d'Antsingy. *La Terre et la Vie*: 18-27.

STAFF One agent and two full-time auxiliaries.

BUDGET Salaries provided by the government.

LOCAL PARK OR RESERVE ADMINISTRATION Reserve headquarters is at Antsalova with a guard post at Bekapaka.

FAUNA

Birds

Coua ruficeps
Coua gigas
?Tachybaptus rufolavatus (record questioned)
Lophotibis cristata
Vanga curvirostris

Mammals

Lepilemur edwardsi
Microcebus coquereli
Propithecus verreauxi
Phaner furcifer
Microcebus murinus
Lemur fulvus
Hapalemur griseus

Reptiles

**Brookesia perarmata*
Lygodactylus klemmeri

Nonmarine Molluscs

The Gorges and grottes de Salapango are in this area, but probably not actually in the reserve. The following species occur in the Bemaraha region and may also occur in the gorges de Salapango (see below):

Tropidophora bemaraensis
Tropidophora chavani (Salapango)
Tropidophora filopura "
Tropidophora petiti "
Tropidophora vignali "
Boucardicus petiti (near R. Nameroko)
Edentulina battistini
Kalidos bournei
Tropidophora semidecussata
Tropidophora pyrostoma (near Miandrivazo)

Gorges (and grottes) de Salapango - these species are specifically recorded from this locality:

Tropidophora chavani
Tropidophora filopura
**Tropidophora petiti*
Tropidophora vignali
Edentulina battistini
Edentulina stumpfii
**Ampelita milloti*
Ampelita namerokoensis
Chondrocyclus mamillaris
Acroptychia bathiei
Kalidos bournei
Helicophanta oviformis

NAME Réserve Naturelle Intégrale de **TSIMANAMPETSOTSA** (No.10).

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 31 December 1927.

GEOGRAPHICAL LOCATION 24°02'-11'S, 43°36'-51'E. 100 km south of Toliara in the province of Toliara.

ALTITUDE 10-160 m.

AREA 43 200 ha.

LAND TENURE Government land.

PHYSICAL FEATURES The western part of the reserve comprises the shallow, brackish Tsimanampetsotsa lake (20 x 3 km), saturated with sulphates of lime. The lake, which has shores of virtually unvegetated arenaceous soil, is aligned north-south and lies about 7 km from the west coast. To the east of the lake is xerophytic forest on calcareous bedrock. There are numerous underground caves. The climate is dry with precipitation below 400 mm a year and 9-11 dry months. Amount and timing of rainfall can be very variable. Other forms of precipitation are likely to have a significant impact on the vegetation. The minimum temperature in the coolest months is between 15° and 20°C.

VEGETATION Xerophtyic scrub on the calcareous plateau, and typical south-western brush formation on the arenaceous soils. The vegetation is a remarkable assembly of Didiereaceae (an endemic family of trees or shrubs with the habit of cacti or cactiform euphorbias) and Euphorbiaceae. Tree species 10-12 m high dominate a stratum of impenetrable scrub, rich in lianas. The ground stratum is sparse. The reserve covers a part of the very restricted distribution of *Alluaudia montagnacii*. Plants show a wide variety of adaptations to xerophytic conditions. Numerous species of Leguminosae, Combretaceae, Tiliaceae and Liliaceae are found.

ZONING None.

CONSERVATION MANAGEMENT The boundaries are not marked on the ground, though the reserve was apparently, at least up to 1972, still well respected, as a local 'fady' (taboo) acted on local villagers in conjunction with the official protection, and the villagers did not like accompanying visitors into the reserve. The particular characteristics of the site (calcareous plateau surrounded by very rocky hillsides covered with an uninflammable xerophytic bush and lakesides of practically bare soil) also shelter it from bush fires. The reserve is reportedly the only one without feral zebu cattle as there is apparently no, or very little, fresh water. There being no fish in the lake, there is no human disturbance for fishing. Overall, the reserve is therefore reported to be little disturbed and in good condition. The area in which it is situated is one of very low population density, and efficient surveillance could easily be carried out by controlling the exit to Androka and that to Toliara. The plateau which borders the lake should be included in the reserve and it would be advisable, for example, to protect the potholes facing Itampolo in which lives *Typhleotris madagascariensis*, a legally protected blind fish.

DISTURBANCES OR DEFICIENCIES Apparently relatively few (see above).

SCIENTIFIC RESEARCH Little recent research appears to have been carried out.

VISITOR AND SCIENTIFIC FACILITIES None.

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

Germain, L. (1935). Etude du reserve naturelle du lac Manampetsa [sic]. *Ann. Sci. Nat. Zool.* XVII: 421-481.

Milon, P. (1950). Deux jours au lac Tsimanampetsoa [sic]. Observations ornithologiques. *Naturaliste Malgache* 2(1): 61-67.

STAFF One full-time auxiliary.

BUDGET None.

LOCAL PARK OR RESERVE ADMINISTRATION None.

FAUNA

Birds

Accipiter madagascariensis
Buteo brachypterus
Falco newtoni (R)
Turnix nigricollis
Charadrius thoracicus
Pterocles personatus
Streptopelia picturata (R)
Coracopsis vasa (R)
Coracopsis nigra (R)
Agapornis cana
Cuculus rochii (R)
Coua cursor
Coua cristata
Coua ruficeps
Coua verreauxi
Centropus toulou (R)
Otus rutilus (R)
Ninox superciliaris

Caprimulgus madagascariensis (R)
Alcedo vintsioides (R)
Leptosomus discolor (R)
Mirafra hova
Phedina borbonica (R)
Coracina cinerea (R)
Vanga curvirostris
Xenopirostris xenopirostris
Falculea palliata
Leptopterus viridis
Leptopterus chabert
Monticola imerina
Neomixis tenella
Neomixis striatigula
Nesillas typica
Thamnornis chloropetoides
Cisticola cherina
Newtonia amphichroa
Newtonia brunneicauda
Newtonia archboldi
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Foudia madagascariensis (R)
Lonchura nana (R)
Ploceus sakalava
Dicrurus forficata (R)

Mammals

Lepilemur leucopus (probably)
Propithecus verreauxi
Lemur catta

Microgale pusilla has been found in owl pellets in the region (M. Nicoll, *in litt.*, 28.10.86).

Reptiles

?*Pyxis arachnoides*
Geochelone radiata

Nonmarine Molluscs

Many of the following species were collected at lac 'Manampetsa':

**Microcystis bathiei*
Kalidos lapillus
Kalidos chastelli
Clavator grandidieri
Subulina manampetsaensis
Leucotaenius favannii
Leucotaenius procteri
Georissa petiti
Tropidophora philippiana
Tropidophora semidecussata (fossil)

The following species were recorded in the reserve during a survey in the 1930s (Petit, 1935; see also Part V.9. and Appendix 2). Names of some of these species have since been changed.

Clavator favannei

non endemic

Subulina octona
Subulina ferriezi
Planorbis trivialis
Planorbis crassilabrum
Ligatella philippi
Segmentina angusta
Melania tuberculata
Georissa petiti
Truncatella teres

Nonmarine Crustacea

Amphipoda:

Grandidierella mahafalensis
Orchestia ancheidos

An expedition carried out in the 1930s, as part of a series to inventory the reserves, recorded the following crustaceans (Monod, 1935):

Ostracoda:

Acoccypris capillata (not endemic)

Tanaid?:

Apseudes thaumastocheles (n.sp., blind, in chalky mud, ?endemic)

Isopoda:

Aphiloscia annulicornis (not endemic)
Pyrgoniscus petiti (n.sp.)

Amphipoda:

Grandidierella megnae (not endemic)

To the north of this reserve is found the cave of Mitoho. This is an extremely important cave faunistically, and in 1935 it was reported that some measures had been taken for its conservation (Germain, 1935). It contains a remarkable collection of cave species of marine origin, as well as diurnal soft water species. The cave is on the edge of an ancient cliff near the plateau of Mahafaly and is connected with the water table circulating under the plateau (Paulian & Delamare Deboutteville, 1956). Since the cave is the only source of fresh water in the area, its fauna may easily become threatened (Paulian, 1983). The following endemic crustaceans are found there:

Isopoda:
Anopsilana poissoni
Decapoda:
Typhlopatsa pauliani

Fish
The blind cave fish, *Typhleotris madagascariensis*, is found in the limestone potholes near Itampolo; it has been recommended that the reserve be extended to cover this area.

NAME Réserve Naturelle Intégrale **d'ANDOHAHELA** (No.11)

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 11 June 1939. The area of the reserve was increased from 30 000 ha on 1 June 1966 by Decree 66-242.

GEOGRAPHICAL LOCATION 24°30'-58'S, 46°32'-52'E. 40 km north-west of Taolanaro in the extreme south of the country.

ALTITUDE 100-1956 m

AREA 76 020 ha, in three noncontiguous blocks, one (Parcel 1) 63 100 ha, one (Parcel 2) 12 420 ha and the third (Parcel 3) 500 ha.

LAND TENURE Government land.

PHYSICAL FEATURES Parcel 1 varies in altitude from 100 m to 1956 m (Pic d'Andohahela); Parcel 2 from ca 110 m to 1005 m (Pic de Vohidagoro); Parcel 3 is at ca 125 m. Climate in parcel 1 is humid, with rainfall of 1500-2000 mm, no dry season and mean annual temperature of about 23°C; that in parcel 2 is much drier, with rainfall usually lower than 500 mm per annum and a dry season of 5-6 months. Parcel 1 is an important watershed, containing the source of over ten rivers, including the Mananara, rising at Anpamosira and flowing westward and the Manampanihy flowing east from Vohibe (O'Connor *et al.*, 1985). The Mananara, which flows along the northern boundaries of Parcel 2, is the only permanent water source for that part of the reserve.

VEGETATION Each of the three parcels has a distinct vegetation type.

Vegetation in Parcel 1 is typical of submontane tropical rainforest, of which it constitutes the southernmost extension in Madagascar. Buttressed trees of up to 35 m occur, though generally tree height does not exceed 25 m. Genera characteristic of this forest type include *Tambourissa, Symphonia* and *Dalbergia*, with members of the families Lauraceae, Compositaceae and Rubiaceae represented on the higher slopes. The endemic family Humbertaceae is found within the reserve. Orchidaceae and Cycathaceae are common, and the epiphytic cactus *Rhipsalis* occurs. Epiphytes in general are abundant, and at higher altitudes mosses and lichens are found.

Parcel 2 consists mainly of spiny thorn forest with some bush and scrub and also some gallery forest along the Menanara River in the northern part of the reserve. The highest hills have no forest cover and are generally covered with tussock grass and other herbaceous vegetation, with *Aloe* and *Pachypodium* spp. In the thorn forest, the endemic genera *Alluaudia* and *Didierea* are well represented; one species of the former (*A. ascendens*) is endemic to the Mandrare region, as is the baobab *Adansonia za* (Bombaceae). Species of Euphorbiaceae, Leguminosae and Crassulaceae are also abundant.

Parcel 3 has a high density of the endemic palm *Neodypsis decaryi* and was originally set up specifically to protect this species. It also has a belt of vegetation transitional between the spiny forest and the eastern rain forest. Leguminosae, particularly *Acacia* spp., are well represented as are Cucurbitaceae and Euphorbiaceae. There is some deciduous forest with *Tamarindus indica* along one of the non-permanent rivers, the Andehamara, and introduced *Eucalyptus* has become established along the eastern end of the parcel.

ZONING None apart from the three defined areas.

CONSERVATION MANAGEMENT Principal management at present is in the north-east of Parcel 1, near the village of Vohibaka, where a scheme to prevent fires spreading into the reserve has been started by the Chef de Cantonnement Forestier. Villagers have been using back fires to clear a 20 m wide firebreak which also deliniates the boundary of the reserve. Payment for this work up to the present has been in the form of food provided personally by the Chef de Cantonnement Forestier.

O'Connor *et al.* have made several suggestions for improving management of the reserve: 1. Review of the present boundaries; there are large areas of the reserve which are devoid of forest and it is suggested that these be excluded from the reserve in exchange for equal areas of forest. This is particularly advocated for the thorn forest, of which there are considerable intact areas around parcel 2, as it is perceived as under increasing pressure for charcoal production and exploitation of *Alluaudia* wood. The boundaries of parcel 1 are in question at present as the original markers were incorrectly placed. 2. Clear delineation of boundaries, involving extension of the firebreak scheme around Vohibaka. The possibility of fencing parcel 3 should be investigated - its small size makes fencing feasible and its proximity to the main road makes it desirable. 3. An increase in the number of guards to ten, preferably employing local villagers, and provision of uniforms. 4. Provision of transport for the Chef de Cantonnement Forestier. 5. Promotion of local agricultural development schemes to alleviate pressure on the reserve. The critical need for funding for these activities is stressed.

DISTURBANCES OR DEFICIENCIES All three parcels have deforested areas; in parcel 1 these are presumed to be largely the result of bush fires, in parcel 2 a product of wood-cutting and in parcel 3 a combination of the two. The lower, flat areas are used to cultivate rice while the higher areas are used as cattle pasture, and are burned annually to provide new growth for grazing. In parcels 1 and 2 these areas are extensive, though few are of recent origin; in parcel 1, however, bush fires are likely to be a problem near border villages, particularly near Eminiminy on the eastern side of the reserve. Slopes within the reserve here were noted by O'Connor *et al.* (1985) to be devoid of forest and it was thought likely that the villagers no longer considered them part of the reserve. There was also some evidence that the extent of cultivated land in the reserve was expanding in the southern end of parcel 1, north of the village of Isaka Ivondro; houses were noted within the reserve and new clearings were observed along the Ambahibe River. Fires have been recorded in the vicinity of Parcel 3 and could pose a serious threat to the area if not controlled. Livestock habitually graze within the reserve boundaries and wood-cutting is a problem where villages occur near to forested parts of the reserve. Wood taken from Parcel 1 is used mainly for fuel in homes whereas that taken from Parcel 2 is used for fuel and house building and is also taken for sale to markets in Ambovombe, Amboasary and Taolanaro. There is, however, as yet no evidence for large-scale logging within the reserve. Hunting is generally not a major problem, though may be of some importance in the north and east of Parcel 1 where cattle thieves hide and in parcel 3 where the *Lemur catta* population has been reduced as a result of hunting for food. Elsewhere such hunting as occurs appears to be mainly as a pastime rather than to provide a significant supply of proteim. It is thought likely that some animals, particularly lemurs, are caught alive for sale as pets. The reserve is seriously understaffed, with only two guards and a Chef de Réserve covering over 76 000 ha.

SCIENTIFIC RESEARCH The area has been surveyed in the past (Paulian *et al.*, 1973); *Propithecus* has been the subject of a brief study by Richard at Hazafotsy (Parcel 2). There area is at present the subject of study by O'Connor.

VISITOR AND SCIENTIFIC FACILITIES None. Access to Parcel 1 is difficult, although a road runs from Ranomafana to Isaka Ivondro on the eastern boundary. There are four paths, three of which follow the boundaries of the parcel with the fourth cutting through from east to west (Andonabe to Evasia). Parcel 2 is more accessible, from the road from Amboasary to Hazofotsy which continues to Ambatoabo, crossing the northern boundary of the parcel; this road is passable for most of the year and from it a path cuts south to Bevilany. Parcel 3 is easily accessible from R.N. 13 which runs from Fort Dauphin to Amboasary. There is a hut at Hazafotsy owned by the government agronomy service which has been used by visiting scientists.

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

O'Connor, S., Pidgeon, M., and Randria, Z. (1985). A conservation program for the Andohahela Reserve (Réserve Naturelle No. 11). Paper given at 'Seminaire Scientifique international sur l'etat de recherche sur l'equilibre des ecosystèmes forestiers de Madagascar.' Antananarivo, October 1985.

Paulian, R., Blanc, C., Guillaumet, J-L., Betsch, J-M., Griveaud, P. and Peyrieras, A. (1973). Etude des écosystèmes montagnards dans la région malagache. II Les chaînes Anosyennes. Géomorphologie, climatologie et groupments végéteaux. Campagne RCP 225 1971-1972. *Bull. Mus. Natn. Hist. Nat. Paris* 3° sér. no. 118 Ecol. 1: 1-40.

STAFF A Chef de Réserve (i.e. the Chef de Cantonnement Forestier et Poste R.N. 11), a Chef de Poste Est and a second guard, posted at Hazafotsy (see below).

BUDGET Salaries paid by the government.

LOCAL PARK OR RESERVE ADMINISTRATION Protection of the reserve is coordinated by the Chef de Cantonnement Forestier et Poste R.N. 11, who is located at Amboasary-Sud. There are two guardposts, one at Eminiminy on the eastern side of Parcel 1 (Poste Est), the other at Hazafotsy on the northern boundary of Parcel 2.

FAUNA

Birds

The following species have been recorded by O'Connor *et al.* (1985) in their surveys of all three parcels of the reserve; it is not regarded as a complete avifaunal list.

Lophotibis cristata
Aviceda madagascariensis
Polyboroides radiatus
Accipiter madagascariensis
Buteo brachypterus
Falco newtoni (R)
Margaroperdix madagarensis
Turnix nigricollis
Pterocles personatus
Streptopelia picturata (R)
Treron australis (R)
Alectroenas madagascariensis
Coracopsis nigra (R)
Coracopsis vasa (R)
Agapornis cana
Coua gigas
Coua reynaudii
Coua cursor
Coua cristata
Coua caerulea
Centropus toulou (R)
Otus rutilus (R)
Ninox superciliaris
Caprimulgus madagascariensis (R)
Alcedo vintsioides (R)
Ipsidina madagascariensis

Eurystomus glaucurus (R)
Leptosomus discolor (R)
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus sp
Hypsipetes madagascariensis (R)
Tylas eduardi
Schetba rufa
Vanga curvirostris
Xenopirostris xenopirostris
Falculea palliata
Leptopterus viridis
Hypositta corallirostris
Copsychus albospecularis
Neomixis viridis
Cisticola cherina
Newtonia brunneicauda
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderspatana
Lonchura nana (R)
Ploceus nelicourvi
Ploceus sakalava
Foudia madagascariensis (R)
Dicrurus forficatus (R)

In addition there is a nineteenth century record of *Brachypteracias squamiger*, and *Atelornis pittoides* has been recorded from the Anosyennes hills.

Mammals
The following species have either been recorded by O'Connor and co-authors or identified by forest guards or villagers in the reserve. Numbers in parentheses indicate the parcel(s) in which the species has been recorded. A question mark indicates occurrence expected from known distribution of the species but not confirmed.

Cheirogaleus medius [2,?3]
Cheirogaleus major [1]
Microcebus murinus [2,?3]
Microcebus rufus [1]
Phaner furcifer [?2]
Avahi laniger [1]
Lepilemur mustelinus [1]
Lepilemur leucopus [2,?3]
Propithecus diadema [1]
Propithecus verreauxi [1,2,?3]
Daubentonia madagascariensis [1]
Hapalemur griseus [1]
Lemur fulvus [1]
Lemur catta [1,2,3]

Cryptoprocta ferox [1,2,?3]
Galidia elegans [1]
Salanoia concolor [1]
Fossa fossa [1]
Galidictis fasciata [?1]

Amphibians
No specific data, but the following amphibians are recorded from the Anosyennes chain of hills, the southern end of which comprises the R.N.I. d'Andohahela

Anodontohyla boulengeri
**Madecassophryne truebae*
Mantidactylus bertini
**Mantidactylus grandisonae*
Mantidactylus redimitus
**Boophis microtis*
**Anodontohyla rouxae*
**Microhyla palmata*
Mantidactylus elegans
Mantidactylus microtympanum
Mantidactylus tricinctus

Information used in this account has been kindly provided by Sheila O'Connor and Mark Pidgeon.

NAME Réserve Naturelle Intégrale de **MAROJEJY** (No.12).

MANAGEMENT CATEGORY I (Strict Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 3 January 1952.

GEOGRAPHICAL LOCATION 14°18'-39'S, 49°33'-52'E. To the north-west of Andapa in the province of Antseranana.

ALTITUDE 90-2137 m.

AREA 60 150 ha.

LAND TENURE Government land.

PHYSICAL FEATURES The reserve includes the massif of Marojejy, and its principal foothills, notably Ambatosoratra, Ambodilahitra and Beondroka. The area comprises a very rugged massif chiefly composed of gneiss, which is divided into three main blocks. At around 1100 m, the mid-slopes become increasingly steep, leading up to narrow quartzite ridges which precede the rocky escarpments encircling the west slopes of the massif. There is a wide range of microclimates. Rainfall on the eastern and south-eastern slopes is thought to reach or exceed 3000 mm a year, which would be the highest rainfall in Madagascar; measured rainfall at Andapa and Sambava is ca 2000 mm a year. Average temperatures at the lowest altitudes on the eastern side are approximately 22.3°C in July and 26.9°C in February. Winter temperatures on the summit of Marojejy (2133 m) are ca 1.5°C.

VEGETATION Overall, plant species diversity is very high, with over 100 genera and 2000 species recorded, several apparently endemic to the massif. Humbert (1955) has given a detailed description of the vegetation of the Marojejy Massif, divided into four altitudinal zones. The lowest zone, from 50 m to ca 800 m is high, dense, closed canopy rainforest, with a canopy height of 25-30 m and relatively clear horizontal stratification. Species diversity is very high. The most commonly represented families in the canopy are: Euphorbiaceae, Rubiaceae, Araliaceae, Ebenaceae (*Diospyros*), Sapindaceae, Sapotaceae, Anacardiaceae, Elaeocarpaceae (*Echinocarpus*), Lauraceae (*Ocotea, Ravensara*), Clusiaceae (*Ochrocarpus*), Myrtaceae, Burseraceae (*Canarium*), Moraceae, Bignoniaceae, Apocynaceae, Tiliaceae, Malpighiaceae, Monimiaceae, Flacourtiaceae, Loganiaceae. The intermediate stratum consists of small trees and large shrubs, mostly of the families Rubiaceae, Euphorbiaceae, Ochnaceae, Erthryoxylaceae, Myrsinaceae, Celastraceae, Violaceae, Flacourtiaceae. The ground layer is generally patchy, consisting of grasses and herbs, generally of the families Labiaceae, Acanthaceae, Gesneraceae, Melastomaceae, Balsaminaceae. Epiphytes are abundant.

Transition from this stage to mid-altitude rainforest is made gradually, at around 800-900 m. This zone is characterised by a lower canopy height (18 to 25 m), with canopy trees generally branching lower down their trunks; the intermediate stratum tends to disappear, while the ground layer becomes denser and more varied. Although the species represented are generally different from those in the lower altitude forest, the families, and to some extent the genera, tend to be the same. Trees which are notably abundant or considered characteristic include species of *Weinmannia, Apodocephala, Brachylaena* and *Podocarpus*. Pteridophytes, particularly members of the Cyathaceae, are also abundant.

Lichen or moss forest is best developed between 1450 and 1850 m, although it can be found as low as 1200 m altitude. Tree height is up to 6-10 m (max. 12 m), with trees often branching extensively from their bases. There is no intermediate stratum, but a dense and varied ground layer. Trees and shrubs mostly belong to the families Compositae (*Vernonia, Senecio, Apodocephala, Psiadia*), Lauraceae, Rubiaceae, Cunoniaceae (*Weinmannia*), Araliaceae (*Cussonia*), Euphorbiaceae (*Uapaca, Acalypha, Croton*), Rutaceae, Verbenaceae (*Vitex, Clerodendron*), Ericaceae (*Agauria, Philippia*), Sterculiaceae (*Dombeya*), Taxaceae (*Podocarpus*), Myricaceae (*Myrica*). Virtually monotypic stands of the bamboo *Arundinaria marojejyensis* are found on the least developed soils. Mosses and lichens are very abundant, both as ground cover and festooning trees and shrubs. Other epiphytes include ferns, species of *Peperomia* and orchids such as *Bulbophyllum*.

Above 1850 m altitude is found vegetation which, depending on soil conditions and microclimate, has the appearance either of maquis or of heath. Shrubs chiefly belong to the families Compositae, Ericaceae, Rubiaceae, Melastomaceae, Clusiaceae, Araliaceae, Euphorbiaceae, Myrtaceae; less numerous are members of the Cunoniaceae, Flacourtiaceae, Sapotaceae, Pittosporaceae, Sterculiaceae, Rutaceae, Verbenaceae, Vacciniaceae. *Arundinaria marojejyensis* forms scattered dense stands and tree ferns (Cyatheaceae) are found to ca 2000 m altitude. Herbaceous plants consist largely of sedges (Cyperaceae) and grasses (Gramineae) and there are small marshes and swampy depressions with a distinctive flora.

ZONING None.

CONSERVATION MANAGEMENT The entire perimeter is marked by boundary stones connected by a largely overgrown footpath. There are four guards who each patrol a given sector of the boundary at about four-monthly intervals; however the guards lack equipment for prolonged foot patrols within the reserve.

DISTURBANCES OR DEFICIENCIES The reserve is undermanned. Some tavy (slash-and-burn) cultivation is carried out in valleys which are rarely patrolled. The areas surrounding the reserve in the south and much of the west have been deforested to the boundary; the state of the northern and eastern boundaries is unknown. Before the reserve was created, coffee was grown at 400-500 m within the reserve boundaries; these areas are now slowly regenerating to native forest. The frequency of rain and storms provides effective protection of the reserve at higher altitudes.

SCIENTIFIC RESEARCH One of the best studied massifs, first surveyed in 1933.

VISITOR AND SCIENTIFIC FACILITIES None; there are no tourist paths or trails within the reserve, although a tractor track from Andapa to Doany provides access to the reserve in the west between 500 and 1000 m.

PRINCIPAL REFERENCE MATERIAL

Andriamampianina, J. and Peyrieras, A. (1972). Les réserves naturelles intégrales de Madagascar. In: *Comptes rendus de la Conférence internationale sur la Conservation de la Nature et de ses Ressources à Madagascar, Tananarive, Madagascar 7-11 octobre 1970.* IUCN, Switzerland.

Guillaumet, J-L., Betsch, J-M., Blanc, C., Morat, P., Peyrieras, A. and Paulian, R. (1975). Etude des ecosystèmes montagnards dans la region malgache. III. Le Marojezy. IV. L'Itremo et l'Ibity. Géomorphologie, climatologie, faune et flore (Campagne RCP 225, 1972-1973). *Bull. Mus. Natn. Hist. Nat.* (3). 309. (Ecol. generale): 25, 27-67.

Humbert, H. (1955). Une merveille de la nature à Madagascar. Première exploration botanique du Massif de Marojejy et de ses satellites. *Mém. Inst. sci. de Madagascar.* Série B. Tome VI. P.271.

Nicoll, M.E. and Langrand, O. (1987). Report on the first phase of WWF - Protected areas programme in Madagascar. Unpd. report, 62 pp.

STAFF An agent and 4 auxiliaries full-time.

BUDGET Salaries paid by the government.

LOCAL PARK OR RESERVE ADMINISTRATION Headquarters at Andapa, and guardposts at Doany and Ambalamanasy.

FAUNA

Birds

Lophotibis cristata
Aviceda madagascariensis
Eutriorchis astur
Polyboroides radiatus
Accipiter henstii
Accipiter madagascariensis
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Falco zoniventris
Margaroperdix madagascarinus
Turnix nigricollis
Dryolimnas cuvieri
Mentocrex kioloides

Sarothrura insularis
Sarothrura watersi
Streptopelia picturata (R)
Treron australis (R)
Alectroenas madagascariensis
Agapornis cana
Coracopsis vasa (R)
Coracopsis nigra (R)
Coua caerulea
Cuculus rochii
Coua reynaudii
Coua cristata
Centropus toulou (R)
Otus rutilus (R)
Asio madagascariensis
?Ninox superciliaris
Caprimulgus madagascariensis (R)
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Ipsidina madagascariensis
Eurystomus glaucurus (R)
Leptosomus discolor (R)
Brachypteracias leptosomus
Brachypteracias squamiger
Atelornis crossleyi
Philepitta castanea
Neodrepanis coruscans
Phedina borbonica (R)
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus madagascariensis
Phyllasterphus zosterops
Hypsipetes madagascariensis (R)
Schetba rufa
Vanga curvirostris
Xenopirostris polleni
Leptopterus chabert
Leptopterus viridis
Leptopterus madagascarinus (R)
Oriolia bernieri
Euryceros prevosti
Hypositta corallirostris
Tylas eduardi
Monticola sharpei
Nesillas typica
Newtonia brunneicauda
Neomixis viridis
Neomixis tenella
Terpsiphone mutata (R)
Oxylabes madagascariensis
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Lonchura nana (R)
Ploceus nelicourvi
Foudia madagascariensis (R)
Foudia omissa
Saroglossa aurata
Dicrurus forficatus (R)

Mammals

Hapalemur griseus
Propithecus diadema
Lemur fulvus
Lemur macaco
Varecia variegata reported
Cryptoprocta ferox
Galidia elegans
Hemicentetes semispinosus
Microgale talazaci
Tenrec ecaudatus
Microcebus rufus
Pteropus rufus

Amphibians

**Mantipus minutus*
Plethodontohyla notosticta
Rhombophryne testudo
Stumpffia psologlossa
**Stumpffia tridactyla*
Laurentomantis horrida
Mantidactylus bicalcaratus
Mantidactylus lugubris
Mantidactylus redimitus
**Mantipus serratopalpebrosus*
Plethodontohyla ocellata
**Stumpffia grandis*
**Stumpffia roseifemoralis*
Dyscophus insularis
Mantidactylus asper
**Mantidactylus klemmeri*
**Mantidactylus pseudoasper*

Reptiles

Zonosaurus aff. *rufipes*
**Brookesia griveaudi*
Chamaeleo gastrotaenia
Chamaeloe nasutus
Brookesia betschi
Chamaeleo aff. *malthe*
Pararhadinea melanogaster
**Brookesia karchei*
Chamaeleo peyrierasi
Chamaeleo globifer
Chamaeleo bifidus
Chamaeleo aff. *brevicornis*
Brookesia aff. *minima*
Liopholidophis stumpffi

Nonmarine Molluscs
Those marked + have definitely been recorded within the reserve.

Acroptychia metablata +	*Ampelita gaudens* +
Tropidophora tricarinata	**Ampelita globulus* +
Tropidophora zonata	*Ampelita lamarei* +
Helicophanta amphibulima +	*Ampelita perampla* +
Kalidos oleatus +	**Malagrion paenelimax*
Macrochlamys stumpfii +	

NAME Réserve Special Botanique **d'AMBOHITANTELY.**

MANAGEMENT CATEGORY IV (Managed Nature Reserve).

LEGAL PROTECTION Protection of all resources within the reserve is total. Access is not restricted by the establishing decree.

DATE ESTABLISHED 12 February 1982, upgraded from Forêt classée to a Réserve Spéciale Botanique.

GEOGRAPHICAL LOCATION Ca 18°08'-18°13'S, 47°18'-47°21'E; on the Tampoketsa d'Ankazobe some 80 km north of Antananarivo.

ALTITUDE 1200-1650 m.

AREA 5600 ha.

LAND TENURE Government land.

PHYSICAL FEATURES The reserve consists of 'tampoketsa', that is levelled off remains of ancient erosion surfaces at high altitude, generally forming highly dissected plateaux bordered by steep escarpments. The formation is assumed to be late Cretaceous in origin. Altitude of the tampoketsa is 1600 m, though the forest descends to around 1450 m. Rainfall averages around 1500 mm per annum, with a marked wet season from November to March. Mean maximum temperature is 26°C, minimum 12°C.

VEGETATION The area contains one of the few remaining vestiges of the central plateau forest. In 1964, the forest consisted of a single tract of ca 2000 ha on the eastern slope of the tampoketsa, with an additional 1000 ha of small scattered fragments mainly at the heads of valleys on the tampoketsa itself. The forest has very close floristic affinities with the eastern rain forest, especially at lower altitudes, where it appears to be more or less primary.

ZONING None.

CONSERVATION MANAGEMENT Ambohitantely is the focus for IUCN/WWF Project 1912, Protection and Management of Ambohitantely Forest Reserve. The reserve was first set up on the initiative of the Direction des Eaux et Forêts with the support of WWF. This project, under the responsibility of the Plant Biology and Biochemical Service of Antananarivo University, is mainly scientifically orientated in support of management. Work is in progress on an inventory of the flora. The Plant Biology and Biochemical Service made two visits to the area in 1982 and three in 1983, with the aid of the WWF Representation, which provided the vehicle and fuel. WWF will also support the development of this newly established reserve. The area could be particularly valuable as a training area because of its proximity to Antananarivo. Studies made here will help in developing plans to reafforest the tampoketsa region using native trees, and will form the basis of a public conservation education campaign.

DISTURBANCES OR DEFICIENCIES The most serious danger is fire, but boundaries also need to be marked, guards installed, access controlled, and paths maintained.

SCIENTIFIC RESEARCH Studies of the fauna and flora, carried out by Antananarivo University, under IUCN/WWF Project 1912, concentrate on plants of medicinal, ornamental, or possible economic use, and on endangered or rare species. Studies also concentrate on the effect of fire on the vegetation.

VISITOR AND SCIENTIFIC FACILITIES There are no facilities within the reserve, but there are nearby facilities at Antananarivo.

PRINCIPAL REFERENCE MATERIAL

IUCN/WWF Project 1912. Protection and Management of Ambohitantely Forest Reserve.

Bastian, G. (1964). La forêt d'Ambohitantely, Madagascar. *Revue de Géographie* 5: 1-42.

STAFF No information.

BUDGET The reserve has received funding from the WWF direction à Madagascar.

LOCAL PARK OR RESERVE ADMINISTRATION There is a forest station at Manankazo.

FAUNA

Mammals

Lemur fulvus

Reptiles

The following records were provided by C. Raxworthy (*in litt.*, 4.12.86).

Chamaeleo nasutus
Chamaeleo parsonii
Phesluma lineata

Amphibians

Mantidactylus peraccae
Mantidactylus punctatus
Platypelis pollicaris
Plethodontohyla laevis

Nonmarine Molluscs

Vitrina madagascariensis

Nonmarine Crustacea

Decapoda

Hydrothelphusa humbloti

NAME Réserve Speciale de **BEZA MAHAFALY**

MANAGEMENT CATEGORY IV (Managed Nature Reserve).

LEGAL PROTECTION Total.

DATE ESTABLISHED 1979. Inaugurated November 1985.

GEOGRAPHICAL LOCATION Just west of the Sakamena River, about 35 km north-east of Betioky-Sud; ca 23°30'S, 44°40'E. The reserve is divided into two non-contiguous parcels, one lying along the Sakamena River, the second some 5 km west of the Sakamena.

ALTITUDE Ca 100-200 m.

AREA 600 ha in two parcels, one of 100 ha, the second of 500 ha.

LAND TENURE Government land.

PHYSICAL FEATURES The first (100 ha) parcel borders the Sakamena River, which normally contains water during the rainy season, from November or December to March; for the rest of the year it is a dry sandy river bed (Richard *et al.*, 1985).

VEGETATION The first parcel consists of low gallery forest, dominated by *Tamarindus indica*; the second consists of spiny forest dominated by *Alluaudia procera* with other members of the Didiereacae and Euphorbiaceae (Richard *et al.*, 1985).

ZONING None apart from the two defined areas.

CONSERVATION MANAGEMENT The smaller parcel is bounded by a barbed-wire fence, erected in 1979; the larger has a 3 m swathe cut around it to delineate the boundaries. *Opuntia* has been planted to provide an effective barrier. Grids of trails have been cut within the reserve, these being 100 m-to-a-side in the smaller parcel and 500 m-to-a-side in the larger (Richard *et al.*, 1985).

DISTURBANCES OR DEFICIENCIES The reserve appears to be well protected at present. Cattle and goats formerly ranged throughout the forests at Beza Mahafaly; since 1979 these have been excluded from the smaller parcel by the boundary fence, though it is not clear if they still enter the larger (Richard *et al.*, 1985).

SCIENTIFIC RESEARCH The Beza Mahafaly project is based on an Inter-University Accord between the University of Madagascar, Yale University and Washington University. One of its principal roles is to provide a site for research on the flora and fauna of the south-west of Madagascar, and on the relations between the Madagascan people and the natural environment. The importance of baseline survey work as a preliminary to more detailed studies has been emphasised (Richard *et al.*, 1985). Up to the present, more or less detailed inventories of primates, insectivores and rodents, birds and insects, particularly Hymenoptera, have been carried out (see Fauna below) along with a study of the structure and composition of the vegetation inside and outside the reserve. This last study is intended to give information on the regeneration of the natural vegetation and the impact of livestock grazing on this, with the reserve, being fenced, effectively acting as a large scale exclosure. A more detailed study of the demography and behaviour of *Propithecus verreauxi* in the larger parcel of the reserve was begun in 1984. Plans for further research include: a study of the ethnomedicine of the region, to be expanded to a general ethnobotanical survey of the area; extending the study of forest structure, diversity and regeneration to the second parcel; establishment of an on-site herbarium; exploration of the phenology and pollination ecology of dominant tree and shrub species in the two parcels; a study of the behavioural ecology of *Lemur catta*; research on the reptile community of the reserve with a detailed study of *Geochelone radiata* (Richard *et al.*, 1985).

VISITOR AND SCIENTIFIC FACILITIES Huts for equipment and cooking.

PRINCIPAL REFERENCE MATERIAL

Rakotomanga, P., Richard, A.F. and Sussman, R.W. (1985). Beza Mahafaly. Formation et Mesures pour la conservation. Paper given at 'Seminaire Scientifique international sur l'etat de recherche sur l'equilibre des ecosystèmes forestiers de Madagascar.' Antananarivo, October 1985.

Richard, A.F., Rakotomanga, P. and Sussman, R.W. (1985). Beza Mahafaly: recherches fondamentales et appliquées. Paper given at 'Seminaire Scientifique international sur l'etat de recherche sur l'equilibre des ecosystèmes forestiers de Madagascar.' Antananarivo, October 1985.

STAFF One chief warden, five permanent guards plus auxiliary guards.

BUDGET The Beza Mahafaly project has received financial support from WWF-US since 1980.

LOCAL PARK OR RESERVE ADMINISTRATION Reserve headquarters are at Betioky-Sud.

FAUNA

Birds

The following species have been recorded by Randrianasolo and Pidgeon (*fide* Richard *et al.*, 1985) and updated by Pidgeon (pers. comm., 1986).

Polyboroides radiatus
Accipiter madagascariensis
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Margaroperdix madagarensis
Turnix nigricollis
Dryolimnas cuvieri
Streptopelia picturata (R)
Coracopsis nigra (R)
Coracopsis vasa (R)
Agapornis cana
Coua gigas
Coua cursor
Coua cristata
Centropus toulou (R)
Otus rutilus (R)
Ninox superciliaris
Alcedo vintsioides (R)
Leptosomus discolor (R)
Coracina cinerea (R)
Hypsipetes madagascariensis (R)
Vanga curvirostris
Xenopirostris xenopirostris
Falculea palliata
Leptopterus chabert
Leptopterus viridis
Eurystomus glaucurus (R)
Copsychus albospecularis
Neomixis tenella
Neomixis striatigula
Newtonia brunneicauda
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Zosterops maderaspatana
Ploceus sakalava
Foudia madagascariensis (R)
Dicrurus forficatus (R)

Mammals

Propithecus verreauxi
Lepilemur leucopus
Lemur catta
Microcebus murinus
Cryptoprocta ferox
Echinops telfairi
Setifer setosus
Geogale aurita
Tenrec ecaudatus
Suncus madagascariensis

Cheirogaleus medius has been recorded within 1 km of the reserve. This is the only known site where *Geogale aurita* is common (M. Nicoll, *in litt.*, 28.10.86).

Reptiles

The following species have been recorded by C. Raxworthy (*in. litt.*, 4.12.86) and M. Pidgeon and S. O'Connor (pers. comm., 10.10.86).

Geochelone radiata
Hemidactylus mabouia
Homopholis sakalava
Phelsuma mutabilis
Geckolepis typica
Paroedura bastardi
Paroedura pictus
Tracheloptychus madagascariensis
Mabuya gravenhorsti
Mabuya elegans
Mabuya aureopunctata
Chamaeleo verrucosus
Leioheterodon geayi
Leioheterodon madagascariensis
Ithycyphus miniatus
Acrantophis dumerilii
Chalaradon madagascariensis
Erymnochelys madagascariensis

Much of the information in this account has been kindly provided by Sheila O'Connor and Mark Pidgeon.

NAME Réserve Speciale de **NOSY MANGABE**

MANAGEMENT CATEGORY IV (Managed Nature Reserve).

LEGAL PROTECTION Protection of all resources within the reserve is total. Access is not restricted by the establishing decree.

DATE ESTABLISHED 14 December 1965 by Decree No. 65-795.

GEOGRAPHICAL LOCATION 15°25'S, 49°45'E. A small island situated to the east of Maroantsetra, 6 km off the coast of Madagascar in the Bay of Antongil.

ALTITUDE From sea level to 331 m.

AREA 520 ha (the whole island).

LAND TENURE Government owned.

PHYSICAL FEATURES Cretaceous limestone island, with very rugged topography.

VEGETATION The island has a typical east coast rainforest vegetation including species of *Canarium*, *Ocotea* and *Ravensara*, along with many palms and ferns. Much of the forest is secondary.

ZONING None.

CONSERVATION MANAGEMENT Aye-aye *Daubentonia Madagascariensis* were introduced onto the island in 1966. Other than this, relatively little active management appears to have been carried out, although the island does not appear to be unduly disturbed. A boat with outboard motor is available for patrols and there is a building which could serve as a laboratory on the island.

DISTURBANCES OR DEFICIENCIES The island can only support limited tourism and this must be more strictly controlled. It has been suggested (IUCN Project 1953) that no more buildings be constructed on the island. Planned staff housing should be built on the adjacent mainland. Any manipulation of the habitat should be strictly minimised. There is a fishermen's hut at one end of the island which is in constant use.

SCIENTIFIC RESEARCH A study of *Varecia variegata* was due to begin in autumn 1986.

VISITOR AND SCIENTIFIC FACILITIES A one room laboratory.

PRINCIPAL REFERENCE MATERIAL
IUCN/WWF Project 1953.

STAFF Two agents and two auxiliaries.

BUDGET Salaries paid by the government. WWF has provided funds for management.

LOCAL PARK OR RESERVE ADMINISTRATION No information.

FAUNA

Birds
Records are from O. Langrand (unpublished data, *in litt.*, 28.10.86).

Accipiter francesii (R)
Buteo brachypterus
Dryolimnas cuvieri
Streptopelia picturata (R)
Coracopsis nigra (R)
Cuculus rochii (R)
Centropus toulou (R)
Alcedo vintsioides (R)

Ipsidina madagascariensis
Leptosomus discolor (R)
Motacilla flaviventris
Hypsipetes madagascariensis (R)
Leptopterus chabert
Copsychus albospecularis
Nesillas typica
Newtonia amphichroa
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Ploceus nelicourvi
Dicrurus forficatus (R)

Mammals

Daubentonia madagascariensis
Microcebus rufus
Lemur fulvus
Varecia variegata
Setifer setosus
Oryzorictes sp.

Pteropus rufus is present on islands 1 km distant (M. Nicoll, *in litt.*, 28.10.86).

Amphibians

?* *Mantella laevigata*
* *Boophis leucomaculatus*
?* *Mantidactylus webbi*
Dyscophus antongili

Reptiles

The following species, excepting *Liopholidophis thieli*, have been recorded by Q. Bloxam (*in litt.*, 23.07.86) and C. Raxworthy (*in litt.*, 4.12.86). The record for *Pseudoxyrhopus heterurus* is the first definite locality record for this species.

Sanzinia madagascariensis
Liopholidophis thieli
Pseudoxyrhopus heterurus
Homopholis antongilensis
Phelsuma guttata
Paroedura androyensis
Ebenavia inunguis
Uroplatus fimbriatus
Chamaeleo oustaleti
Chamaeleo pardalis
Brookesia peyrierasi
Zonosaurus aeneus
Zonosaurus madagascariensis
Amphiglossus sp.

NAME Réserve de faune de **PERINET-ANALAMAZOATRA**.

MANAGEMENT CATEGORY IV (Managed Nature Reserve).

LEGAL PROTECTION All resources within the reserve are totally protected. Access is theoretically not controlled by the decree setting up the reserve, although a permit, issued by the Direction des Eaux et Forêts, is required for entry.

DATE ESTABLISHED 21 June 1970.

GEOGRAPHICAL LOCATION 100 km east of Antananarivo to the east of Moramanga; 18°28'S, 48°28'E.

ALTITUDE 930-1040 m.

AREA 810 ha.

LAND TENURE Government land.

PHYSICAL FEATURES The reserve lies within a crystalline massif with rugged topography; soils are principally lateritic. Annual rainfall is ca 1700 mm, with most in January and least in October. Mean monthly temperature varies from 14°C in August to 24°C in January; cyclones may occur between November and March.

VEGETATION Medium altitude tropical moist forest; characteristic canopy genera include *Weinmannia*, *Tambourissa*, *Symphonia*, *Dalbergia*, *Ravensara* and *Vernonia*. The understorey strata are particularly dense and include representatives of *Cyathea*, *Dypsis*, *Plantago*, *Smilax*, *Rubus*, *Alchemilla* and *Sanicula*. Epiphytes, including orchids (especially *Bulbophyllum*) and *Rhipsalis*, are abundant.

ZONING None.

CONSERVATION MANAGEMENT The reserve is well marked on the ground and there are numerous well-used trails. The reserve is generally left undisturbed apart from path clearing activities; patrols are carried out on an *ad hoc* basis and only occasionally penetrate the furthest reaches of the reserve. A private organization, the Friends of the Reserves of Andasibe (Périnet), has recently been formed and could play an active role in assisting in the maintenance of the reserve.

DISTURBANCES OR DEFICIENCIES The reserve is too small to protect this forest type adequately. Tavy (slash-and-burn) is the principal cultivation technique used in the region; with the increasing human population it is becoming unsustainable and poses a severe long-term threat. The reserve is being encroached from the south and east by tavy, though is still buffered to the north and west by native and plantation forests. There is evidence of hunting and exploitation of hardwoods within the reserve. There is also substantial collection of animals to supply both the national and overseas pet trades; animals involved include *Phelsuma*, *Chamaeleo* and *Mantidactylus* spp, *Sanzinia madagascariensis*, *Microcebus rufus*, *Hapalemur griseus* and *Lemur fulvus*.

SCIENTIFIC RESEARCH Many studies have been carried out on the fauna and flora of the reserve.

VISITOR AND SCIENTIFIC FACILITIES The reserve is easily accessible from Antananarivo and Toamasina, either by rail or by road; the latter passes alongside the reserve. The forest station associated with the reserve has accomodation, though this is in a poor state of repair.

PRINCIPAL REFERENCE MATERIAL

Nicoll, M.E. and Langrand, O. (1987). Report on the first phase of WWF - Protected areas programme in Madagascar. Unpd. report, 62 pp.

STAFF The Chef de Station Forestière is responsible for the reserve; there are also two labourers.

BUDGET Salaries paid by the government.

LOCAL PARK OR RESERVE ADMINISTRATION The reserve is under the responsibility of the Service de la Protection de la Nature, Direction des Eaux et Forêts, B.P. 243, Antananarivo. Local responsiblity lies with the Chef de Station Forestière d'Analamazoatra.

FAUNA

Birds

Records are from Dee (in press) (see part V.1.), amended by M. Pidgeon, O. Langrand, P. Thompson, J. Thorsen, J. Ganzhorn and T. Moermond (unpublished data).

Tachybaptus pelzelnii
Ardeola idae (R)
Lophotibis cristata
Anas melleri
Aviceda madagascariensis
Eutriorchis astur
Polyboroides radiatus
Accipiter madagascariensis
Accipiter henstii
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Falco zoniventris
Margaroperdix madagarensis
Mesitornis unicolor (probable)
Dryolimnas cuvieri
Canirallus kioloides
Sarothrura insularis

Sarothrura watersi
Streptopelia picturata (R)
Treron australis (R)
Alectroenas madagascariensis
Coracopsis vasa (R)
Coracopsis nigra (R)
Cuculus rochii
Coua cristata
Coua caerulea
Coua serriana
Coua reynaudii
Centropus toulou (R)
Tyto soumagnei
Otus rutilus (R)
Asio madagascariensis
Caprimulgus enarratus
Caprimulgus madagascariensis (R)
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Ipsidina madagascariensis
Eurystomus glaucurus (R)
Brachypteracias leptosomus
Atelornis pittoides
Atelornis crossleyi
Leptosomus discolor (R)
Philepitta castanea
Neodrepanis coruscans
Neodrepanis hypoxantha
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus madagascariensis
Phyllastrephus zosterops
Phyllastrephus tenebrosus
Hypsipetes madagascariensis (R)
Tylas eduardi
Calicalicus madagascariensis
Vanga curvirostris
Xenopirostris polleni
Leptopterus chabert
Leptopterus madagascarinus (R)
Leptopterus viridis
Hypositta corallirostris
Copsychus albospecularis
Monticola sharpei
Neomixis viridis
Neomixis striatigula
Neomixis tenella
Hartertula flavoriridis
Oxylabes madagascariensis
Mystacornis crossleyi
Acrocephalus newtoni
Crossleyia xanthophrys
Nesillas typica
Cisticola cherina
Dromaeocercus brunneus
Dromaeocercus seebohmi
Randia pseudozosterops
Newtonia amphichroa
Newtonia brunneicauda
Newtonia fanovanae
Pseudobias wardi
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Lonchura nana (R)
Ploceus nelicourvi
Foudia madagascariensis (R)
Foudia omissa
Saroglossa aurata
Dicrurus forficatus (R)

Neodrepanis hypoxantha has been recorded just outside the reserve.

Mammals

Cheirogaleus major
Microcebus rufus
Avahi laniger
Indri indri
Daubentonia madagascariensis
Hapalemur griseus
Lemur fulvus
Lemur rubriventer
Lepilemur microdon
Hemicentetes semispinosus
Microgale taiva
Microgale thomasi
Microgale talazaci
Microgale melanorrhachis
Microgale pusilla
Microgale gracilis
Oryzorictes hova
Setifer setosus
Tenrec ecaudatus
Suncus madagascariensis
Brachytarsomys albicauda
Eliurus myoxinus
Eliurus minor
Gymnuromys roberti
Nesomys rufus

Varecia variegata has been recorded in the vicinity, although there are no records from the reserve itself; *Propithecus diadema* previously occurred in the reserve but no longer does so, although it is still present in the area.

Amphibians

Anodontohyla boulengeri
Platyhyla grandis
Platypelis tubifera
?**Mantidactylus acuticeps*
**Mantidactylus eiselti*
Mantidactylus liber
Mantidactylus pulcher
Boophis difficilis
Boophis granulosus
Boophis idae
Boophis paulianus
**Boophis reticulatus*
**Boophis viridis*
**Paracophyla tuberculata*
Platypelis pollicaris
**Mantella aurantica*
Mantidactylus blommersae
Mantidactylus flavobrunneus
Mantidactylus opiparis
Mantidactylus tornieri
Boophis erythrodactylus
Boophis hilleni
Boophis miniatus
Boophis rappoides
Boophis untersteini

Reptiles

Several of the following are records provided by C. Raxworthy (*in litt.*, 4.12.86).

**Lygodactylus guibei*
**Phelsuma flavigularis*
Phelsuma lineata
Uroplatus fimbriatus
Brookesia theili
**Brookesia therezieni*
Chamaeleo nasutus
Chamaeleo parsonii
Chamaeleo willsii
Amphiglossus melanopleura
Pararhadinea albignaci
Pararhadinea melanogaster
Micropisthodon ochracheus
Liopholidophis stumpffi
Liopholidophis thieli

Nonmarine Crustacea

Isopoda:

Suarezia differens
Philoscia reducta
Bethalus bipunctatus
Calmanesia erinaceus
Didima humilis
Armadillo otion
Akermania hystrix

NAME Réserve **d'ANALABE**

MANAGEMENT CATEGORY IV (Managed Nature Reserve).

LEGAL PROTECTION Private land. Status unknown.

DATE ESTABLISHED Reserve management and status under revision since 1984.

GEOGRAPHICAL LOCATION The centre of the reserve is at 19°29'S, 44°34'E; 60 km north of Morondava. The reserve is bounded to the north by sisal plantations around the village of Beroboka sud; there is no other clearly defined limit. The eastern edge of the reserve is close to a permanent lake and marsh system.

ALTITUDE Entirely below 100 m above sea level.

AREA Unclear; somewhere in the range 2000 to 12 000 ha.

LAND TENURE Private land owned by the de Heaulme family.

PHYSICAL FEATURES The reserve lies on the Morondava coastal plain; the land is flat with depressions forming seasonal or permanent marshes or lakes. Soil is sandy and water retention following rains is low. Annual rainfall is in the region of 700-1500 m, almost all of which falls from November to February, with most in January. Mean annual maximum temperature is

31.1°C, mean annual minimum temperature 18.9°C. The reserve extends to the Mozambique Channel and includes some mangrove and beach features. There is evidence of many seasonal stream beds.

VEGETATION Mainly dry western deciduous forest. Notable trees include baobab *Adansonia grandidieri* and tamarind *Tamarindus indica*. There is also thorny and succulent bush and scrub. There are many lianes and the undergrowth can be very dense. Average tree height is low, with the canopy generally at 10-13 m, though baobabs can reach 15 m.

ZONING The reserve is split by the remains of a sisal plantation. Plans have been drawn up by the owner, J de Heaulme, to divide the reserve into three parcels. One would be a strict nature reserve, the second a parcel for scientific research and the third for tourism.

CONSERVATION MANAGEMENT A reserve manager was present until early 1986; currently (1987) there is no effective management.

DISTURBANCES OR DEFICIENCIES The reserve is unprotected at present. Incursions for tavy cultivation are being made and there is a high risk of damage from bush fires which burn surrounding forest annually. Tracks for oil exploration have been cut through the forest on a 5 km grid system; these have made the reserve very vulnerable to exploitation, particularly for fuel wood. Fuel wood collection does not appear to be very extensive at present but is expected to increase. Hunting, principally for *Tenrec ecaudatus* and *Hypogeomys antimena*, occurs throughout the reserve; its current impact is unknown, though may not be very great (D. Curl *in litt.* to S. O'Connor, 27.7.86). There is evidence of burning along the roads and burned patches for small agricultural plots were seen 100 m off the road; wood is taken out of the reserve.

SCIENTIFIC RESEARCH Little at present.

VISITOR AND SCIENTIFIC FACILITIES Under consideration. Plans exist to renovate existing houses and plantation buildings to provide lodges and a conservation education centre; a research centre may also be included in the development plans.

PRINCIPAL REFERENCE MATERIAL

Nicoll, M.E. and Langrand, O. (1987). Report on the first phase of WWF - Protected areas programme in Madagascar. Unpd. report, 62 pp.

STAFF None at present.

BUDGET Unknown.

LOCAL PARK OR RESERVE ADMINISTRATION None; the reserve is owned by J. de Heaulme, B.P. 37, Taolanaro.

FAUNA

Birds

Records are from O. Langrand (unpublished data, *in litt.*, 28.10.86) and S. O'Connor and M. Pidgeon (pers. comm., 10.10.86).

Lophotibis cristata
Anas bernieri
Aviceda madagascariensis
Haliaeetus vociferoides
Polyboroides radiatus
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Falco zoniventris
Margaroperdix madagarensis
Mesitornis unicolor
Turnix nigricollis
Dryolimnas cuvieri
Charadrius thoracicus
Pterocles personatus
Streptopelia picturata (R)
Treron australis
Coracopsis vasa (R)

Coracopsis nigra (R)
Agapornis cana
Cuculus rochii
Coua gigas
Coua coquereli
Coua cristata
Coua ruficeps
Centropus toulou (R)
Otus rutilus (R)
Ninox superciliaris
Asio madagascariensis
Caprimulgus madagascariensis (R)
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Leptopterus madagascarinus (R)
Eurystomus glaucurus (R)
Leptosomus discolor (R)
Mirafra hova
Phedina borbonica (R)
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus madagascariensis
Hypsipetes madagascariensis (R)
Vanga curvirostris
Falculea palliata
Leptopterus viridis
Leptopterus chabert
Leptopterus madagascarinus (R)
Copsychus albospecularis
Acrocephalus newtoni
Nesillas typica
Cisticola cherina
Newtonia brunneicauda
Neomixis tenella
Terpsiphone mutata (R)
Nectarinia notata (R)
Nectarinia souimanga (R)
Zosterops maderaspatana
Ploceus nelicourvi
Ploceus sakalava
Lonchura nana (R)
Dicrurus forficatus (R)

Mammals

Lemur fulvus
Lepilemur ruficaudatus
Microcebus murinus
Microcebus coquereli
Mungotictis striata
Tenrec ecaudatus
Propithecus verreauxi
Phaner furcifer
Cheirogaleus medius
Hypogeomys antimena
Cryptoprocta ferox

Reptiles

Pyxis planicauda
Erymnochelys madagascariensis
Oplurus cuvieri
Acrantophis dumerilii
Leioheterodon madagascariensis
?Leioheterodon geayi
Chamaeleo verrucosus
Chalaradon madagascariensis

NAME **BERENTY** Reserve

MANAGEMENT CATEGORY IV (Managed Nature Reserve).

LEGAL PROTECTION The reserve is privately owned, though is held in a trust which should ensure long-term protection.

DATE ESTABLISHED 1930s; precise date unknown.

GEOGRAPHICAL LOCATION 24°50'S, 46°20'E. Near Amboasary and 80 km from Taolanaro (Fort Dauphin).

ALTITUDE Ca 0-30 m.

AREA Berenty Reserve is composed of 5 parcels, comprising some 250-265 ha in total. Parcel 1 (known as Malaza) is 200 ha, parcel 2 ca 20 ha, parcel 3 ca 12 ha, parcel 4 ca 2 ha, parcel 5 (Anjapolo) is 20-30 ha. In addition the 97 ha forest of Bealoka some 7 km north of Berenty is to be incorporated into the reserve system.

LAND TENURE Owned by the de Heaulme family.

PHYSICAL FEATURES The reserve is situated in a sisal plantation and is bordered by the Mandrare River.

VEGETATION Parcel 1 consists of a corridor of spiny forest dominated by Euphorbiaceae, Didiereacae and crassulids, with gallery forest with *Acacia* and *Tamarindus* close to the river; parcels 2 and 5 consist of spiny forest; parcel 3 is a planted forest of *Pithecelobium dulce* mixed with old Acacia and Tamarind trees; parcel 4 is a 2 ha sacred spiny forest with tombs. Bealoka consists of degraded gallery forest.

ZONING None.

CONSERVATION MANAGEMENT Reportedly well protected, being fenced and guarded. Little active management takes place at present.

DISTURBANCES AND DEFICIENCIES Principal problems are: river flooding and river bank erosion, with areas of river bank up to 20 m wide having been lost from parts of the reserve since the 1960s; mature tree die-off, mainly affecting *Tamarindus, Acacia* and *Nestina*, the causes of which are unknown; poor regeneration in many parts of the forest, due to invasion of the rubber vine *Cissus quadrangularis*.

SCIENTIFIC RESEARCH Work has been carried out on the lemurs since the early 1960s, most recently by O'Connor.

VISITOR AND SCIENTIFIC FACILITIES There are guest houses and a museum. A small entrance fee is charged.

PRINCIPAL REFERENCE MATERIAL

Jolly, A. (1966). *Lemur behavior.* Chicago University Press.

Jolly, A., Oliver, W.L.R. and O'Connor, S.M. (1982). Population and troop ranges of *Lemur catta* and *Lemur fulvus* at Berenty, Madagascar: 1980 census. *Folia primatologica* 39(1-2): 115-123.

Mertl-Millhollen, A.S., Gustafson, H.L., Budnitz, N., Dainis, K. and Jolly, A. (1979). Population and territory stability of the *Lemur catta* at Berenty, Madagascar. *Folia primatologica* 31: 106-22.

STAFF The whole reserve is under the control of the manager of the sisal concession in which it is situated. There are four guards in parcel 1, two in parcel 2, one each in parcel 3 and 5, and two at Bealoka.

BUDGET Not known.

LOCAL PARK OR RESERVE ADMINISTRATION See 'staff' above.

FAUNA

Birds

Most of the following species were recorded at Berenty during the period September 1983 - May 1986 by M.S. Pidgeon; additional records were provided by O. Langrand (unpublished data, *in litt.*, 28.10.86).

Ardea humbloti
?Aviceda madagascariensis
Polyboroides radiatus
Accipiter madagascariensis
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Falco zoniventris
Turnix nigricollis
Dryolimnas cuvieri
Pterocles personatus
Streptopelia picturata (R)
Treron australis
Coracopsis nigra (R)
Coracopsis vasa (R)
Agapornis cana
Cuculus rochii
Coua gigas
Coua cristata
Centropus toulou (R)

Otus rutilus (R)
Ninox superciliaris
Caprimulgus madagascariensis
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Ipsidina madagascariensis
Leptosomus discolor (R)
Eurystomus glaucurus (R)
Mirafra hova
Phedina borbonica (R)
Motacilla flaviventris
Coracina cinerea (R)
Hypsipetes madagascariensis (R)
Calicalicus madagascariensis
Xenopirostris xenopirostris
Vanga curvirostris
Falculea palliata
Leptopterus chabert
Leptopterus viridis
Leptopterus madagascarinus (R)
Copsychus albospecularis
Acrocephalus newtoni
Neomixis tenella
Neomixis striatigula
Nesillas typica
Cisticola cherina
Newtonia archboldi
Newtonia brunneicauda
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Nectarinia notata (R)
Lonchura nana (R)
Zosterops maderaspatana
Ploceus sakalava
Foudia madagascariensis (R)
Dicrurus forficatus (R)

Mammals

Lepilemur leucopus
Microcebus murinus
Lemur fulvus
Pteropus rufus
Setifer setosus
Lemur catta
Propithecus verreauxi
Cheirogaleus medius
Tenrec ecaudatus
Eliurus sp

Reptiles

Acrantophis dumerilii
Dromicodryas bernieri
Leioheterodon madagascariensis
Leioheterodon sp.

Captive colonies of *Geochelone radiata* and *Pyxis arachnoides*.

Information used in this account has been kindly provided by Sheila O'Connor and Mark Pidgeon.

VII. OTHER IMPORTANT AREAS

The diversity and degree of endemism of the fauna and flora of Madagascar are such that almost all areas of undegraded natural vegetation on the island will be of considerable biological interest and value. Any selection of areas outside the Réserves Naturelles Intégrales and the National Parks as sites of particular importance will thus to some extent be arbitrary, especially as knowledge of all these sites (as indeed of the protected areas themselves) is more or less incomplete.

In terms of diversity of both animal and plant species, the most important areas are undoubtedly those with surviving low to mid-altitude rain forest; these are most extensive in the north-east of the island, from around 14°S to 18°S, although rain forest still persists along the length of the eastern escarpment to the far south. Identification of areas of particularly high diversity requires further study: Perrier de la Bathie noted (in *La végétation malgache* 1921, Marseille and Paris) that the whole of the eastern rain forest, to an altitude of ca 800 m, formed a single highly complex formation with essentially the same facies. Vegetatively the forest varied very little from north to south, but somewhat more so from east to west, this latter being almost certainly a reflection of increasing altitude. Floristic composition did appear to change somewhat, with gradual replacement of species by equivalent congeners, which however left the appearance and structure of the forest unchanged; the implication is that species diversity also remains relatively unchanged. Variations in faunistic composition are less clear; although, for example, more bird species appear to have been recorded in the northern half of the rain forest belt than in the southern half, this may well be a product of greater observer effort - the diverse avifaunas recorded recently at ca 21°S at Ranomafana (q.v.) and at ca 24°S in R.N.I. No.11 (Andohahela) tend to bear this out.

The following sites or regions have, however, had attention drawn to them in the literature or have emerged in the compilation of this report as areas of particular richness or interest; they should still be considered as examples or indicators.

RAIN FOREST AREAS

FORESTS OF MAROANTSETRA

Forests in this area (the Antongil Bay region) include those of Ambohitsitondrona, Beanana and Ambohivoangy. Records cited from 'Ahitsitondrona' are thought to refer to Ambohitsitondrona. Strict protection of remaining forest areas here was advocated in the Proceedings of the 1970 Conference on Conservation in Madagascar.

FAUNA

Birds

Ardeola idae (R)
Lophotibis cristata
Aviceda madagascariensis
Eutriorchis astur
Circus maillardi (R)
Accipiter madagascariensis
Accipiter francesii (R)
Falco zoniventris
Mesitornis unicolor
Canirallus kioloides
Sarothrura insularis
Actophilornis albinucha
Glareola ocularis
Alectroenas madagascariensis
Coracopsis vasa (R)
Coracopsis nigra (R)
Agapornis cana
Coua delalandei (Ex)
Coua serriana
Coua reynaudii
Otus rutilus (R)
Asio madagascariensis
Caprimulgus enarratus
Zoonavena grandidieri (R)
Ipsidina madagascariensis
Brachypteracias leptosomus

Brachypteracias squamiger
Atelornis pittoides
Leptosomus discolor (R)
Philepitta castanea
Neodrepanis coruscans
Phedina borbonica (R)
Coracina cinerea (R)
Phyllastrephus madagascariensis
Phyllastrephus zosterops
Phyllastrephus tenebrosus
Tylas eduardi
Calicalicus madagascariensis
Schetba rufa
Vanga curvirostris
Xenopirostris polleni
Leptopterus madagascarinus (R)
Oriolia bernieri
Euryceros prevostii
Hypositta corallirostris
Copsychus albospecularis
Monticola sharpei
Neomixis tenella
Neomixis viridis
Neomixis striatigula
Oxylabes madagascariensis
Mystacornis crossleyi
Acrocephalus newtoni
Nesillas typica
Randia pseudozosterops
Newtonia amphichroa
Newtonia brunneicauda
Pseudobias wardi
Terpsiphone mutata (R)
Nectarinia notata (R)
Zosterops maderaspatana
Lonchura nana (R)
Foudia omissa
Saroglossa aurata

Mammals

Propithecus diadema
Hapalemur griseus
Indri indri
Varecia variegata
Phaner furcifer
Oryzorictes talpoides
Microgale talazaci

Reptiles

Brookesia thieli
**Typhlops ocularis*
Lycodryas betisleanus
Chamaeleo linotus
Geodipsas infralineata

Nonmarine Molluscs

Boucardicus beananae (Maroantsetra)
**Boucardicus nanus* (Ambohivoangy)
Ampelita cerina (Maroantsetra)
Ampelita fulgurata (Ambohitsitondrona)
Ampelita lamarei (Ambohitsitondrona, Ambohivoangy)
Ampelita lanx (Ambohivoangy)
Ampelita stragulum (Maroantsetra, Ambohivoangy)
Kalidos feneriffensis (Maroantsetra)
Kalidos hestia ('Ahitsitondrona')
Kalidos humbloti (Ambohivoangy)
Kaliella ahitsitondronae ('Ahitsitondrona')
Clavator moreleti (Maroantsetra)
Helicophanta amphibulima (Maroantsetra)
Fauxulus millotti (Ambohitsitondrona)
Acroptychia aequivoca (Ambohivoangy)
**Cyclotus millotti* (Ambohivoangy)
Macrochlamys stumpfi (Ambohivoangy)
Tropidophora goudotiana (Ambohitsitondrona, Ambohivoangy, Beanana)
Tropidophora perinetensis (Ambohivoangy)
Tropidophora pulchella (Ambohitsitondrona)
Tropidophora tricarinata (Ambohitsitondrona, Ambohivoangy, Beanana)
Trochonanina millotti ('Ahitsitondrona')
**Omphalotropis arbusculae* (Ambohivoangy)

MASOALA PENINSULA

The Masoala Peninsula lies to the east of Antongil Bay and is contiguous with the preceding area. Réserve Naturelle Intégrale No. 2 was situated in the north-eastern part of the peninsula, covering an area of 27 682 ha within the limits 15°17'-15°24'S and 50°13-50°30'E; it was de-gazetted in 1964.

FAUNA

Birds
Most of the following species have been recorded by O. Langrand (*in litt.*, 28.10.86).

Lophotibis cristata
Aviceda madagascariensis
Eutriorchis astur
Polyboroides radiatus
Accipiter henstii
Accipiter madagascariensis
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Falco zoniventris
Margaroperdix madagarensis
Mesitornis unicolor
Turnix nigricollis
Dryolimnas cuvieri
Canirallus kioloides
Sarothrura insularis
Streptopelia picturata (R)
Treron australis (R)
Alectroenas madagascariensis
Coracopsis vasa (R)
Coracopsis nigra (R)
Agapornis cana
Cuculus rochii (R)
Coua serriana
Coua reynaudii
Coua cristata
Coua caerulea
Centropus toulou (R)
Tyto soumagnei
Otus rutilus (R)
Asio madagascariensis
Caprimulgus madagascariensis (R)
Caprimulgus enarratus
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Ipsidina madagascariensis
Eurystomus glaucurus (R)
Brachypteracias leptosomus
Brachypteracias squamiger
Atelornis pittoides
Atelornis crossleyi
Leptosomus discolor (R)
Philepitta castanea
Neodrepanis coruscans
Phedina borbonica (R)
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus madagascariensis
Phyllastrephus zosterops
Hypsipetes madagascariensis (R)
Calicalicus madagascariensis
Schetba rufa
Vanga curvirostris
Xenopirostris polleni
Leptopterus viridis
Leptopterus chabert
Leptopterus madagascarinus (R)
Oriolia bernieri
Euryceros prevostii
Hypositta corallirostris
Tylas eduardi
Copsychus albospecularis
Monticola sharpei
Nesillas typica
Newtonia brunneicauda
Neomixis tenella
Neomixis viridis
Neomixis striatigula
Pseudobias wardi
Terpsiphone mutata (R)
Oxylabes madagascariensis
Mystacornis crossleyi
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Ploceus nelicourvi
Foudia madagascariensis (R)
Foudia omissa
Lonchura nana (R)
Saroglossa aurata

'SIHANAKA FOREST'

This is the name given by explorers to that part of the eastern rain forest, from the eastern coast to the Mangoro valley, east and south of Lake Alaotra, and in particular in the hinterland of Toamasina, especially between the towns of Didy and Fito. As discussed in the data sheet for *Eutriorchis astur*, (see Appendix 3.A), this name is technically a misnomer as the Sihanaka people live to the west of the rain forest proper, which is inhabited by the Betsimisaraka. As with the forests of Maroantsetra, this term cannot be applied precisely to a geographical entity, but rather to remaining areas of forest in the region.

A number of threatened rain forest birds are best known from this region, and preservation of the remaining forest here is strongly advocated as a vital step in the conservation of these species.

FAUNA

Birds

Lophotibis cristata
Aviceda madagascariensis
Eutriorchis astur
Accipiter henstii
Falco zoniventris
Mesitornis unicolor
Sarothura insularis
Gallinago macrodactyla
Coracopsis nigra (R)
Coua serriana
Coua reynaudi
Tyto soumagnei
Otus rutilus (R)
Asio madagascariensis
Caprimulgus enarratus
Ipsidina madagascariensis
Brachypteracias leptosomus
Brachypteracias squamiger
Atelornis pittoides
Atelornis crossleyi
Leptosomus discolor (R)
Philepitta castanea
Neodrepanis coruscans
Neodrepanis hypoxantha
Phyallastrephus zosterops
Phyllastrephus tenebrosus
Phyllastrephus cinereiceps
Tylas eduardi
Schetba rufa
Xenopirostris polleni
Oriola bernieri
Hypositta corallirostris
Copsychus albospecularis
Monticola sharpei
Neomixis tenella
Neomixis viridis
Hartertula flavoriridis
Oxylabes madagascariensis
Mystacornis crossleyi
Crossleyia xanthophrys
Dromaeocercus brunneus
Newtonia amphichroa
Newtonia fanovanae
Pseudobias wardi
Zosterops maderaspatana

RANOMAFANA

Ranomafana (21°16'S, 47°28'E) is situated ca 45 km north-east of Fianarantsoa in central-eastern Madagascar. A 1969 inventory of the forest domain of Madagascar quotes a forested area of 22 730 ha shared by the adjacent cantons of Ranomafana and Tsaratanana. This forest was not accorded any protected status at that time and the extent of surviving forest is unclear. This is the only site where *Hapalemur simus* is definitely known to survive, and the otherwise rarely recorded *Lemur rubriventer* has been described as 'abundant' here (P. Wright *in litt.* to S. O'Connor and M. Pidgeon, 22.08.86). Six threatened bird species have been recorded here since 1984 and for several Ranomafana marks a southern extension of the known range. N.B. There are at least two other localities named Ranomafana in eastern Madagascar. The following records were provided by O. Langrand and M. Nicoll (*per* O. Langrand, *in litt.*, 24.12.86).

FAUNA

Birds

Aviceda madagascariensis
Polyboroides radiatus
Accipiter henstii
Buteo brachypterus
Falco newtoni (R)
Mesitornis unicolor
Dryolimnas cuvieri
Canirallus kioloides
Sarothrura insularis
Streptopelia picturata (R)
Treron australis (R)
Alectroenas madagascariensis
Coracopsis vasa (R)
Coracopsis nigra (R)
Cuculus rochii (R)
Coua reynaudii
Coua caerulea
Centropus toulou (R)
Otus rutilus (R)
Asio madagascariensis
Caprimulgus madagascariensis (R)
Caprimulgus enarratus
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Ipsidina madagascariensis
Eurystomus glaucurus (R)
Brachypteracias leptosomus
Atelornis pittoides
Atelornis crossleyi
Leptosomus discolor (R)
Philepitta castanea
Neodrepanis coruscans
Phedina borbonica (R)
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus zosterops
Phyllastrephus cinereiceps
Phyllastrephus madagascariensis
Hypsipetes madagascariensis (R)
Calicalicus madagascariensis
Schetba rufa
Vanga curvirostris
Xenopirostris polleni
Leptopterus madagascarinus (R)
Leptopterus viridis
Leptopterus chabert
Tylas eduardi
Copsychus albospecularis
Monticola sharpei
Acrocephalus newtoni
Nesillas typica
Cisticola cherina
Dromaeocercus brunneus
Dromaeocercus seebohmi
Newtonia brunneicauda
Neomixis tenella
Neomixis viridis
Neomixis striatigula
Pseudobias wardi
Terpsiphone mutata (R)
Oxylabes madagascariensis
Crossleyia xanthophrys
Mystacornis crossleyi
Nectarinia souimanga (R)
Nectarinia notata (R)
Zosterops maderaspatana
Ploceus nelicourvi
Foudia omissa
Foudia madagascariensis (R)
Lonchura nana (R)
Dicrurus forficatus (R)

Mammals

Cheirogaleus major
Microcebus rufus
Avahi laniger
Propithecus diadema
Hapalemur simus
Lemur fulvus
Lemur rubriventer
Lepilemur sp
Fossa fossana
Galidia elegans
Galidictis fasciata
Cryptoprocta ferox
Hemicentetes semispinosus
Setifer setosus
Tenrec ecaudatus
Microgale thomasi
Nesomys rufus
Brachytarsomys albicauda

Amphibians

Heterixalus alboguttatus
Anodonthyla boulengeri
Plethodontohyla notostica
Mantidactylus liber
Mantidactylus blommersae
Boophis hillenii

Reptiles

Zonosaurus aenus
Chamaeleo nasutus
Phelsuma lineata
Zonosaurus sp
Chamaeleo brevicornis
Sanzinia madagascariensis

NON RAIN FOREST AREAS

ANKARANA MASSIF/AMBILOBE KARST

This area, in the far north of the island (ca 13°S, 49°E) is sometimes known as the Ankara, under which it has been declared a special reserve of 18 220 ha, set up in 1956 (not to be confused with the Namoroka- Kelifely-Ankara karst in Mahajanga province, part of which is R.N.I. 8).

The area, the northernmost sizeable karst area on the island, has the longest known cave system in Madagascar - the Grotte d'Andrafiabé, which has been extensively surveyed[1].

FAUNA

Birds

Ardeola idae (R)
Lophotibis cristata
Anas bernieri
Polyboroides radiatus (R)
Streptopelia picturata (R)
Mesitornis variegata
Actophilornis albinucha
Pterocles personatus
Nesillas typica

Mammals

Lemur fulvus
Fossa fossana
Lemur coronatus

Reptiles

Homopholis boivini
Lygodactylus rarus
**Chamaeleo petteri*
Androngo allaudi
Ramphotyphlops braminus
Liophidium therezieni
**Lygodactylus expectatus*
**Phyllodactylus homalorhinus*
Amphiglossus waterloti
Androngo elongatus
Pseudoxyrhopus microps

The area is also an important refuge for the Nile Crocodile *Crocodylus niloticus.*

Nonmarine Crustacea
Nine species of amphipods were collected in the area by the 1981 Southampton University Expedition, four of them new to science:

Amphipoda

Caridina parvocula sp nov.
Caridina unca sp nov.
Caridina nilotica
Parisia dentata sp nov.
Parisia microphthalma
Caridina crurispinata sp nov.
Caridina norvestica
Caridina isaloensis
Parisia macrophthalma

Nonmarine Molluscs

Tropidophora cuvieriana
Tropidophora deliciosa
Tropidophora deshayesiana
Tropidophora humberti
Tropidophora milloti
Tropidophora surda siana
Helicophanta socii
Kalidos humbloti

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1 Southampton University Madagascar Expedition 1981 Final Report. Unpd, 136 pp.; Radofilao, T. (1977). *Ann. Univ. Madagascar Serie Sci, Nat. and Math,* 14: 195-204.

ANKARATRA MASSIF

The Ankaratra is a volcanic massif situated about 70 km south of Antananarivo (see Part I.2.iv.). As early as 1950, much of the primary forest which originally covered the massif had already disappeared, and the rest was going fast. In view of the importance of this area, both botanically and zoologically, and the urgent need for a zoological inventory, efforts were being made between 1947 and 1958 by the staff of I.R.S.M. to collect material from the remaining wooded areas.

Within the massif is situated the Manjakatompo forest station, which contains a vestige of natural high altitude forest, a pinetum, and clear streams (populated with introduced trout) and lakes. There are all-year tracks, one leading to the summit of Tsiafajavona, at 2643 m the highest point in the massif.

FAUNA

Birds

Anas melleri
Buteo brachypterus
Margaroperdix madagarensis
Leptosomus discolor (R)
Mirafra hova
Motacilla flaviventris
Monticola sharpei
Nesillas typica
Dromaeocercus seebohmi
Newtonia brunneicauda
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Zosterops maderaspatana
Lonchura nana (R)
Foudia madagascariensis (R)
Foudia omissa

Mammals

Microgale dobsoni

Amphibia (those marked *(M)* recorded at Manjakatompko)

Plethodontohyla tuberata (M)
Tomopterna labrosa
Mantidactylus domerguei (M)
Boophis erythrodactylus (M)
Boophis williamsi (M)
**Pseudohemisus pustulosus*
Mantidactylus aerumnalis
Mantidactylus pauliani (M)
Boophis microtympanum

Reptiles

**Millotosaurus mirabilis*
Phyllodactylus homalorhinus
Pseudoxyrhopus imerinae
Phelsuma barbouri
Mabuya madagascariensis

Nonmarine molluscs (all from Manjakatompo)

Clavator bathiei
Sitala amabilis
Sitala gaudens
Clavator moreleti
Macrochlamys stumpfii
Vitrina madagascariensis
Acroptychia aequivoca

Crustacea (blind endemic species, recorded at Manjakatompo)

Isopoda:

Styloniscus albidus
Didima humilis
Microcercus rotundifrons
Microcercus mascarenicus
Akermania sylvatica
Suarezia differens
Ankaratridium caecum
Armadillo ankaratrae
Bethalus carinatus

also recorded:

Brycoyclops ankaratranus (forest of Ambahona)
Astacoides madagascariensis caldwelli

LAKE IHOTRY

This lake, situated at 21°59'S, 43°36'E, just south of the Mangoky River, is cited as an area of considerable importance for waterbirds. Four threatened birds occur here, two, *Tachybaptus pelzelnii* and *Ardea humbloti* associated with the lake, and two, *Monias benschi* and *Uratelornis chimaera*, occurring in subdesert habitat adjacent to the lake.

FAUNA

Birds

Tachybaptus pelzelnii
Ardea humbloti
Lophotibis cristata
Anas bernieri
Aviceda madagascariensis
Polyboroides radiatus
Circus maillardi (R)
Accipiter henstii
Accipiter madagascariensis
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Falco zoniventris
Monias benschi
Turnix nigricollis
Actophilornis albinucha
Pterocles personatus
Streptopelia picturata (R)
Treron australis (R)
Coracopsis nigra (R)
Coracopsis vasa (R)
Agapornis cana
Coua gigas
Coua cursor
Coua ruficeps
Coua cristata
Centropus toulou (R)
Ninox superciliaris
Caprimulgus madagascariensis (R)
Ipsidina madagascariensis
Uratelornis chimaera
Leptosomus discolor (R)
Phedina borbonica (R)
Phyllastrephus madagascariensis
Hypsipetes madagascariensis
Calicalicus madagascariensis
Xenopirostris xenopirostris
Leptopterus chabert
Copsychus albospecularis
Neomixis tenella
Neomixis striatigula
Acrocephalus newtoni
Thamnornis chloropetoides
Newtonia brunneicauda
Newtonia archboldi
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Zosterops maderaspatana
Ploceus sakalava
Dicrurus forficatus (R)

ZOMBITSE FOREST

The Zombitse Forêt Classée covers 21 500 ha on gently undulating hills which form the western slopes of a sandstone dome. Soils are sandy with a very thin humus layer. There are no water courses in the forest although it acts as an important watershed, feeding springs that form tributaries of the Tehaza River which supplies extensive rice paddies 25 km south of Sakaraha. Climate is dry tropical with annual rainfall of ca 750 mm (maximum in December) and a dry season from May to October characterised by morning fog and heavy dew. The forest is the southernmost western domain dry deciduous forest. Canopy is dense, around 15-20 m tall, and is dominated by *Securinega seyrigii*, *Cedrelopsis grevii*, *Commiphora arofy*, *Khaya madagascariensis* and *Euphorbia anterophora*. Herbaceous strata are very weakly developed. Illegal forestry was carried out from 1974 to 1981, using modern techniques and materials; all exploitable timber species were taken and Hazomalanga *Hernandia voyroni* (Hernandiaceae) has completely disappeared from the canopy. Exploitation has continued using traditional techniques to produce charcoal and building planks. Route Nationale 7 crosses the forest and most disturbance appears to be concentrated here.

The Zombitse Forest holds one of only two or three known tiny populations of *Phyllastrephus apperti* and *Monticola bensoni* has been recorded there in the non-breeding season. The gecko *Phelsuma standingi* is also confined to the region.

FAUNA

Birds

Aviceda madagascariensis
Accipiter francesii (R)
Buteo brachypterus
Falco newtoni (R)
Falco zoniventris
Margaroperdix madagarensis
Turnix nigricollis
Dryolimnas cuvieri
Pterocles personatus
Streptopelia picturata (R)
Treron australis
Coracopsis vasa (R)
Coracopsis nigra (R)
Agapornis cana
Cuculus rochii
Coua gigas
Coua ruficeps
Coua cristata
Centropus toulou (R)
Otus rutilus (R)
Ninox superciliaris
Caprimulgus madagascariensis (R)
Zoonavena grandidieri (R)
Alcedo vintsioides (R)
Eurystomus glaucurus (R)
Leptosomus discolor (R)
Mirafra hova
Phedina borbonica (R)
Motacilla flaviventris
Coracina cinerea (R)
Phyllastrephus madagascariensis
Phyllastrephus apperti
Hypsipetes madagascariensis (R)
Calicalicus madagascariensis
Vanga curvirostris
Falculea palliata
Leptopterus viridis
Leptopterus chabert
Leptopterus madagascarinus (R)
Copsychus albospecularis
Nesillas typica
Cisticola cherina
Newtonia brunneicauda
Neomixis tenella
Neomixis striatigula
Terpsiphone mutata (R)
Nectarinia souimanga (R)
Zosterops maderaspatana
Foudia madagascariensis (R)
Saroglossa aurata
Dicrurus forficatus (R)

Mammals

Microcebus murinus
Phaner furcifer
Propithecus verreauxi
Lemur catta
Lemur fulvus
Lepilemur ruficaudatus
Cryptoprocta ferox
Tadarida sp.
Tenrec ecaudatus
Setifer setosus
Echinops telfairi
Geogale aurita

Reptiles

Phelsuma standingi

The above information is taken from the report on the first phase of WWF - Protected areas programme in Madagascar, by M.E. Nicoll and O. Langrand.

APPENDIX 1. ENVIRONMENTAL LEGISLATION

Legislation concerning the environment and natural resources both terrestrial and marine in Madagascar has been covered by the Rapport National pour Madagascar by Randrianarijaona and Razafimbelo (1983) prepared under the United Nations Environment Programme Regional Seas Programme; only a summary of such legislation will therefore by presented here.

N.B. Protected area legislation is covered in detail in Part VI.1., regulations covering forestry in Part III.6.

A. SPECIES LEGISLATION.

This is based primarily on the 1933 London Convention and on Ordonnance no. 60-126 of 03.10.60.

The fauna has been divided into three categories (protected, game, vermin) and is now constrained under a series of dispositions controlling hunting and fishing. It is not clear if these have replaced the original tripartite classification or have merely amended it - there seems to have been no repeal of this earlier legislation.

Some species can be captured for commercial ends, others only under 'exceptional circumstances'; such exploitation is controlled by Decrees (mainly no 61-093), which lay down the means, time and area of capture. Capture for scientific ends is generally authorized under the payment of a tax proportional to the scientific value of the species concerned (law 71-006).

Some threatened species cannot be captured for any reason. In particular lemurs benefit from special restrictions on their being kept in captivity (Decree no 62-020).

i. Protected Species

All lemuriens	*Dugong dugon*
Egretta gazetta dimorpha	*Egretta alba melanorhynchus*
Bubuculus ibis ibis	*Phoenicopterus ruber*
Phoenicopterus minor	*Lophotibis cristata*
Testudo yniphora	*Testudo radiata*
Acrantophis madagascariensis	*Acrantophis dumerili*
Typhleotris madagascariensis	*Typhleotris pauliani*

All newly introduced species, notably deer.

ii. Vermin

All *Falco, Buteo, Astur*	
Milvus migrans	*Milvus parasitus*
Foudia madagascariensis	*Ardea cinerea*
Ardea purpurea	*Corvus albus*
Coracopsis	*Crocodylus niloticus*
'Felis ocreata'	*Galidictis striata*
Galidictis vitata	*Viverricula schlegeli*
Potamochaerus larvatus	*Pteropus rufus*

N.B. Nomenclature follows that given in relevant ordonnances

B. INTERNATIONAL AGREEMENTS

Madagascar has affiliated to the following international treaties and conventions, concerned with the environment:

i. World Heritage Convention — 6 Feb 1983 (Ratified)
[As of 1986, no Madagascan sites had been formally proposed for inclusion as World Heritage Sites.]

ii. Bonn Convention on Migratory Species — Signed but not ratified

iii. 1933 African Convention — 9 Oct 1969 (Ratified)

iv. 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) — 18 Nov 1975 (Ratified)

The following species and groups of species which occur in Madagascar are listed in the Appendices to the CITES conventions. Trade in Appendix 1 species (or their products) is subject to strict regulation by ratifying nations, with trade for primarily commercial purposes banned; trade in Appendix 2 species is subject to monitoring by ratifying nations.

APPENDIX I	APPENDIX II
MAMMALIA	
All Lemurs	*Cryptoprocta ferox*
Dugong dugon	*Eupleres goudotii*
	Eupleres major
	Fossa fossa
AVES	
	Anas bernieri
	All Falconiformes
	All Psittaciformes
Tyto soumagnei	Strigiformes (except that on Ap I)
REPTILIA	
Geochelone radiata	Testudinidae (except those on Ap I)
Geochelone yniphora	
All Cheloniidae	
Crocodylus niloticus	
Acrantophis spp	*Phelsuma* spp
Sanzinia madagascariensis	*Chamaeleo* spp
PLANTS	
	Pachypodium spp.
	Cactaceae
	Cyatheaceae
	Cycadaceae
	Didieraceae
	Euphorbia spp
	Aloe spp
	Orchidaceae

APPENDIX 2. FAUNAL LISTS

Annotated lists of species for the following groups are provided:

Birds, divided into endemics (country and regional) and non-endemics;

Mammals (all native non-marine species);

Reptiles (all native species);

Amphibians (all native species);

Fish (endemic species and subspecies);

Lepidoptera (Rhopalocera except family Hesperidae);

Molluscs (freshwater and endemic terrestrial species);

Nonmarine Crustacea (selected groups);

These lists serve (together with data sheets for individual species in Appendix 3) as adjuncts to Part V, where the references used in their compilation can be found.

Slightly different formats have been adopted for each group, though this, and any abbreviations used, are explained at the beginning of each list.

MADAGASCAR BIRDS

1. ENDEMIC

(R) indicates endemic to Madagascan region; all others are endemic to Madagascar. Threatened species are treated in detail in Appendix 3.

Family PODICIPEDIDAE

Tachybaptus pelzelnii — Madagascar Little Grebe
INSUFFICIENTLY KNOWN: Common and widepread in recent past, suffered considerable decline around Antananariavo, Lake Alaotra, Lake Ihotry. Widespread but no longer common anywhere. Sealevel - 1800 m; absent only from subdesert in south.

Tachybaptus rufolavatus — Alaotra Grebe
ENDANGERED: Known chiefly from Lake Alaotra in north-east; also from west, although validity of many records away from L. Alaotra is questionable. Is in irreversible process of disappearing through hybridisation with T. ruficollis.

Family ARDEIDAE

Ardeola idae (R) — Madagascar Pond-heron
Occurs throughout; generally considered commoner in west than east. Winters in East and Central Africa; massive recent decline in only well known breeding area (ca 1500 birds in 1945, 50 in 1974) may also have occurred elsewhere. Also on Seychelles.

Ardea humbloti — Madagascar Heron
INDETERMINATE: Very thin distribution in west, chiefly in coastal and adjacent areas; rarely in east. Only 4 breeding sites found: north, central west, south-west, off south-west coast.

Family THRESKIORNITHIDAE

Lophotibis cristata — Madagascar Crested Ibis
Widespread species; western subspecies widespread and common, eastern subspecies shows adaptability: recorded from secondary forest and plantations. Recorded from at least six protected areas.

Family ANATIDAE

Anas bernieri — Madagascar Teal
VULNERABLE: Little known, much persecuted, known from few sites on west coast only, total numbers probably very low.

Anas melleri — Meller's Duck
Most frequently recorded east (from Vondrozo north to Andapa and on central plateau), though also recorded in west. Often hunted. Common in some localities but has suffered an apparent marked decline recently. Introduced Réunion and Mauritius.

Aythya innotata — Madagascar Pochard
ENDANGERED: Poorly known, confined to lakes of north-central plateau, especially Lake Alaotra (but no records from there since 1930s). Also Lake Itasy, Lake Ambohibao, near Antsirabe, Ambatomainty, and Betsileo country.

Family ACCIPITRIDAE

Aviceda madagascariensis — Madagascar Cuckoo-falcon
Widely distributed in a variety of habitats; uncommon though probably overlooked. Nestlings eaten and adults snared at nest.

Haliaeetus vociferoides — Madagascar Fish-eagle
ENDANGERED: Central west coast to North. Main areas: between Antseranana and Nosy Bé, Lake Kinkony, Antsalova, coastline between Mangoky and Fierenana rivers. Population most recently estimated at around 30 pairs.

Eutriorchis astur — Madagascar Serpent Eagle
ENDANGERED: Very poorly known, last seen by ornithologist 50 years ago. Humid east, dense rain forest. Ampa Simanavy (in Mangoro Valley), Rogez, Maroantsetra, Farafangana, Marojejy Reserve (possible records only). Extremely rare.

Polyboroides radiatus — Madagascar Harrier-hawk
Widely distributed in variety of wooded habitats and open country. Fairly common except centre, extreme north, south, and south-west. Adapted to degraded/secondary woodland.

Circus maillardi (R) — Madagascar Harrier
Rare; marshes and grassland of east and west; reported as locally fairly common (Lake Ihotry, near Vohimarina). Also Réunion and Anjouan.

Accipiter hensti — Henst's Goshawk
Widely distributed in variety of habitats but uncommon and in decline. Treated as harmful species under government decree, still in force.

Accipiter madagascariensis — Madagascar Sparrowhawk
Largely confined to areas below 1000 m; extremely rare in east, uncommon in west, somewhat commoner in subdesert south-west. Forest, open woodland, wooded savanna.

Accipiter francesii (R) — Frances's Sparrowhawk
Common in dry and humid and even degraded forest throughout. Most common in north-east. Also on Comoros. On government list of harmful species. 0-1800 m.

Buteo brachypterus — Madagascar Buzzard
Common throughout, most records from east, locally abundant. Prefers savanna, forest edges, adapted to exploited/degraded forest. 0-1800 m.

Family FALCONIDAE

Falco newtoni (R) — Madagascar Kestrel
Reasonably common throughout especially central plateau; prefers open areas to dense forest; found in degraded habitat and cultivated areas. Commonest raptor. Also on Aldabra. On government list of harmful species. 0-2000 m.

Falco zoniventris — Banded Kestrel
Widely distributed but rare, may be commonest in north-east and south-west. Probably overlooked. Treated as harmful species under government decree, still in force. Forest, wooded savanna, cultivated areas. Insectivorous.

Family PHASIANIDAE

Margaroperdix madagarensis — Madagascar Partridge
Widely distributed except dense forest, south-west and south. Up to 2500 m in Tsaratanana Massif. Rice, savanna, afforestation areas, secondary woodland. Common but diminishing through hunting. Introduced Réunion and Mauritius (now extinct on latter).

Family MESITORNITHIDAE

Mesitornis variegata — White-breasted Mesite
RARE: Terrestrial forest bird, currently known from only two sites: Ankarafantsika, which is, however a protected area, and north-east of Morondanva. In past known from near Tsarakibany and perhaps in the Analalava and Haut-Sambirano.

Mesitornis unicolor — Brown Mesite
INSUFFICIENTLY KNOWN: Rainforest, perhaps wider distribution than known, possibly throughout East. Most reliable records from circle with diameter Antananarivo to Toamasina and from south-east corner.

Monias benschi — Subdesert Mesite
RARE: Terrestrial, restricted range in subdesert (south-west) between Mangoky and Fierenana rivers. Sea level to 130 m. Common over much of range, at times abundant.

Family RALLIDAE

Mentocrex kioloides — Grey-throated Rail
(= Canirallus kioloides)
East from Manombo north to the north-west (Sambirano); reaches central high plateau (1450 m). Common in humid forest (1 pair per km: Périnet). Can adapt to secondary woodland.

Sarothrura insularis — Madagascar Flufftail
East, north-west (Sambirano), north (Mt. d'Ambre). Secondary brush/grassland on forest edge. 0-2300 m. Commonest in East.

Sarothrura watersi — Slender-billed Flufftail
INSUFFICIENTLY KNOWN: Recorded from 3 widely separated areas: south-east Betsileo (south-centre), Andapa (north-east), Antananarivo. Small swamps (association with Cyperus).

Dryolimnas cuvieri — White-throated Rail
Rather common throughout in forests. 0-1800 m, but rare above 1100 m. Edges of marshes and streams. Commonest north-west and humid eastern forest. Rarer on central plateau.

Rallus madagascarienesis — Madagascar Rail
East, north-east (Andapa) and central plateau. 0-1800 m. Commoner at higher altitudes. Few records.

Amaurornis olivieri — Sakalava Rail
INSUFFICIENTLY KNOWN: Rare and localised; known from only three widely separated areas in the Sakalava country in west. Recorded from Antsalova, Ambaratabe, Tsiribahina River, Nosy Ambositra. Marshes and streams.

Family TURNICIDAE

Turnix nigricollis — Madagascar Buttonquail
Widespread and common in variety of open habitats, especially high plateau. 0-1900 m. Introduced to Mauritius and Réunion.

Family JACANIDAE

Actophilornis albinucha — Madagascar Jacana
Centre-east (from Mahanoro north); north-east, north-west, west down to Tuléar; north-central plateau. Commonest in west, north-west and north-east; less recorded from forested east, where it occurs in forest clearings and rice-cultivation areas.

Family GLAREOLIDAE

Glareola ocularis — Madagascar Pratincole
East from Fianarantsoa to north-east, north-west, northern savanna and west (Bekipay and Mangoky). Migratory to Africa. Rocks on perennial rivers, beaches, river edges.

Family CHARADRIIDAE

Charadrius thoracicus — Madagascar Plover
RARE: Restricted to coastal grassy areas of south-west though first described in east. Population probably under 1000.

Family SCOLOPACIDAE

Gallinago macrodactyla — Madagascar Snipe
East, central plateau (as far west as Sakay), north (Tsaratanana) up to 2700 m. Common (2 pairs per hectare at Tampoketsa d'Ankazobe) but status needs watching since habitat disturbed by rice growing.

Family PTEROCLIDIDAE

Pterocles personatus — Madagascar Sandgrouse
West: common from Taolanaro (south-east) to north-west. Extends beyond Sambirano (between Amabanja and Antseranana). Sandy dry plains, savanna, sparsely wooded regions.

Family COLUMBIDAE

Alectroenas madagascariensis — Madagascar Blue Pigeon
Most records from north (Sambirano, Tsaratanana, Andapa and Mt. d'Ambre). Also from length of the east. Common in dense forests, commoner in east than west where it migrates March-July. Numbers at Périnet reduced by hunting.

Streptopelia picturata (R) — Madagascar Turtle Dove
Throughout east, west, subdesert (south-west), common in forest, brushland, plantations; less so in open areas. 0-2000 m. Also on Comoros, Aldabara, Chagos. Introduced Seychelles, Mauritius, Réunion, Amirantes.

Treron australis (R) — Madagascar Green Pigeon
Very common in wooded areas, 0-1000 m. Absent from high plateau. Hunted. Also Comoros.

Family PSITTACIDAE

Agapornis cana — Grey-headed Lovebird
Very wide distribution in a variety of habitats. Common throughout, but particularly in lower and less arid areas. Uses cultivated areas, rice fields, degraded forest.

Coracopsis vasa (R) — Greater Vasa Parrot
Widespread. Woodland east, west, south, including degraded. Prefers coastal plains 0-1000 m. Visits cultivated areas. Common. Also Anjouan, Réunion. On government list of harmful species.

Coracopsis nigra (R) — Lesser Vasa Parrot
Common throughout; woodland (including degraded) preferring denser forest and brush than C. vasa, thus less common in west than C. vasa. 0-2050 m. Also Comoros, Seychelles. On government list of harmful species.

Family CUCULIDAE

Coua caerulea — Blue Coua
East from Taolanaro to Sambirano (north-west) with relict population in dry wood at Bora (Antsohihy). Rain forest but also mangroves. 0-1800 m.

Coua cristata — Crested Coua
Wide distribution in variety of habitats; predominance of records from west and centre, less from humid east where its presence marks a south- ward extension coinciding with rain forest destruction.

Coua verreauxi — Verreaux's Coua
Highly restricted, only in dry south-west, between Fierenana and Menarandra rivers, but fairly common; occurs within Lake Tsimanampetsotsa Nature Reserve. Confined to area of thick coastal scrub on coral rag.

Coua reynaudii — Reynaud's Coua
Common in eastern rainforest from Manombo north to north-east and Sambirano as far west as Mandraka in centre. Relict population in dry forest at Bora (Antsohihy). Up to 2500 m.

Coua serriana — Red-breasted Coua
Northern part of humid east (one old record from south-east) from Sihanaka to Sambava. Common in its limited range. 0-1000 m.

Coua ruficeps — Red-capped Coua
West from Faux Cap north to Mampikony in 2 discrete populations; south-west and west around Mahajanga. Less common in extreme south. Adaptable to degraded regions. Also in dry forest, savanna, sandy areas.

Coua cursor — Running Coua
West from Morondava south to Cap Ste. Marie. Desert brush, dry forest. 0-160 m.

Coua coquereli — Coquerel's Coua
West from Sakaraha north to Maromandia. Incursions into south-west sub-desert and Sambirano. Rarely in degraded forest. Common but local.

Coua gigas Giant Coua
West: Toliara north to Mampikony. Recent records extend range to Berenty and Andohahela in south-east, west of Taolanaro. 0-700 m. Dry forest areas. Primary habitat only, not in degraded zones. Rather common in some areas.

Coua delalandei Snail-eating Coua
EXTINCT: Known chiefly from Nosy Borah (Ile Sainte-Marie) (north-east); no precise records from mainland. Forest dweller, subsisting on molluscs.

Cuculus rochii Madagascar Little Cuckoo
Widespread and quite common, only absent from driest part of south; wooded areas savanna and marshes, 0-1800 m. Migrates from east to west (and on to Africa) during rainy season.

Centropus toulou (R) Madagascar Coucal
Common and widespread in wooded and brush areas throughout except for treeless central plateau regions where less recorded (though common at Sahavondronina). 0-1800 m. Prefers less dense wooded areas; also in marshland and degraded woodland. Also on Mayotte, Aldabra.

Family TYTONIDAE
Tyto soumagnei Madagascar Red Owl
INDETERMINATE: Known with certainty from humid rainforest only in centre-East; seen only once in past 50 years. Recorded from circle whose diameter runs between Toamasina and Antananarivo.

Family STRIGIDAE
Otus rutilus (R) Madagascar Scops Owl
Reported as common, scattered records from a wide area in forest/brushlands including partially exploited forest. Also on Comoros. 0-1800 m.

Ninox superciliaris White-browed Owl
All records from west and south-west between Ampotaka and Morondava except one from Marojejy. Not rare, forest and wooded savanna.

Asio madagascariensis Madagascar Long-eared Owl
Mostly in centre-east forest, as far west as Antananarivo. Also recorded west savanna (Tabiky) and Maromandia. 0-1800 m. Rather rare but probably overlooked.

Family CAPRIMULGIDAE
Caprimulgus enarratus Collared Nightjar
All records except two (Taolanaro and unknown locality in south-east) from centre-east and north-west (Sambirano) from dense evergreen forest. 0-1800 m. Quite common.

Caprimulgus madagascariensis (R) Madagascar Nightjar
East from Ambodiasy north to Antseranana. Records also from Antananarivo area, Mampikony and Toliara, Sakaraha, Lac Ihotry (west). Can adapt to degraded areas; forest and open brush. Also on Aldabra.

Family APODIDAE
Collocalia francica (R) Mascarene Swiftet
Rare; East coast. Also on Mauritius and Réunion.

Zoonavena grandidieri (R) Madagascar Spinetail
Widely distributed forest dweller. 0-1000 m, common especially at lower altitudes. South-east, north-east, west, south-west; commonest in east. Also on Grand Comoro.

Family ALCEDINIDAE
Alcedo vintsioides (R) Madagascar Malachite Kingfisher
(= Corythornis vintsioides)
Common east and west (and recorded from subdesert). No strict association with water. 0-1800 m. Found in degraded woodland, afforestations and on tideline. Also on Comoros.

Ipsidina madagascariensis Red and White Kingfisher
(= Ceyx madagascariensis)
Widely distributed except extreme south-west; largest concentrations of records in centre. Quite common in east, rarer in west. Common on Mt. d'Ambre and Sambirano. 0-1800 m.

Family LEPTOSOMATIDAE
Leptosomus discolor (R) Courol
Widely distributed. Common in east in forests and secondary brush; in west and subdesert only found in denser savanna and wooded plains. 0-2000 m. Uses degraded areas of forest. May migrate to west during humid season. Also Mayotte, Anjouan.

Family BRACHYPTERACIDAE
Eurystomus glaucurus (R) Broad-billed Roller
Found throughout, September to April, migrates to Africa for remainder of year. Plentiful even in east. Also on Comoros, Aldabra, vagrant to Réunion and Rodrigues.

Brachypteracias leptosomus Short-legged Ground-roller
RARE: Occurs in 2 discrete areas: north-east (Marojejy to around Maroantsetra) and centre-east (chiefly Sihanaka forest). Deep rainforest. Like all Ground-rollers probably overlooked.

Brachypteracias squamigera Scaly Ground-roller
RARE: Deep rainforest in centre and north-east: Marojejy, Andapa, Maroantsetra, Masoala, Soamiana, Sihanaka forest, Périnet, Rogez and perhaps in South-east. 0-1800 m.

Atelornis pittoides Blue-headed Ground-roller
Formerly regarded as rare, now known to be widespread from Mt. d'Ambre in north to Châines Anosyennes in south and as far west as Mandraka. Occurs in several reserves. Dense evergreen forest.

Atelornis crossleyi Rufous-headed Ground-roller
RARE: Confined to deep rainforest in east, with records scattered from Tsaratanana Massif south to Vondrozo region. Rarest and least known Ground-roller.

Uratelornis chimaera Long-tailed Ground-roller
RARE: Restricted range within subdesert (South-west) between Mangoky and Fierenana rivers, ranging up to 80 m; distribution coincides with that of Didierea woodland, within which it may be locally abundant.

Family PHILEPITTIDAE
Philepitta castanea Velvet Asity
Common throughout east from Taolanaro north to north-west (Sambirano). As far west as heights of Mandraka where not rare. 0-1800 m. Can adapt to secondary/exploited woodland.

Philepitta schlegeli Schlegel's Asity
Confined to west (from Tsiandro north) and Sambirano; old north-east record. Dense forest, localised, but common in Sambirano.

Neodrepanis coruscans Sunbind Asity
East from Vondrozo north to Tsaratanana. Locally common in many places. 0-1800 m. Favours higher altitudes. Moves out into dense secondary brush.

Neodrepanis hypoxantha Yellow-bellied Sunbird Asity
INDETERMINATE: East, centre in forests east and perhaps south of Antananarivo and the Sihanaka forest. Known only from 13 specimens collected before 1930, and records of breeding in 1973 and 1976.

Family ALAUDIDAE
Mirafra hova Madagascar Bush Lark
Widespread and common especially south-west and centre uplands in open ground, into forest clearings, degraded forest. 0-2500 m.

Family HIRUNDINIDAE

Phedina borbonica (R) Mascarene Martin
Fairly common but irregular distribution throughout east, west, subdesert. Breeding up to 2200 m (Tsaratanana). Forest, including degraded and afforestation areas. Also Réunion, Mauritius, vagrant to Seychelles. Migratory north to south.

Family MOTACILLIDAE

Motacilla flaviventris Madagascar Wagtail
Widespread, except for south and south-west. Especially common on high plateau up to 2600 m. Cultivated ground, exploited forest, paddy fields. Possibly seasonal migrant.

Family CAMPEPHAGIDAE

Coracina cinerea (R) Madagascar Cuckoo-shrike
Common throughout in a variety of habitats, including degraded areas, up to 2300 m. Occurs in mixed species foraging groups. Also on Comoros.

Family PYCNONOTIDAE

Hypsipetes madagascariensis (R)Madagascar Bulbul
One of commonest birds, found in forest and brush throughout. 0-2500 m. Uses degraded habitat, afforestation areas. Also on Mayotte, Anjouan, Moheli, Aldabra, Seychelles.

Phyllastrephus cinereiceps Grey-crowned Greenbul
RARE: Possibly occurs throughout rainforests of east but known from only a few scattered sites. Inhabits ground cover of deep rainforest. Recorded from Fianarantsoa, Sihanaka forest, Fanovana, Ranomafana.

Phyllastrephus tenebrosus Dusky Greenbul
RARE: Recorded from only 3 areas in the east (Sihanaka forest, Périnet-Analamazaotra and Maroantsetra). May be overlooked. Probably confined to primary rainforest.

Phyllastrephus zosterops Short-billed Greenbul
East from near Vondrozo north to Mt. d'Ambre (including Tsaratanana). Dense humid forest plus secondary woodland. Variable in abundance throughout range.

Phyllastrephus apperti Appert's Greenbul
RARE: Known from only one locality (Zombitsy forest south-east of Ankazoabo) in south-west. Local and sparse within known range. Dense dry forest.

Phyllastrephus madagascariensis Long-billed Greenbul
Widespread: east from Taolanaro to Antalaha; west from Vohemar to Toliara (including Sambirano). Common. Uses secondary woodland. Absent from central massif.

Family VANGIDAE

Calicalicus madagascariensis Red-tailed Vanga
East, Tsaratanana, north-west (Sambirano), south-west: common (less so in west); forest and woodland including partially exploited. Occurs in mixed species foraging groups. 0-2050 m.

Schetba rufa Rufous Vanga
East (from Vondrozo north to Andapa), west (from Sakaraha to Mahajanga area). Forest bird, locally common but absent from many places. Greatest density in primary forests.

Vanga curvirostris Hook-billed Vanga
Widespread and fairly common throughout east and west in wooded areas/forest into degraded/secondary growth, mangroves in north-west, plantations. Occurs in mixed species foraging groups.

Xenopirostris xenopirostris Lefresnaye's Vanga
Restricted to south-west subdesert where not uncommon in undergrowth of limestone collines on coast, especially with Didierea bush and Euphorbia.

Xenopirostris damii Van Dam's Vanga
RARE: Known this century only from Ankarafantsika (south-east of Mahajanga) which is however a protected area and where it occurs in fairly good numbers. Previously collected in north-west. Primary deciduous forest.

Xenopirostris polleni Pollen's Vanga
INDETERMINATE: Wide variety of localities in east primary rainforests (although type is from north-west coast). Suspected sight record from Marojejy; all other records from central part of east. Wider range than often stated.

Falculea palliata Sicklebill
Primarily west distribution, but including Berenty (near Taolanaro in South-east), Mt. d'Ambre and Sambava in north-east. Largest concentration of records is from west and south-west. Common, occurs in mixed species foraging flocks. 0-900 m.

Leptopterus viridis White-headed Vanga
(= Artamella viridis)
Widespread in a variety of habitats: woodland, primary humid and dry forest, coastal mangroves, brush, subdesert. Common.

Leptopterus chabert Chabert's Vanga
Widespread throughout east and west (except extreme north and Sambirano). Occurs in secondary/exploited forest, rice paddies and mangroves.

Leptopterus madagascarinus (R) Blue Vanga
(= Cyanolanius madagascarinus)
Common in forest and brush in east, Mt d'Ambre, Sambirano; less common in west, rarer in south ranging into edge of subdesert. Uses degraded habitat. 0-1800 m. Occurs in mixed species foraging groups. Also on Comoros (Moheli). Perhaps locally migratory.

Oriolia bernieri Bernier's Vanga
Treated as Indeterminate in previous Red Data Book but widely distributed in rain-forests. Probably overlooked in tree tops. Occurs in mixed species foraging groups. 500-1000 m.

Euryceros prevostii Helmet Bird
Local, total population may be low: primary forest in humid east from Fanovana to Andapa; never in degraded areas.

Tylas eduardi Tylas Vanga
Occurs in the east from Vondrozo north to Tsaratanana (west to Andrangolsaka). Discrete western population found around Morondava south to south-east of Ankazoabe; rare in west, perhaps a mangrove dweller. In east in dense forest. Nowhere common.

Hypositta corallirostris Coral-billed Nuthatch-Vanga
Occurs in the east from Taolanaro north to Marojejy. Not rare, evergreen rainforest, near sea level - 1800 m. Possibly commoner at higher altitudes.

Family MUSCICAPIDAE

Copsychus albospecularis Madagascar Magpie Robin
Common throughout, especially in wooded areas/forest edges, neighbouring brush, even in interior of evergreen forest, and exploited/degraded areas.

Monticola sharpei Forest Rockthrush
(= Pseudocossyphus sharpei)
Found in the east from Ivohibe north to Mt. d'Ambre, west to Massif d'Itremo and Tsaratanana. Locally common: dense forest including secondary woodland, also high plateau grassland. 100-2200 m.

Monticola imerina Littoral Rockthrush
(= Pseudocossyphus imerina)
Local south-west (Mangoky) to Taolanaro (south-east). Common. Dunes, dry grassland with Euphorbia and Didierea, not in forest.

Monticola bensoni — Benson's Rockthrush
(= Pseudocossyphus bensoni)
INSUFFICIENTLY KNOWN: probably quite widespread but as yet known only from a few dry rocky areas in south-west: Mangoky river region and north of Isalo massif. Keeps mostly to rocks/cliff faces.

Neomixis striatigula — Stripe-throated Jery
East (north to Andapa) and South-west. Two subspecies: forest from Fanovana north to Andapa in upland areas, 800-1800 m. More common southern subspecies extends as far east as Fianarantsoa.

Neomixis viridis — Green Jery
East from Ivohibe north to Tsaratanana. All records from inland areas 1000-2050 m. Often in damp, mossy forest. Not very common.

Neomixis tenella — Common Jery
Widespread and common. Records from all areas (few in central plateau) and variety of habitats, wooded subdesert, rainforest, severely degraded secondary woodland. 0-1200 m.

Hartertula flavoriridis — Wedge-tailed Jery
Uncommon, east rainforests, stronghold Sihanaka forest; other records Vondrozo, Lakata (presumably Lakato), Périnet-Analamazaotra Special Reserve, Bejofo-Bealanan, Tsaratanana Nature Reserve.

Oxylabes madagascariensis — Yellow-browed Oxylabes
Rather common east, north-east, north (Mt. d'Ambre) from Manombo (with old record from Taolanaro). Most records from within circle whose diameter is Antananarivo-Toamasina. Dense rainforest. 0-1800 m.

Mystacornis crossleyi — Crossley's Babbler
East from Manombo north to Andapa. Common, especially away from coast and at higher altitudes in dense humid forest. 0-1800 m. Occurs in foraging parties of mixed species.

Acrocephalus newtoni — Madagascar Swamp Warbler
Widespread and rather common east, north-west, west, central massif; marshes, mangroves, rivers. 0-1800 m.

Crossleyia xanthophrys — Madagascar Yellowbrow
INDETERMINATE: Confined to rainforest in centre-east with one record from north (Tsaratanana). Seen only twice in past 50 years but possibly overlooked.

Nesillas typica — Madagascar Brush Warbler
Widespread and common; absent only from extreme South-east. Most records are from East, North, North-west. Variety of habitats; primary forest, brush, severely degraded secondary forest. 0-2750 m.

Thamnornis chloropetoides — Kiritika
Restricted to south-west subdesert but common. Cap Sainte-Marie north to Lake Ihotry. Shrub, brush, small trees, often Euphorbia and Didierea in sandy, arid area.

Cisticola cherina — Madagascar Cisticola
Common and widespread through variety of habitats. Most records are from east between Faroany river and Mohambo and from central massif. 0-2000 m. Savanna, partially exploited primary forest, swamp, cultivated areas, shoreline.

Dromaeocercus seebohmi — Grey Emu-tail
Humid east from Ankaratra to Tsaratanana at altitude, 900-2600 m. Common. Bushes, marshes, rivers.

Dromaeocercus brunneus — Brown Emu-tail
Centre-east rainforest. Fairly common in Périnet-Analamazaotra Special Reserve; locally abundant in Sihanaka forest, Fierenana forest and even partially exploited forest at Nangarana.

Randia pseudozosterops — Rand's Warbler
Rainforest. Originally considered very rare, now known to be commoner and fairly widespread. Also occurs in secondary woodland. Occurs in mixed species foraging groups.

Newtonia brunneicauda — Common Newtonia
Widespread and common. Occurs in east from Manombo to Mt. d'Ambre and in west down to Ampotaka (south-west). Uses degraded woodland. 0-2000 m.

Newtonia amphichroa — Dark Newtonia
Humid east from Ivohibe north to Mt. d'Ambre (two specimens from south-west were perhaps wrongly labelled). Not common. Dense forest. 500-1800 m.

Newtonia archboldi — Archbold's Newtonia
Restricted to south-west and not common; Ampotaka north to Lake Ihotry in brush, low forest; often found in Euphorbia and Didierea brush.

Newtonia fanovanae — Red-tailed Newtonia
INDETERMINATE: Known only from single specimen from humid forest, now cleared, in east-centre. If it is not an invalid taxon based on an aberrant bird, it is either overlooked, genuinely rare or extinct.

Pseudobias wardi — Ward's Flycatcher
Occurs in east from Ivohibe north to Tsaratanana. Only a few records but reported as not uncommon. Dense humid forest. 170-1800 m.

Terpsiphone mutata (R) — Madagascar Paradise Flycatcher
Widespread and common in all areas and variety of woodland habitat (included exploited forest). 0-2000 m. Also on Comoros, Seychelles, Mascarenes and Réunion.

Family NECTARINIIDAE

Nectarinia notata (R) — Madagascar Green Sunbird
Fairly common east and west forest and brush, including degraded woodland and central plateau. Less common in south-west. Prefers coastal plain to forested mountain slopes but found up to 1800 m. Less common than N. souimanga. Also Comoros.

Nectarinia souimanga (R) — Souimanga Sunbird
Common in east and west in forest and brush, including degraded woodland. High altitudes bushes (2300 m in Tsaratanana massif) to subdesert undergrowth. Also on Aldabra, Iles Glorieuses.

Family ZOSTEROPIDAE

Zosterops maderaspatana — Madagascar White-eye
Widespread and abundant in wooded areas throughout including exploited/degraded forest and afforestation areas.

Family ESTRILDIDAE

Lonchura nana (R) — Madagascar Mannikin
(= Lepidopygia nana)
Widespread and common, most records from east, north of Sahavandronina (Fianarantsoa) to Tsaratanana. Also in west as far south as Toliara. 0-2000 m. Primary forest, exploited, cultivated areas. Also on Mayotte.

Family PLOCEIDAE

Ploceus nelicourvi — Nelicourvi Weaver
East from Manombo north to north-west (Sambirano) and north-east; evergreen forest: unexploited, partially exploited and exploited. Fairly common. 0-1800 m.

Foudia sakalava — Sakalava Weaver
Three discrete populations; localised, often absent from apparently suitable areas. South-west, north-centre (around Mahajanga), north-east (Antseranana): forest and wooded savanna, mangroves. Locally very common.

Foudia madagascariensis (R) Madagascar Fody
West, east, subdesert. Common. 0-2000 m Especially in open brushy ground, remnant woodlands, clearings, afforestation areas. On government list of harmful species because of rice damage. Hybridizes with F. omissa. Also on Réunion and Mauritius, Rodrigues.

Foudia omissa Forest Fody
Restricted to humid east as far as Manombo and north (Antseranana); hybridizes with F. madagascariensis. Extends to central plateau (Manjakatompo); forest, sometimes degraded, rice fields. 0-1800 m.

Family STURNIDAE
Saroglossa aurata Madagascar Starling
(= Hartlaubius auratus)
East, north, west as fas as Tsiandra; common, occurring in forest, secondary woodland, wooded savanna, wood edges, near cultivated areas. 0-1800 m. More common on coastal plain than inland.

Family DICRURIDAE
Dicrurus forficatus (R) Crested Drongo
Widespread throughout wooded areas. Rather common even in open country, uses degraded woodland. Rare above 1000 m, absent central plateau. Also Comoros.

II. NON-ENDEMIC BIRD SPECIES

(B) indicates breeding species
(I) indicates introduced species

Podicipedidae
Tachybaptus ruficollis (B) Little Grebe
Common throughout and expanding.

Diomedeidae Black-browed Albatross
Diomedea melanophris
Very rare accidental to South.

Procellariidae
Macronectes giganteus Giant Petrel
Accidental to east, south-east, south.

Pachyptila vittata Broad-billed Prion
Very rare accidental to east, north-east.

Puffinus pacificus (B) Wedge-tailed Shearwater
Rare breeder (on islands near Morombe); visitor to north-east.

Hydrobatidae
Oceanites oceanicus Wilson's Petrel
Visitor to south, south-east and east; common Apr-July.

Fregatta tropica Indian Ocean Black-bellied Petrel
Accidental to south, south-east and east.

Phaethontidae
Phaethon aethereus Red-billed Tropicbird
Very rare accidental.

Phaethon lepturus (B) White-tailed Tropicbird
Rare in south, south-east and west. Breeds Antseranana.

Phaethon rubricauda Red-tailed Tropicbird
Fairly regular accidental.

Sulidae
Sula sula Red-footed Booby
Rare visitor; breeds Iles Glorieuses, Europa, Tromelin.

Sula leucogaster Brown Booby
Rare visitor; breeds Iles Glorieuses.

Phalacrocoracidae
Phalacrocorax africanus (B) Long-tailed Cormorant
Rather common throughout; 0-1500 m.

Anhingidae
Anhinga rufa (B) African Darter
Rather common throughout; 0-1400 m.

Pelecanidae
Pelecanus rufescens (B)? Pink-backed Pelican
Occasional in west; may breed.

Fregatidae
Fregata minor Great Frigatebird
Visitor to east and west coasts.

Fregata ariel Lesser Frigatebird
Very rare, accidental north, north-west and east.

Ardeidae
Ixobrychus minutus (B) Little Bittern
Occurs throughout but rather rare. 0-1000 m.

Nycticorax nycticorax (B) Night Heron
Rather common, throughout but localised. 0-1500 m.

Butorides striatus (B) Green-backed Heron
Rather common throughout. 0-750 m. Less common in west, becoming rarer in south.

Ardeola ralloides (B) Squacco Heron
Rather common throughout, particularly in west. 0-1800 m.

Bubulcus ibis (B) Cattle Egret
Common, found throughout. 0-1800 m.

Egretta ardesiaca (B) Black Egret
Rare and localised, north and centre.

Egretta gularis (B) Western Reef Heron
Widespread other than in dense forest or extensive savanna.

Egretta alba (B) Great White Egret
Rather rare though widespread breeder. 0-800 m.

Ardea cinerea (B) Grey Heron
Rather common throughout, except for east. 0-1400 m.

Ardea melanocephala Black-headed Heron
Rare straggler to West.

Ardea purpurea (B) Purple Heron
Common breeder, 0-1800 m. Normally away from coast.

Ardea goliath Goliath Heron
Very rare straggler to west.

Scopidae
Scopus umbretta (B) Hamerkop
Common breeder throughout, 0-1800 m. Numbers declining for no obvious reason.

Ciconiidae
Anastomus lamelligerus (B) Openbill
Rather common throughout except in east. 0-1200 m.

Mycteria ibis (B) Yellow-billed Stork
Mainly west and south-west, also centre (especially Lake Alaotra).

Threskiornithidae
Plegadis falcinellus (B) Glossy Ibis
Common throughout but numbers declining. 0-1500 m.

Threskiornis aethiopica (B) Sacred Ibis
Rather rare, rivers south-west, west, north-west.

Platalea alba (B) African Spoonbill
Rare breeder in west and north.

Phoenicopteridae
Phoenicopterus ruber (B) Greater Flamingo (B)
Localised in west. Breeds in L. Tsimanampetsotsa and L. Ihotry.

Phoeniconaias minor (B) Lesser Flamingo (B)
Rather common south-west and west, breeds L. Ihotry.

Anatidae
Dendrocygna bicolor (B) Fulvous Tree Duck
Rather common but localized; declining through hunting.

Dendrocygna viduata (B) White-faced Tree Duck
Common throughout, 0-1500 m; commonest duck on Madagascar.

Sarkidiornis melanota (B) Knob-billed Goose
Rather common especially in west. 0-1200 m. Declining throughout.

Nettapus auritus (B) Dwarf Goose
Rather common throughout.

Anas erythrorhynchos (B) Red-billed Teal
Common throughout, 0-1500 m.

Anas hottentota (B) Hottentot Teal
Rather common througout, 0-1800 m.

Thalassornis leuconotus (B) White-backed Duck
Rather rare though found throughout (except at altitude), 0-1000 m. Lakes, marshes.

Accipitridae
Milvus migrans (B) Yellow-billed Kite
Common throughout especially centre and west, less so east and south-west. 0-2000 m.

Macheiramphus alcinus (B) Bat-eating Hawk
Throughout forests but rather rare. Wooded savanna, dense forest with cliffs.

Falconidae
Falco eleonorae Eleanora's Falcon
Uncommon, winter visitor. Records from wide area.

Falco concolor Sooty Falcon
Rather rare migratory visitor, (December-April) mostly in west and south-west.

Falco peregrinus (B) Peregrine
Resident, rare but throughout. 0-1000 m. Small endemic subspecies.

Phasianidae
Coturnix coturnix Common Quail
Local, north, north-west, centre, east. 0-1500 m. Migrates from Africa, no definite evidence of breeding.

Coturnix delegorguei (B) Harlequin Quail
Breeds; common in north savanna, west and south-west. Open grasslands.

Numididae
Numida meleagris (I) Helmeted Guineafowl
Common in west and south-west; somewhat less so in east. Declining through hunting.

Rallidae
Porzana pusilla (B) Baillons Crake
Breeds, elusive and uncommon though found throughout in humid areas 0-1800 m.

Porphyrio porphyrio (B) Purple Swamphen
Widespread in wetlands and marshes.

Porphyrio alleni (B) Allen's Swamphen
Fairly common breeder in larger marshes, 0-750 m.

Gallinula chloropus (B) Moorhen
Common throughout, 0-1800 m.

Fulica cristata (B) Red-knobbed Coot
Rather common throughout. 0-1800 m.

Rostratulidae
Rostratula benghalensis (B) Painted Snipe
Rather common breeder, though rare in South-west. 0-1200 m.

Recurvirostridae
Himantopus himanotpus (B) Black-winged Stilt
Rather common throughout, 0-750 m. No breeding colony yet located.

Recurvirostra avosetta Common Avocet
Accidental visitor.

Dromadidae
Dromas ardeola (B)? Crab Plover
Rather common west, north-west and north coasts, found throughout year, probably breeds.

Charadriidae
Charadrius hiaticula Common Ringed Plover
Accidental migrant, Oct-Mar.

Charadrius pecuarius (B) Kittlitz's Plover
Common breeder, west and south-west, less so in east. 0-950 m.

Charadrius marginatus (B) White-fronted Plover
Rather common breeder.

Charadrius tricollaris (B) Three-banded Plover
Rather common throughout, 0-1800 m.

Charadrius mongolus Lesser Sand Plover
Rare accidental.

Charadrius leschenaultii Greater Sand Plover
Fairly common migrant.

Pluvialis dominica Lesser Golden-Plover
Accidental visitor.

Pluvialis squatarola Grey Plover
Fairly common migrant, Sept-Apr.

Scolopacidae
Calidris alba Sanderling
Fairly common migrant, Sept-Apr.

Calidria alpina Dunlin
Rare visitor to coasts.

Calidris minuta Little Stint
Vagrant.

Calidris ferruginea Curlew Sandpiper
Fairly common migrant Oct-Mar.

Philomachus pugnax Ruff
Rare migrant.

Limosa limosa Black-tailed Godwit
Rare visitor, recorded north of Antananarivo.

Limosa lapponica Bar-tailed Godwit
Rare migrant Nov-Mar.

Numenius phaeopus Whimbrel
Common migrant Sept-April.

Numenius arquata Eurasian Curlew
Uncommon migrant Nov-April, has been seen throughout year.

Tringa stagnatilis Marsh Sandpiper
Uncommon migrant to freshwater.

Tringa nebularia Common Greenshank
Rare migrant, usually Nov-March, has been recorded June-Aug.

Tringa ochropus — Green Sandpiper
Vagrant.

Tringa glareola — Wood Sandpiper
Rare migrant in West, Oct-Mar.

Xenus cinereus — Terek Sandpiper
Fairly common migrant Oct-April.

Actitis hypoleucos — Common Sandpiper
Common migrant Aug-Mar.

Arenaria interpes — Ruddy Turnstone
Fairly common migrant Sept-May, some remain through year.

Stercorariidae

Stercorarius parasiticus — Arctic Skua
Rare, west coast.

Stercorarius skua — Great Skua
No information.

Laridae

Larus cirrocephalus (B) — Grey-headed Gull
Rare and local.

Larus novaehollandiae — Silver Gull
No information.

Larus dominicanus — Southern Black-backed Gull
Rather common South-west coast.

Gelochelidon nilotica — Gull-billed Tern
No information.

Sterna caspia (B) — Caspian Tern
Widespread though rare and localised.

Sterna bergii (B) — Swift Tern
Rather common on all coasts except east. Breeds on coastal islands.

Sterna bengalensis (B)? — ?Lesser Crested Tern
Commonest tern on Madagascar. Probably breeds.

Sterna dougallii (B) — Roseate Tern
Erratic visitor to north, north-east and south-west, often in considerable numbers. Breeds Toamasina, Toliara.

Sterna hirundo — Common Tern
Visitor Dec-Jan.

Sterna anaethetus (B) — Bridled Tern
Rare accidental.

Sterna fuscata (B) — Sooty Tern
Breeds Toamasina, Toliara and Iles Glorieuses.

Sterna saundersi — Saunder's Tern
Rather common visitor, Nov-Mar.

Chlidonias hybrida (B) — Whiskered Tern
Rather common but localised, breeds Oct-Nov.

Chlidonias leucopterus — White-winged Black Tern
Migrant visitor to lakes, Dec-Jan.

Anous tenuirostris — Lesser Noddy
Rather common on coasts.

Anous stolidus (B) — Brown Noddy
Rather common on coasts, breeds south of Toamasina and Iles Glorieuses.

Gygis alba — White Tern
Found occasionally on coasts.

Columbidae

Oena capensis (B) — Long-tailed Dove
Common breeder throughout except East, fluctuating population and distribution. 0-1500 m.

Cuculidae

Pachycoccyx audeberti (B) — Thick-billed Cuckoo
Known only from 5 specimens all from East forest Sihanaka - Bay d' Antongil in most densely forested areas. Always uncommon, last collected June 1922. African counterpart can be easily overlooked, so it may still survive.

Tytonidae

Tyto alba (B) — Barn Owl
Rather common, east, north-east, also in west, subdesert. 0-1800 m

Asio capensis (B) — Marsh Owl
East, west into edge of subdesert. 0-1800 m. Quite common but local.

Apodidae

Apus melba (B) — Alpine Swift
Throughout, wide ranging and reasonably common, commonest in north-east. 0-1300 m.

Apus barbatus (B) — African Black Swift
Breeds throughout.

Cypsiurus parvus (B) — African Palm Swift
Rather common, except high plateau and heavy forest. 0-1100 m.

Meropidae

Merops superciliosus (B) — Bee-eater
Common throughout except high plateau and dense forest. Breeds.

Upopidae

Upupa epops (B) — Hoopoe
Distinctive endemic subspecies (U. e. marginata); widespread except dense forest.

Hirundinidae

Riparia riparia — Sand Martin
Winter vagrant.

Riparia paludicola (B) — African Sand Martin
Rather common breeder in east and High Plateau, especially at high altitude (500-2400 m).

Hirundo rustica — Swallow
Irregular west coast winter visitor.

Muscicapidae

Saxicola torquata (B) — Stonechat
Common throughout, especially at altitude. 0-2400 m. Breeds.

Sturnidae

Acridotheres tristis (I) — Indian Mynah
Introduced, common and increasing. Competes with Upupa epops. Avoids altitude and forest; its expansion is an indication of deforestation.

Corvidae

Corvus albus (B) — Pied Crow
Common throughout.

MADAGASCAR MAMMALS

All species are endemic unless otherwise indicated. Lemurs are treated in detail in Appendix 3.

INSECTIVORA

Family TENRECIDAE

Echinops telfairi
Apparently widespread and abundant in the drier, western and southern parts of the island.

Hemicentetes semispinosus
Apparently relatively widespread in the eastern forested regions; apparently occurs at lower altitude than the following species.

Hemicentetes nigriceps
Eastern forests, apparently at higher altitude than the preceding.

Setifer setosus
Apparently widespread and abundant over much of the island.

(The two specimens from the eastern rain forest, named as 'Dasogale fontoynonti' are now known to be aberrant Setifer setosus (M. Nicoll in litt., 28.10.86))

Tenrec ecaudatus
Widely distributed on the island; catholic habitat preferences; introduced to the Comoros, Seychelles, Réunion and Mauritius.

Geogale aurita
Recorded from the north-east (Fenoarivo Atsinanana) and south-west (Toliara and Morondava); Common at Beza Mahafaly.

Limnogale mergulus
Recorded from freshwater streams in eastern Madagascar, including Vohitra, Andranotobaka, Amborompotsy and Antsampandrono. Rare.

Microgale brevicaudata
Known from Mananara (Mahanara) on the north-east coast, 75 km south of Vohemar; possibly a very localized species.

Microgale cowani
Recorded from the Ankafina forest in the eastern Betsileo region and at Andasibe (Analamazaotra).

Microgale crassipes
Known only from the type from Antananarivo (possibly collected from the region of Andrangoloaka, 70 km east of the capital).

Microgale decaryi
Known from near the cave of Andrahomana near Taolanaro.

Microgale drouhardi
Collected from the Antseranana region of northern Madagascar and the Andringitra area in the south-east.

Microgale longicaudata
Recorded from Ankafina, in eastern Betsileo.

Microgale longirostris
Known from Ampitambé in the south-east.

Microgale majori
Known from the Ankafina forest in eastern Betsileo.

Microgale (Paramicrogale) occidentalis
Maintirano, western Madagascar

Microgale parvula
Known from the type specimen collected on the Montagne d'Ambre.

Microgale principula
Recorded from Midongy-du-Sud, south-eastern Madagascar.

Microgale proxilicaudata
Antseranana, northern Madagascar (may be a subspecies of M. longicaudata).

Microgale pusilla
Described from Ikongo forest near Vinanitelo; apparently not rare in museum collections, though reportedly only known from the type locality.

Microgale sorella
Recorded from Beforona forest, near Andevorante in northern Madagascar.

Microgale taiva
Collected in the south-east at Ambohimitombo forest in the Tanala region, north-eastern Betsileo; also known from Périnet and Vondrozo.

Microgale thomasi
Collected from Ampitambé forest, northeastern Betsileo, Ivohimanitra forest (Ambohimanga) in southeastern Madagascar, Périnet, Vondrozo and the forest of Antrangolonka.

Microgale melanorrhachis
Recorded from Perinet and Ivohibe in the east.

Microgale (Nesogale) dobsoni
Collected in Nandesen forest, central Betsileo, also Manjakatompo (Ankaratra massif), Andringitra, Ambohimitambo, Ampitambe and Vinanintelo.

Microgale (Nesogale) talazaci
Collected in forest of Ikongo near Vinanitelo (south of Fianarantsoa) and from Périnet, Maroantsetra, Analapa, Vondrozo and Andapa.

Microgale (Leptogale) gracilis
Reputedly rare, though possibly widespread in central eastern forests. Specimens from the forest of Ambohimitambo (eastern Betsileo), Ankeramadinika, Périnet and Andringitra.

Oryzorictes hova
Recorded from Ankaye and Antsianaka in central Madagascar; also Périnet and the Maroansetra region. Considerable confusion exists between this species and the following.

Oryzorictes talpoides
Recorded from the north-west (the Marovoay plain near Mahajanga) and from the east (Maroantsetra and Périnet); believed not to be rare, and to live in proximity to human habitations.

Oryzorictes (Nesoryctes) tetradactylus
Recorded from Vinanitelo south-east of Fianarantsoa, the high plateaux region, Antsirabé and Andringitra.

Suncus etruscus (=madagascariensis)
NON-ENDEMIC. North African coast and Ethiopia; possibly also West Africa. Madagascan form (also on Comoros) may be separate species.

Suncus murinus
NON-ENDEMIC. North-east coast of Africa from Egypt to Tanzania, also Zanzibar and Comoros. Also widespread in Asia, where probably introduced.

CHIROPTERA

Family PTEROPODIDAE

Eidolon helvum
NON-ENDEMIC. Widespread in the Afrotropical region.

Pteropus rufus
Madagascar; abundant in coastal regions, though otherwise localised (M. Nicoll, in litt., 28.10.86).

Rousettus madagascariensis
Madagascar, apparently from the east; has been included in the widespread R. lanosus though its status as a separate species has been affirmed.

Family EMBALLONURIDAE
Emballonura atrata
Eastern and central Madagascar. The sole member of the genus outside its range in south-east Asia, Malaysia and the South Pacific.

Taphazous mauritianus
NON-ENDEMIC. Widespread in the Afrotropical region.

Family NYCTERIDAE
Nycteris madagascariensis
Madagascar. This may be the Madagascan representative of the widespread Nycteris thebaica.

Family HIPPOSIDERIDAE
Hipposideros commersoni
NON-ENDEMIC. Widespread in the Afrotropical region.

Triaenops furculus
North and western Madagascar, also Aldabra.

Triaenops humbloti
Eastern Madagascar; may be only a colour variant of T. rufus.

Triaenops persicus
NON-ENDEMIC. Afrotropical region and Iran.

Triaenops rufus
Eastern Madagascar.

Family MYZOPODIDAE
Myzopoda aurita
An endemic species in a monotypic family known from few specimens, mostly collected before 1900 and apparently from widely scattered localities mostly in the east of Madagascar (from Taolanaro north to Maroantsetra), though there is a record from Mahajanga in the west.

Family VESPERTILIONIDAE
Eptesicus capensis
NON-ENDEMIC, widespread in the Afrotropical region.

Myotis goudoti
Madagascar, also Anjouan in the Comoros.

Pipistrellus nanus
NON-ENDEMIC, widespread in the Afrotropical region.

Scotophilus nigrita
NON-ENDEMIC, widespread in the Afrotropical region.

Scotophilus robustus
Madagascar. Considered by Hayman and Hill to be perhaps the Madagascan representative of the widespread S. nigrita, though its validity as a separate species has been reasserted.

Scotophilus dinganii
NON-ENDEMIC, widespread in the Afrotropical region; has been included in S. nigrita.

Scotophilus barbonicus
Madagacar and Reunion. Has been stated by Hayman and Hill to perhaps belong to the widespread S. leucogaster, though its validity as a species has been reasserted.

Miniopterus minor
NON-ENDEMIC, widespread in the Afrotropical region.

Miniopterus schreibersi
NON-ENDEMIC; very wide distribution from southern Europe through Africa and Asia to Australia.

Family MOLOSSIDAE
Otomops martiensseni
NON-ENDEMIC, occurs in eastern Africa from Djibouti to Angola and South Africa.

Mormopterus acetabulosus
NON-ENDEMIC, also known from Ethiopia, Réunion, Mauritius and South Africa.

Mops condylurus
NON-ENDEMIC, widespread in the Afrotropical region.

Mops midas
NON-ENDEMIC, widespread in the Afrotropical region.

Tadarida fulminans
NON-ENDEMIC, known from east Africa, as far west as eastern Zaire.

Mormopterus jugularis
Madgascar. Genus has been included in Tadarida.

Chaerophon pumila
NON-ENDEMIC, widespread in the Afrotropical region.

PRIMATES

Family CHEIROGALEIDAE
Allocebus trichotis
Known only from four specimens collected from the eastern forests, most recently in 1965.

Cheirogaleus major
Reportedly fairly abundant in eastern rainforests.

Cheirogaleus medius
Still widespread in the dry, deciduous western and southern forests from the Bay of Narinda to Taolanaro.

Microcebus (Mirza) coquereli
Restricted range in the forests of the west principally between the Onilahy and Fierenana rivers, and also on the Ampasindava Peninsula and the adjoining region.

Microcebus murinus
The most abundant lemur, along with M. rufus, occurring throughout the forested areas of the west, south and south-west from Taolanaro to the Sambirano region; also on Nosy Bé.

Microcebus rufus
Occurs throughout the forests of the eastern region, from Fort-Dauphin to the Montagne d'Ambre. Has been considered a subspecies of M. murinus.

Phaner furcifer
A specialized gum-feeder, occurring principally in the west, though with small populations in the north, east and south.

Family INDRIIDAE
Avahi laniger
Occurs in the eastern and north-western forests.

Indri indri
Restricted to coastal and montane rainforest from sea level to around 1800 m in north-eastern Madagascar, from Antongil Bay in the north to the Masora River in the south. The largest lemur.

Propithecus diadema
Found in forests of the north-east and east.

Propithecus verreauxi
Has a wide distribution in the north-west, west, south-west and south.

Family DAUBENTONIIDAE

Daubentonia madagascariensis
Believed to be more widespread than previously thought in the eastern forests; introduced to Nosy Mangabe where still survives.

Family LEMURIDAE

Hapalemur simus
Apparently known only from humid forest in the Fianarantsoa region, where recently recorded at Ranomafana.

Hapalemur griseus
Found in eastern and north-western forested regions, occurring over a wide altitudinal range.

Lemur catta
Occurs in the dry forests of the south and south-west where it is considered still relatively abundant.

Lemur coronatus
Found in the extreme north of the island as far south in the west as the Ankarana limestone karst and in the east to the Fanambana River.

Lemur fulvus
Widespread in forested regions of the island other than in the extreme south; has been considered conspecific with L. macaco but populations of the two are now known to exist in sympatry in the north and specific distinction is generally upheld.

Lemur macaco
Found in humid forests of the north-west (including the Tsataratanana Massif) and the coastal islands of Nosy Bé and Nosy Komba.

Lemur mongoz
Occurs in north-western Madagascar and on the Comorian islands of Moili and Ndzouani, to which it has almost certainly been introduced.

Lemur rubriventer
Appears to occur throughout the forested interior of the east from the Tsaratanana Massif in the north to the Andringitra massif in the south.

Lepilemur mustelinus
Found in the northern part of the eastern forests between Toamasina and Antalaha.

Lepilemur microdon
Occurs in the southern part of the eastern forests from Périnet to Taolanaro.

Lepilemur leucopus
Found in the dry southern forests from Taolanaro westwards possibly as far as the Onilahy River.

Lepilemur septentrionalis
Occurs in the extreme north, north of Ambilobé and to the south and east of the Montagne d'Ambre.

Lepilemur ruficaudatus
Occurs in the western forests, though limits of range are ill-defined; to the south it occurs at least as far as the Onilahy River and to the north the boundary with L. edwardsi appears to be the Tsiribihina River.

Lepilemur dorsalis
Occurs in the Lokobé forest on Nosy Bé Island and the forests on the north-western coast of Madagascar facing this.

Lepilemur edwardsi
Confined to western Madagascar, from the Bay of Mahajamba south at least as far as Antsalova and possibly to the Tsiribihina River.

Varecia variegata
Occurs in the humid eastern rainforests.

CARNIVORA

Family VIVERRIDAE

Fossa fossana
Apparently widely distributed though at low density in wooded or forested areas in the east.

Eupleres goudotii
Rarely recorded and little known, though reported from the eastern coastal region and the north of the island; known to occur at Périnet.

Galidia elegans
Apparently occurs in wooded areas in the east and west.

Mungotictis lineatus
Inhabits deciduous woodlands on sand in the west and south-west of Madagascar; it is apparently relatively common, even in somewhat degraded areas.

Galidictis striata
Occurs in the eastern rainforests where it is apparently very little known, though according to reports not uncommon.

Salanoia concolor
Known from the eastern rainforests, where it is thought to be rather rare.

Cryptoprocta ferox
Widespread in Madagascar, though apparenly very rare on the central plateau.

RODENTIA

Family CRICETIDAE

Hypogeomys antimena
Known only from the sandy coastal area in the region of Morondava. Burrows and is largely nocturnal.

Macrotarsomys bastardi
Found in dry regions in most of the western part of Madagascar; seems to be limited by the 20° isotherm.

Macrotarsomys ingens
Known from the forest of Ankarafantsika in the north-west of Madagascar; also represented by fossil remains in the south-west of the island.

Nesomys rufus
Eastern rainforests; one specimen was caught in 1928 at Maintirano on the western coast. Diurnal.

Eliurus minor
Eastern rain forests. Originally described from Ampitambe forest in northeastern Betsileo; recently collected at Périnet and in the Maroansetra region. The Eliurus complex is highly variable and probably contains more than two species (M. Nicoll in litt., 28.10.86).

Eliurus myoxinus
Apparently widespread; believed likely to inhabit most of the residual forests in the west and centre of the island as well as the eastern rainforest.

Gymnuromys roberti
Eastern rain forests; originally described from Ampitambe forest in northeastern Betsileo. Seldom caught where Rattus rattus is locally abundant.

Brachytarsomys albicauda
Eastern forest species; strictly arboreal.

Brachyuromys betsiloensis
Recorded from the south-eastern part of the Betsileo region, where it is known from some dozen specimens, and from the Andringitra massif.

Brachyuromys ramirohitra
Recorded from Ampitambe forest in the Betsileo region and from the Andringitra massif.

MADAGASCAR REPTILES

NB. Provisional IUCN categories are cited (see Part V.3); those with an asterisk are quoted from a published IUCN Red Data Book - these species are treated in detail in Appendix 3. Cardinal points are abbreviated N, S, E, W and C (central). Madagascan names, where known, are quoted in single inverted commas. For references see Part V.3.

TESTUDINES

Family TESTUDINAE

Geochelone radiata Shaw, 1802 V*
ENDEMIC. Restricted to Didierea forest occurring in a narrow arc across southern Madagascar; has been recorded from near Amboasary in the south-east to near Morombe in the south-west. 'Sokake'.

Geochelone yniphora Vaillant, 1885 E*
ENDEMIC. Restricted to three forest 'islands' in the vicinity of Baly Bay, including Cape Sada, in northwest Madagascar. 'Angonoka'.

Kinyxis belliana Gray, 1831
Introduced; acclimatised in the northwest, also recorded near Amboasary in the southeast.

Pyxis arachnoides Bell, 1827 I*
ENDEMIC. Restricted to coastal areas (10-20km inland) in the south and south-west, from Morombe in the south-west to Amboasary in the south-east.

Pyxis planicauda (Grandidier, 1867) I* (prob E)
ENDEMIC. Apparently restricted to the Andranomena forest, an area of approximately 100 sq km situated 20km northeast of Morondava on the central-west coast. 'Kapidolo'.

Family CHELONIIDAE

Caretta caretta (Linnaeus, 1758) V*
Nesting occurs particularly in the southeast, around Taolanaro, and with some nesting along the west coast as far north as Morondava. Annual nesting numbers estimated at less than 300. Under pressure from exploitation. 'Ampombo'.

Chelonia mydas (Linnaeus, 1758) E*
Small scale nesting occurs. Exploited, mainly for domestic consumption. 'Fanonjato'.

Eretmochelys imbricata (Linnaeus, 1766) E*
Good numbers still nest, mainly in the northern third of the island and in the southwest, but is heavily exploited and populations have declined to a remnant of former size. An estimated 2500 Hawksbills are taken annually, mainly by the Vezo people of the southwest. 'Fano'.

Lepidochelys olivacea (Eschscholtz, 1829) E*
Nesting has been recorded in the northwest although other reports suggest presence of a feeding population only.

Family DERMOCHELYIDAE

Dermochelys coriacea (Vandelli, 1761) E*
Rare, accidental in Madagascar waters.

Family PELOMEDUSIDAE

Erymnochelys madagascariensis (Grandidier, 1867) I*
ENDEMIC. Present in freshwater habitats at low to moderate altitude in the west and northwest, from the Mangoky River in the southwest, northward to the Sambirano basin west of the Massif de Tsaratanana. Exploited for food by the riverine Sakalava people and others around Lake Kinkony, possibly affected by habitat loss. 'Réré'.

Pelomedusa subrufa (Lacépède, 1788)
Present almost throughout Madagascar. Not eaten. Widespread in Africa. 'Kapika'.

Pelusios castanoides Hewitt, 1931
Almost throughout the western half of Madagascar and along coastal areas in the southeast and east. Eaten locally. Widespread in eastern Africa.

Pelusios subniger (Lacépède, 1788)
Occurs along the eastern littoral; possibly an ancient introduction. Eaten locally. Widespread in south-central and eastern Africa.

CROCODYLIA

Family CROCODILIDAE

Crocodylus niloticus (Laurenti 1768) V*
Reported common in most waters during the nineteenth century, now very diffuse and rare due to persecution and over-exploitation. Widespread in Africa. 'Voay' or 'Mamba'.

SAURIA

Family GEKKONIDAE

Ailuronyx trachygaster (Duméril, 1851)
ENDEMIC. Locality unknown.

Ebenavia inunguis Boettger, 1878
NE, E, SE, SW, St. Marie, Nosy Bé, Nosy Mangabe (etc); also on Comoros and Mauritius. In Réserve du Betampona (Toamasina region). On coastal rocks, under bark, in forests, to 800m. Common on St. Marie.

Geckolepis anomala Mocquard, 1909
ENDEMIC. S.

Geckolepis maculata Peters, 1880
NW, E, W, Nosy Bé; also Comoros. Found in huts, cracks in tree trunks.

Geckolepis petiti Angel, 1942
ENDEMIC. Andranovaho, Mahafaly Prov. Type locality only.

Geckolepis polylepis Boettger, 1893
ENDEMIC. NW, SW, W, St.Marie.

Geckolepis typica Grandidier, 1867
ENDEMIC. NE, SE, SW.

Gehyra mutilata (Wiegmann, 1835)
E; very widespread outside Madagascar. Well known for frequenting human habitation.

Hemidactylus mabouia (Moreau de Jonnès, 1818)
Common throughout; very widespread outside Madagascar. In huts, on coast, low mountains.

Hemidactylus frenatus Duméril et Bibron, 1837
Common throughout; very widespread outside Madagascar.

'Hemidactylus gardinieri' Boulenger, 1909
Listed as synonym of H. mercatorius Gray 1842 in Das Tierreich Gekkonidae checklist; widespread outside Madagascar.

Homopholis antongilensis Böhme & Meier, 1980
ENDEMIC. Antongil Bay area, including Nosy Mangabé.

Homopholis boivini (Dumeril, 1856)
ENDEMIC. Extreme north, between Ambilobe and Antseranana (Diego Suarez). (Removed from synonymy of H. heterolepis, Böhme & Meier, 1980.).

Homopholis sakalava (Grandidier, 1867)
ENDEMIC. Arid SW and W, Ampanihy to Mahajanga. (Removed from synonymy of H. heterolepis (sensu Russell, 1978), Böhme & Meier, 1980; includes in synonymy H. heterolepis Boulenger, 1896.

Lygodactylus arnoulti Pasteur, 1964
ENDEMIC. C - Montagne de l'Ibity, 25km S of Antsirabé, 2150m. Type locality only. Under stones.

Lygodactylus blanci Pasteur, 1967
ENDEMIC. C - Mt. Ibity.

Lygodactylus cowani
ENDEMIC. SW, C, S-C. Synonym: Microscalabotes bivittis (Peters, 1883).

Lygodactylus decaryi Angel, 1930
ENDEMIC. SE - Massif de l'Angavo, Taolanaro Prov. Single specimen only, collected under bark, 400m.

Lygodactylus expectatus Pasteur & Blanc, 1967
ENDEMIC. Ambilobé karst (Ankarana massif), 12km NNW of Ankarana also Antseranana area. Among masses of fallen debris at foot of karst cliffs, in dry vegetation, on rocks. Partly or totally non-arboreal.

Lygodactylus guibei Pasteur, 1964
ENDEMIC. E - Périnet, between Toamasina-Antananarivo. Arboreal. In humid forest.

Lygodactylus heterurus Boettger, 1913
ENDEMIC. Nosy Bé.

Lygodactylus klemmeri Pasteur, 1964
ENDEMIC. NW - Forêt de l'Antsingy.

Lygodactylus madagascariensis (Boettger, 1881)
ENDEMIC. NE, E, SE., inc. Mt. d'Ambre & Sambirano. Arboreal, in humid forest, to 1000m, also rocks, scrub.

Lygodactylus miops Günther, 1891
ENDEMIC. E, SE. East of Antalaha. Arboreal. In humid forest.

Lygodactylus montanus Pasteur, 1964
ENDEMIC. SE-C - summit of Mt. Ivohibe. Three specimens only.

Lygodactylus ornatus Pasteur, 1964
ENDEMIC. NW - Mt. Mandritsara. Known by holotype only.

Lygodactylus rarus Pasteur & Blanc, 1973
ENDEMIC. Eastern cliffs of Ambilobé karst (extreme NE of Ankarana massif) and Mangindramo, and edges of Tsaratanana forested massif 1350m.

Lygodactylus robustus Boettger, 1913
ENDEMIC. S, SE, S-C.

Lygodactylus spinulifer
ENDEMIC. NE, E, SE. Forest species, to 1000m.

Lygodactylus tolampyae (Grandidier, 1872)
ENDEMIC. W, NW.

Lygodactylus tuberifer Boettger, 1913
ENDEMIC. SW, W.

Lygodactylus tuberosus Mertens, 1965
ENDEMIC. Localities unknown.

Lygodactylus verticillatus Mocquard, 1895
ENDEMIC. SE, S, SW. On calcareous littoral rocks, scrub, bushes.

Millotisaurus mirabilis Pasteur, 1962
ENDEMIC. Mt. Tsiafajavona, 2300-2500m. Single locality.

Paragehyra petiti Angel, 1929
ENDEMIC. Lavenombato in Toliara Prov., at foot of calcareous cliffs in Mahafaly area. Single locality?

Phelsuma barbouri Loveridge, 1942
ENDEMIC. E - Forest between Toamasina-Antananarivo, also Tsiafajavona (main summit of Ankaratra massif, SSW of Antananarivo). Arboreal, also on & among rocks on Tsiafajavona. Feeds on small invertebrates.

Phelsuma bimaculata Kaudern, 1922
ENDEMIC. E.

Phelsuma dubia (Boettger, 1881)
NW, SW, W, S-C, Nosy Bé; also in Tanzania. 'Sasaka'.

Phelsuma flavigularis Mertens, 1962
ENDEMIC. E - Périnet (950m) c 100km E of Antananarivo. Type locality only.

Phelsuma guttata Kaudern, 1922
ENDEMIC. NE, E, S.

Phelsuma laticauda (Boettger, 1880)
NW, SE, S, SW, W, Nosy Bé; also Comoros and Seychelles.

Phelsuma lineata Gray, 1831
ENDEMIC. NW, NE, E, SE, C, S-C. Moderately common forest species, found in coastal areas & up to 1100 m, on Agave leaves around Toamasina. Maximum density along east coast. 'Antsiantsy'.

Phelsuma madagascariensis Gray, 1831
NW, N, NE, E, S, SW, W, St. Marie, Nosy Bé; also Seychelles. Very common in Antseranana, common in east and north generally. Enters huts, along littoral in SE, frequent in NW forests.

Phelsuma mutabilis (Grandidier, 1869)
ENDEMIC. NW, SE, S, SW, W, C. Very common in forest along River Onilahy. Found under bark, also in arid scrub. One of smallest Phelsuma, only 3cm snout-vent. 'Tsatsake'.

Phelsuma quadriocellata (Peters, 1883)
ENDEMIC. S, C.

Phelsuma serraticauda Mertens, 1963
ENDEMIC. E - Ivoloina, 12km N of Toamasina. Type locality only.

Phelsuma standingi Methuen et Hewitt, 1913
ENDEMIC. SW: Maroamalona, forests along R. Onilahy.

Phelsuma trilineatum Gray, 1842
ENDEMIC. SW. Locality unknown.

Phyllodactylus androyensis Grandidier, 1867
ENDEMIC. SE, SW, St. Marie. Sunny rocks on coast.

Phyllodactylus barbouri Angel, 1936
ENDEMIC. 'Madagascar', no precise locality.

Phyllodactylus bastardi (Mocquard, 1900)
ENDEMIC. SE, S, SW, W. On sunny rocks on coast, arid scrub, subdesert, to 350m. After P. pictus is most frequently seen species of genus.

Phyllodactylus gracilis (Boulenger, 1896)
ENDEMIC. SW.

Phyllodactylus homalorhinus Angel, 1936
ENDEMIC. N - Ankaratra, Ambilobe Dist., Antseranana Prov. Type locality only.

Phyllodactylus oviceps Boettger, 1881
ENDEMIC. Nosy Bé, Sakatia (islet W of Nosy Bé).

Phyllodactylus pictus (Peters, 1854)
ENDEMIC. SE, S, SW, W. Most frequently seen species of genus. On calcareous rocks on coast, etc.

Phyllodactylus porphyreus (Daudin, 1803)
Rarely reported, localities unknown, presence requires confirmation; occurs in southern Africa.

Phyllodactylus stumpffi Boettger, 1878-79
ENDEMIC. N, Nosy Bé.

Uroplatus fimbriatus (Schneider, 1797)
ENDEMIC. NE, E, SE, C, S-C, W-C, Ste. Marie, Nosy Mangabe, Nosy Bé. Forest species, eats insects, 300-1100m. 'Taha-fisaka'.

Uroplatus lineatus Duméril et Bibron, 1836
ENDEMIC. E - Toamasina region. 'Taha-fisaka'.

Uroplatus güntheri Mocquard, 1908
ENDEMIC. Locality unknown. Single specimen.

Uroplatus alluaudi Mocquard, 1894
ENDEMIC. N - Mt. d'Ambre. Two specimens only.

Uroplatus phantasticus (Boulenger, 1888)
ENDEMIC. E, SE, S-C.

Uroplatus ebenaui (Boettger, 1879)
ENDEMIC. N, E, Nosy Bé. Inc. Mt. d'Ambre.

Family IGUANIDAE
Chalarodon madagascariensis Peters, 1854
ENDEMIC. SE, S, SW, W. Especially in S, less frequent in W. Very common in Ambovombe area and elsewhere. Sunny areas, on sand, in clearings in scrub forest. 'Dangalia', 'Dangara'.

Oplurus cuvieri (Gray, 1831)
NW, W; also Comoros. Common throughout NW. In savannah, in very dry regions, bushes. Formerly known as Oplurus sebae Duméril et Bibron, 1837 - see Savage 1952. 'Sitry', 'Androngo'.

Oplurus cyclurus (Merrem, 1820)
ENDEMIC. SE, S, SW. 'Sitry', 'Androngo', 'Androngohazo'.

Oplurus fierinensis Grandidier, 1869
ENDEMIC. SW - Mahafaly area. 'Sitry', 'Androngo'.

Oplurus grandidieri Mocquard, 1900
ENDEMIC. E - Vinanitelo forest & Massif de l'Ikongo. 'Sitry', 'Androngo'.

Oplurus quadrimaculatus Duméril, 1851
ENDEMIC. SE, S, SW. In sunny areas, rock, scrub, coast to 1800m. 'Sitry', 'Androngo'.

Oplurus saxicola Grandidier, 1869
ENDEMIC. SE, S, SW, S-C. Habitat inc. arid scrub. 'Sitry', 'Androngo'.

Family CHAMAELEONTIDAE
NB: categories in this family fide Brygoo (in litt., 20.5.83.).
Brookesia bonsi Ramanantsoa, 1980 K
ENDEMIC. NW - In réserve naturelle No. 8, Tsingy de Namoroka, sub-prefecture of Soalala.

Brookesia decaryi Angel, 1938 R
ENDEMIC. W - coast, forests on Ankarafantsika massif.

Brookesia dentata Mocquard, 1900
ENDEMIC. NW - Suberbieville, S of Maevatanana. Apparently known by Type only.

Brookesia ebenaui (Boettger, 1880) R
ENDEMIC. NW, N, NE, E, C, S-C, Nosy Bé.

Brookesia griveaudi Brygoo, Blanc & Domergue, 1974 K
ENDEMIC. NE. - Marojejy.

Brookesia karchei Brygoo, Blanc & Domergue, 1970 K
ENDEMIC. NE - Mt Marojejy (in Reserve Naturelle). 700m, dense shady high forest of the east region, on the ground on dead leaves, in areas of permanent humidity.

Brookesia lambertoni Brygoo & Domergue, 1970
ENDEMIC. Fito, in Sihanaka country. Type locality only.

Brookesia legendrei Ramanantsoa, 1980 K
ENDEMIC. Nosy Bé, réserve naturelle No. 6.

Brookesia minima Boettger, 1893 K
ENDEMIC. Nosy Bé.

Brookesia nasus Boulenger, 1887 R
ENDEMIC. E, SE, S-C.

Brookesia perarmata (Angel, 1933) K
ENDEMIC. Antsingy region, Menabé Prov., 300m.

Brookesia peyrieresi Brygoo & Domergue, 1975 K
ENDEMIC. NE - Nosy Mangabe, Antongil Bay.

Brookesia ramanantsoai Brygoo & Domergue, 1975 K
ENDEMIC. C - Ambohiboataba forest, east of Mantasoa.

Brookesia stumpffi Boettger, 1879 nt
ENDEMIC. NW, N, E, SW, W, Nosy Bé. In forests, under dry leaves, on old rotten tree trunks.

Brookesia superciliaris (Kuhl, 1820) nt
ENDEMIC. NW, NE, E, SE, E-C, S-C, Nosy Bé.

Brookesia therezieni Brygoo & Domergue, 1970 K
ENDEMIC. E, Périnet, Moramanga sub-prefecture. Type locality only.

Brookesia thieli Brygoo & Domergue, 1969 K
ENDEMIC. E. Moramanga and Maroantsetra sub-prefectures, inc. Périnet. A forest species, 900-1500m, on the ground or among lichens on bushes, diurnal.

Brookesia tuberculata Mocquard, 1894 R
ENDEMIC. N - Mt. d'Ambre.

Brookesia vadoni Brygoo & Domergue, 1968 K
ENDEMIC. NW. Valley of the Iaraka River, near Masoala. 600-1000m. On branches of bushes.

Chamaeleo angeli Brygoo & Domergue, 1968 K
ENDEMIC. NW. On RN 4, N of Tsaramandroso (forêt de l'Ankarafantsika).

Chamaeleo antimena Grandidier, 1872 I
ENDEMIC. SW. Recently removed from synonymy of C. rhinoceratus (Brygoo & Domergue, 1968).

Chamaeleo balteatus Duméril & Bibron, 1851 R
ENDEMIC. Type locality unknown. Five new specimens from forest region between Ifanadiana and Fort Carnot. Recently removed from synonymy of C. bifidus (Brygoo & Domergue, 1969).

Chamaeleo belalandaensis Brygoo & Domergue, 1970
ENDEMIC. SW. Belalanda, 4 km N of Toliara. Single specimen.

Chamaeleo bifidus Brongniart, 1800 R
ENDEMIC. E, S-C.

Chamaeleo boettgeri Boulenger, 1888 R
ENDEMIC. N, Nosy Bé.

Chamaeleo brevicornis Günther, 1879 nt
ENDEMIC. C, S-C.

Chamaeleo campani Grandidier, 1872 I
ENDEMIC. C, E-C.

Chamaeleo capuroni Brygoo, Blanc & Domergue, 1972 K
ENDEMIC.

Chamaeleo cucullatus Gray, 1831 R
ENDEMIC. E.

Chamaeleo fallax Mocquard, 1900 I
ENDEMIC. E, SE, C, S-C.

Chamaeleo furcifer Vaillant et Grandidier, 1880
ENDEMIC. E, C. Known by holotype only.

Chamaeleo gallus Günther, 1877 R
ENDEMIC. E, S-C.

Chamaeleo gastrotaenia Boulenger, 1888 I
ENDEMIC. NE, NW, E, C, S-C.

Chamaeleo globifer Günther, 1879 R
ENDEMIC. C, S-C.

Chamaeleo guibei Hillenius, 1959
ENDEMIC. NE Tsaratanana and C-E "Sihanaka". Known by types only.

Chamaeleo labordi Grandidier, 1872 K
ENDEMIC. SW. Locally common along the Ihotry. Recently removed from synonymy of C. rhinoceratus (Brygoo & Domergue, 1968).

Chamaeleo lateralis Gray, 1831 nt
ENDEMIC. NE, E, SE, S, SW, W, C, S-C. 'Tanata', 'Tanala', 'Tanalahy', 'Sangorita'.

Chamaeleo linotus Müller, 1924 K
ENDEMIC. NE - Ambatodradama, 1000m, Maroantsetra Prov.

Chamaeleo malthe Günther, 1879 R
ENDEMIC. N, NE, E, SE, C, S-C.

Chamaeleo minor (Günther, 1879) R
ENDEMIC. S-C.

Chamaeleo monoceras Boettger, 1913
ENDEMIC. NW - Betsako near Mahajanga. Taxonomic status uncertain. Known by holotype only.

Chamaeleo nasutus Duméril et Bibron, 1836 nt
ENDEMIC. N, NE, E, SE, C, S-C, St. Marie.

Chamaeleo oshaughnessyi Günther, 1881 K
ENDEMIC. NE, E, S-C.

Chamaeleo oustaleti Mocquard, 1894 nt
(ENDEMIC). NW, N, NE, SW, C; & introduced to Ngong Forest near Nairobi, Kenya. 'Tana', 'Sangorita'.

Chamaeleo pardalis Cuvier, 1829 nt
(inc. C. guentheri (Boulenger, 1888)). (ENDEMIC). NW, N, E, inc Mt. d'Ambre; & introduced on Reunion.

Chamaeleo parsonii Cuvier, 1824 I
ENDEMIC. E, C, S-C, St. Marie, Nosy Bé.

Chamaeleo petteri (Brygoo & Domergue, 1966)
ENDEMIC. N - Ankarana massif (cf Ramanantsoa, 1978).

Chamaeleo peyrieresi Brygoo, Blanc & Domergue, 1974 K
ENDEMIC.

Chamaeleo rhinoceratus (Gray, 1843) K
(inc. C. voeltzkowi (Boettger, 1893)). ENDEMIC. NW, SW, W.

Chamaeleo tsaratananensis Brygoo & Domergue, 1968 K
ENDEMIC. N. Tsaratanana massif.

Chamaeleo tuzetae Brygoo, Bourgat & Domergue, 1972
ENDEMIC. SW - Andrenalamivola, near Ambiky, canton of Befandriana S. Known by holotype only.

Chamaeleo verrucosus Cuvier, 1829 nt
ENDEMIC. NW, N, E, SE, S, SW, W.

Chamaeleo willsi Günther, 1890 R
ENDEMIC. C, E-C.

Family SCINCIDAE
NB: categories in this family fide Brygoo in litt., 20.5.83.
Cryptoblepharus boutonii (Desjardins, 1831) nt
Widespread; also very widespread outside Madagascar. Formerly assigned to Ablepharus, see Fuhn 1961.

Amphiglossus andranovahensis (Angel, 1933)
ENDEMIC. SW. Known by holotype only. Removed from Scelotes: Brygoo, 1984.

Amphiglossus ankodabensis Angel, 1930
ENDEMIC. SE. Only two specimens known. Removed from Scelotes: Brygoo, 1984.

Amphiglossus ardouini (Mocquard, 1897) K
ENDEMIC. N - Antseranana and Ambilobe. Removed from Scelotes: Brygoo, 1982.

Amphiglossus astrolabi Duméril et Bibron, 1839 K
ENDEMIC. NE, E, S-C.

Amphiglossus decaryi (Angel, 1930)
ENDEMIC. SE. On littoral rocks. Known by holotype only. Removed from Scelotes: Brygoo, 1985.

Amphiglossus frontoparietalis (Boulenger, 1889) K
ENDEMIC. NE, E, SE. Synonym (Brygoo 1980): Scelotes praeornatus Angel, 1938. Removed from Scelotes: Brygoo 1981.

Amphiglossus gastrostictus (O'Shaughnessy, 1879) K
ENDEMIC. E. Removed from Scelotes: Brygoo, 1984.

Amphiglossus igneocaudatus (Grandidier, 1867) nt
ENDEMIC. S, Centre. Removed from Scelotes: Brygoo, 1984.

Amphiglossus intermedius (Boettger, 1913) K
ENDEMIC. N, W, S. Removed from Scelotes: Brygoo, 1984.

Amphiglossus macrocercus (Günther, 1882) K
ENDEMIC. C, E, SE. Removed from Scelotes: Brygoo, 1984.

Amphiglossus macrolepis (Boulenger, 1888)
ENDEMIC. SE - Taolanaro. Only two specimens known. Removed from Scelotes: Brygoo, 1981.

Amphiglossus melanopleura (Günther, 1877) K
ENDEMIC. N, E. In forest. Removed from Scelotes: Brygoo, 1982.

Amphiglossus melanurus (Günther, 1877) nt
ENDEMIC. Widespread, C, E, S. Removed from Scelotes: Brygoo, 1984. 'Matahotandro', 'Ankotofotsy'.

Amphiglossus mouroundavae (Gradidier, 1872) K
ENDEMIC. N, W. In humid areas, under stones, in tree trunks. Removed from Scelotes: Brygoo, 1984.

Amphiglossus ornaticeps (Boulenger, 1896) R
ENDEMIC. S, E. Removed from Scelotes: Brygoo, 1984.

Amphiglossus poecilopus (Barbour & Loveridge, 1928) K
ENDEMIC. Widespread, E, S, W. Removed from Scelotes: Brygoo, 1984.

Amphiglossus polleni (Grandidier, 1869) K
ENDEMIC. NW, E, SW, W, Nosy Bé. Removed from Scelotes: Brygoo, 1982.

Amphiglossus reticulatus (Kaudern, 1922)
ENDEMIC. NW. Known by type only. Removed from Scelotes: Brygoo, 1980.

Amphiglossus splendidus (Grandidier, 1872) R
ENDEMIC. NW, NE, E, SE, C. Removed from Scelotes: Brygoo, 1982.

Amphiglossus stumpffi (Boettger, 1882) E
ENDEMIC. Nosy Bé. Removed from Scelotes: Brygoo, 1982.

Amphiglossus tsaratananensis Brygoo, 1981
ENDEMIC. N - Tsaratanana Mtns. Known by types only. Removed from Scelotes: Brygoo, 1982.

Amphiglossus waterloti (Angel, 1930) K
ENDEMIC. N - Ambilombe, Antseranana area; also Bora, Antsohihy area.

Androngo allaudi (Brygoo, 1981)
ENDEMIC. N. Mt d'Ambre, Ankarana, Antseranana. Known by types only. Removed from Scelotes: Brygoo, 1982.

Androngo crenni Mocquard, 1906
ENDEMIC. E. Only two specimens known. Removed from Scelotes: Brygoo, 1982.

Androngo elongatus Angel, 1933 K
ENDEMIC. N - Ambilombe, Antseranana area, Nosy Bé. Removed from Scelotes: Brygoo, 1982.

Androngo trivittatus (Boulenger, 1896) R
ENDEMIC. S. A species of the hot dry extreme south. Synonyms (Brygoo, 1979): Pygomeles trivittatus, S. trilineatus Angel, 1949. Removed from Scelotes: Brygoo, 1982.

Cryptoposcincus minimus Mocquard, 1906
ENDEMIC. 'Madagascar' - locality unknown. Known by holotype only.

Mabuya aureopunctata (Grandidier, 1867) nt
ENDEMIC. S, W. In arid scrub.

Mabuya betsileana Mocquard, 1906
ENDEMIC. C - Betafo in Betsileo Prov. Known by type only. Validity of taxon uncertain, geographic error possible.

Mabuya boettgeri Boulenger, 1887 R
ENDEMIC. C, E-C.

Mabuya elegans (Peters, 1854) nt
ENDEMIC. Throughout except C and S-C. One of commonest lizards in NW. Along littoral, arid scrub, under stones in subdesert areas. Includes in synonymy: M. sakalava (Grandidier, 1872), Brygoo 1983, in press.

Mabuya gravenhorsti (Duméril et Bibron, 1839) nt
ENDEMIC. Very common, found throughout, 0-1000m, on coastal rocks, scrub, wooded hills. Favoured by extension of 'savoka' secondary vegetation.

Mabuya madagascariensis Mocquard, 1908 K
ENDEMIC. Type specimen 'Madagascar' - no locality, recently rediscovered on Tsiafajavona (Ankaratra massif).

Paracontias brocchii Mocquard, 1894 R.
ENDEMIC. N - Montagne d'Ambre.

Paracontias hildebrandti (Peters, 1880) K
ENDEMIC. NW, Nosy Bé.

Paracontias holomelas (Günther, 1877) R
ENDEMIC. E - Anzahamaru, near Mahanoro (terra typica).

Paracontias milloti Angel, 1949
ENDEMIC. Nosy Mamoko, Ambariotelo Archipelago. Known by holotype only.

Paracontias rothschildi Mocquard, 1905
ENDEMIC. 'Madagascar' - locality unknown. Known by types only.

Pseudoacontias madagascariensis Barboza du Bocage, 1889
ENDEMIC. Locality unknown. Known only from Holotype, recently (1979) destroyed by fire at the Bocage Museum, Lisbon.

Pygomeles braconnieri Grandidier, 1867 R
ENDEMIC. SW - Toliara area. Fossorial, in sand.

Pygomeles petteri Pasteur et Paulian, 1962
ENDEMIC. NW - Ankarafantsika. Known by types only.

Voeltzkowia fierinensis (Grandidier, 1869) K
ENDEMIC. SW - S of Toliara on Fiherenana River.

Voeltzkowia lineata (Mocquard, 1901) K
ENDEMIC. S, SE,SW. In SW appears not to occur N of R. Fiherenana. Most northerly point Sakaraha (note on habitat in Brygoo 1981).

Voeltzkowia mira Boettger, 1893 K
ENDEMIC. NW. Mahajanga region. Holotype found in rotten trunk of 'Sabra' Palm Hyphaene coriacea, other specimens in sand.

Voeltzkowia petiti (Angel, 1924)
ENDEMIC. SW - Scrub dunes at Tsivono, 24 km of Toliara. Two specimens only.

Voeltzkowia rubrocaudata (Grandidier, 1869) K
ENDEMIC. SW (Fierin: Toliara). N of Toliara and the R. Fiherenana. Beroboka between Morondava and Belo Tsiribihina.

Family CORDYLIDAE (GERRHOSAURINAE)

Tracheloptychus madagascariensis Peters, 1854
ENDEMIC. N (Nasatra), E, SE, S, W.

Tracheloptychus petersi Grandidier, 1869
ENDEMIC. SW - Morombe, Tsivanoha.

Zonosaurus aeneus (Grandidier, 1872)
ENDEMIC. E, W, S-C. Wooded hilly areas, littoral areas.

Zonosaurus boettgeri Steindachner, 1891
ENDEMIC. NE, Nosy Bé.

Zonosaurus karsteni (Grandidier, 1869)
ENDEMIC. W, SW, S-C.

Zonosaurus laticaudatus (Grandidier, 1869)
ENDEMIC. NW, E, SE, S, SW, C.

Zonosaurus madagascariensis (Gray, 1845)
NW, NE, E coast, SW, Nosy Bé, St. Marie; also Glorieuse. Littoral, wooded areas to 1000m, including primary forest.

Zonosaurus maximus Boulenger, 1896
ENDEMIC. SE, E-C, S-C, C. Forest species, also found along rivers and watercourses. Frequent on banks of the Faraony. Found above all in dense leaf litter of mango trees where it seeks earthworms. One of the largest Malagasy lizards, to 67cm.

Zonosaurus ornatus (Gray, 1845)
ENDEMIC. NW, N-C, E, SE, SW, S-C, C. On rocks, in forest. 'Antsiantsy'.

Zonosaurus quadrilineatus (Grandidier, 1867)
ENDEMIC. SW.

Zonosaurus rufipus (Boettger, 1881)
ENDEMIC. E, Nosy Bé.

Zonosaurus trilineatus Angel, 1939
ENDEMIC. Ambovombe.

SERPENTES

NB Status designations and other comments from Domergue (in litt., rec 27.6.83).

Family TYPHLOPIDAE

Ramphotyphlops braminus (Daudin, 1803)
Nossi-be (NW), Ambilobe (NW), Betsako (NW), Toamasina (E), Ambatolampy (C), Mandraka forest (C), Ambovombe (S); worldwide.

Typhlops arenarius (Grandidier, 1872)
ENDEMIC. Morondava, Mahajanga (W), Menabe (W), Toliara (W), Andrahomana (S).

Typhlops decorsei Mocquard, 1901
ENDEMIC. Ambovombe (type), southwest around Toliara.

Typhlops grandidieri Mocquard, 1905
ENDEMIC. "Madagascar".

Typhlops madagascariensis Boettger, 1877
ENDEMIC. Nosy Bé.

Typhlops microcephalus Werner, 1909
ENDEMIC. "Madagascar".

Typhlops mucronatus Boettger, 1880
ENDEMIC. ?

Typhlops ocularis Parker, 1927
ENDEMIC. Known only by the type from Antongil forest, Maroantsetra region (NE).

Typhlops reuteri Boettger, 1881
ENDEMIC. Nosy Bé.

Family BOIDAE

Acrantophis dumerilii Jan, 1860
ENDEMIC. South and southwest. Still moderately common. Localities include: Amboasary (S), Belo (W), Mahabo (W), Morondava (W), Andranolava (C), Toliara (S). Frequents the humid edges of pools and water-courses. 'Do'.

Acrantophis madagascariensis (Duméril et Bibron, 1844)
ENDEMIC. West (north of the Tsiribinina), north, northeast, east. Still moderately common. More rare than Sanzinia. Localities include: Mahajanga (W), Amboasary (W), Ste. Marie de Marovoay (S), Nosy Bé. Frequents the humid edges of pools and water-courses. 'Do' (in general) or 'Ankoma' (in East).

Sanzinia madagascariensis (Duméril et Bibron, 1844)
ENDEMIC. Occurs throughout Madagascar, but especially in the north and the eastern forests. Still moderately common. Localities include: Ankafana (E), Mont de Francais (E), Southeast of Betsileo, Emininy (E), Frandrarazana (E), Mananjary (E), Mandotra (E), Toamasina (E), Tampina (E), Androhinaly (S), Toliara-Tsihombe-Morondava. The smallest malagasy boa, arboreal. 'Manditra' (in east).

Family COLUBRIDAE

Alluaudina bellyi Mocquard, 1894 R
ENDEMIC. Until recently known only by type from Mt d'Ambre (Diégo-Suarez)(N); four new specimens comprise two from Mt d'Ambre, one from Sambava, one from Ambatonutatao. A small secretive species.

Alluaudina mocquardi Angel 1939 R
ENDEMIC. Known from type only found in Ankara cave.

Dromicodryas bernieri (Duméril et Bibron, 1854) nt
ENDEMIC. Widespread, found throughout the island, very common. Includes in synonymy: Liopholidophis pseudolateralis Guibé, 1956 (fide Domergue, in litt., 27.06.83).

Dromicodryas quadrilineatus (Duméril et Bibron, 1854) nt
ENDEMIC. Widespread, found throughout the island, less common than D. bernieri.

Geodipsas heimi Angel, 1936 V
ENDEMIC. Known from type, from Tsihanovoka on the river Sahandrata, also the Zafimanirihy area (forests east of Ambositra).

Geodipsas infralineata (Günther, 1882) V
ENDEMIC. Occurs on the plateau and in eastern forests, localities include: Moramanga (E), Maroantsetra (NE)

Heteroliodon torquatus Boettger, 1913 R
ENDEMIC. Until recently known only by the type, from Andranohinaly (near Toliara) (W); two new specimens are from north of Toliara and Kinkony Forest, south of Morondava.

NB. The genus Ithycyphus is in course of revision, there appear to be several undescribed forms (Domergue, in litt., 27.06.83).

Ithycyphus goudoti (Schlegel, 1854) V
ENDEMIC. Moderately widespread in NE, E and S, also known from the east coast.

Ithycyphus miniatus (Schlegel, 1837) V
ENDEMIC. Nosy Bé (NW), Andrahomana (S), Andranolava (C), Fandrazana (E). 'Fandrefiala'.

Langaha alluaudi Mocquard, 1901 V
ENDEMIC. Occurs throughout the island in forest areas, localities include: Andrahomana (S), Behara (S), Menabe (W), Ambovombe (S), Taolanaro (SE), Bemamanga. 'Fandrefiala'.

Langaha nasuta Shaw, 1790 V
ENDEMIC. Occurs throughout the island in forest areas, localities include: Nosy Bé (NW), Antongil Bay (NE), Ambatomainty (O), Ankarafantsika (O), Imerina (C), Betroka (C), Befanany (SW), Morondava (E).

Leioheterodon geayi Mocquard, 1905 nt
ENDEMIC. Occurs throughout the south, south of the Tsiribihina River, localities include: Fiherana plain (type), Ambovombé (S), Toliara (SW), Betioky (SW), Androka (SW).

Leioheterodon madagascariensis Duméril et Bibron, 1854 nt
ENDEMIC. Rather common and widespread, occurs throughout the island but especially the north and east. 'Menarana'.

Leioheterodon modestus (Günther, 1863) nt
ENDEMIC. Found throughout the island, especially the west and north, also the south as far as Antsirabe. 'Bemavo', 'Le Fompoty'.

Liophidium apperti Domergue, 1983 K
ENDEMIC. Known by a single specimen collected in 1968, in deciduous forest 7km north of the village of Befandriana-sud, 2km east of RN 9 (Toliara-Morombe). This forest has now been cleared; only a few baobabs, 'kily' and 'sakoas' remain.

Liophidium rhodogaster (Schlegel, 1837) V
ENDEMIC. Known from forest regions of the east and north, localities include: Antananarivo (C), Ikongo massif (SE), Ambatomainty, Beforona (E), Nosy Bé.

Liophidium chabaudi Domergue, 1983 K
ENDEMIC. Known from three specimens; the holotype from Ankorongo (near Toliara airport), the second from a dozen km N of Toliara (between Belalanda and Tsongoritela), the third from Bevato (south of Morombe). A sub-fossorial form, occurring in somewhat swampy and saline areas, behind coastal dunes in the littoral zone.

Liophidium therezeni Domergue, 1983 K
ENDEMIC. Known by two specimens collected in 1966 and 1969; the former (holotype) from Anatelo forest bordering the Ankarana massif (Ambilobe sub-prefecture), the latter from Antseranana (Antsiranana).

Liophidium torquatus (Boulenger, 1888) V
ENDEMIC. In humid forest. Localities include: Antongil Bay (NE), Mananjary (E), Anamalazoatra (E), Toamasina (E), Ambositra (C), Ambatodratino (C), Ankirika (C), Ste. Marie de Marovoay (NW), Taolanaro (SE), also the banks of the River Mangoky (SW).

Liophidium trilineatum Boulenger, 1896 R (K)
ENDEMIC. Type from SW, also known from Tsimanampetsotsa and several new specimens from other parts of the south.

Liophidium vaillanti (Mocquard, 1901) R (K)
ENDEMIC (?). Ambovombe (S), Betroka (S-C), Maevatanana (NW), (also reported from Reunion, but this is extremely improbable).

Liopholidophis grandidieri Mocquard, 1904 E (K)
ENDEMIC. Until recently known from the holotype only, from the mouth of the River Saint Augustin (SW), three new specimens are now known from the eastern forests.

Liopholidophis lateralis (Duméril et Bibron, 1854) nt
ENDEMIC. Known from almost the entire island, absent from coastal regions to the south of Toliara. Common on the high plateau, frequently found in parks and gardens (including Tsimbazaza).

Liopholidophis pinguis Parker, 1925 I
ENDEMIC. Antisihanaka (type), also Moramanga and/or (?) Alaotra.

Liopholidophis sexlineatus (Günther, 1882) nt
ENDEMIC. Occurs mainly on the east coast and the plateau, localities include: Betsileo area (C), Imerina (C), Ambatomainty (W), Toamasina (E). A semi-aquatic form, abundant in rice cultivation.

Liopholidophis stumpffi (Boettger, 1881)
ENDEMIC. Most specimens are from Périnet; six other localities are known, mostly along the east coast (including on Marojezy), also Nosy Bé. A humid forest form, typically found in the morning along forest tracks, basking in patches of sunlight.

Liopholidophis thieli Domergue, 1972
ENDEMIC. A humid forest form, found at several localities in the east region, including Périnet (where the type was found in fish culture ponds), also on Nosy Mangabe. Eats amphibians. 'Menamaso'.

NB. The genus Lycodryas is in the course of revision (Domergue, in litt., 27 June 1983).

Lycodryas arctifasciatus (Duméril et Bibron, 1854) R
ENDEMIC. Antananarivo (C), Moramanga (CE), Nosy Bé (NW).

Lycodryas betsileanus (Günther, 1880) R
ENDEMIC. Betsileo area (C), also one new specimen from Maroantsetra (Antongil Bay).

Lycodryas gaimardi (Schlegel, 1837) R
L.g. gaimardi, Taolanaro (SE), Imerina (C), Nosy Bé (NW). L.g. granuliceps, Toliara (SW), Fiherana valley, Befaisitra. Also Comoro Islands (one specimen 'L.g. comorensis'.

Lycodryas guentheri (Boulenger, 1896) R
ENDEMIC. Ambovombe (S), + SW.

Lycodryas inornatus (Boulenger, 1896) R
ENDEMIC. Only three specimens known, two of unknown origin, one from the Didierea forest of Ampotaka (south of the Menarandra river in the Beloha-Androy area).

Lycodryas maculatus (Günther, 1858) R
Known from type, source unknown, and three specimens from the Comoros.

Lycodryas variabilis (Boulenger, 1896) R
ENDEMIC. 'Madagascar', no details.

Madagascarophis colubrinus (Schlegel, 1837) nt
ENDEMIC. Found throughout the island. Several geographic forms. Still fairly common. Found most frequently in termitaria. Malagasy name: 'Renivitsika' or Mere de Fourmis (= Mother of Ants).

Mimophis madagascariensis Günther, 1868 nt
ENDEMIC. A plateau species.

Mimophis mahfalensis (Grandidier, 1867) nt
ENDEMIC. Widespread, especially the south and southwest. Still common. Feeds on snakes.

Micropisthodon ochraceus Mocquard, 1894 R
ENDEMIC. Nosy Bé, second specimen from unknown locality and a few new specimens from Périnet (Analamazaotra). Probably arboreal.

Pararhadinea albignaci Domergue, 1984 K
ENDEMIC. Known by holotype only, from R.S. 19 Analamazaotra (Périnet); found in January 1970, dead on road after heavy rain, between the village of Périnet and the forest station.

Pararhadinea melanogaster Boettger, 1898 R
ENDEMIC. Nosy Bé, also two new specimens from Périnet and Marojezy. A small secretive species.

Pseudoxyrhopus ambreensis Mocquard, 1894 R
ENDEMIC. Known only from type, from Montagne d'Ambre.

Pseudoxyrhopus dubius Mocquard, 1904 I
ENDEMIC. Occurs in the eastern forests, localities include: Ikongo (SE), Ambatomainty. Several specimens recorded during the last two decades. A nocturnal species, probably terrestrial.

Pseudoxyrhopus heterurus (Jan, 1893) R
ENDEMIC. Nosy Mangabe (Bloxam in litt. 23.07.86); no other locality records or recent records.

Pseudoxyrhopus imerinae (Günther, 1888) R
ENDEMIC. Imerina (C), other specimens from Mt Ibity and Mt Tsiafajavony (central plateau).

Pseudoxyrhopus microps Günther, 1881 R
ENDEMIC. Betsileo region, Ankarana. No recent records.

Pseudoxyrhopus occipitalis Boulenger, 1896 R
ENDEMIC. Known from type, from SW, not found again.

Pseudoxyrhopus quinquelineatus (Günther, 1881) V
ENDEMIC. Betsileo region, east coast, northwest, one specimen from the Mahafaly Plateau (S).

Pseudoxyrhopus tritaeniatus Mocquard 1894 I
ENDEMIC. Known only from type, from Betsileo region.

Also two widespread sea snakes (Hydrophiidae), Pelamis platurus and Enhydrina schistosa, are recorded in coastal waters.

Two nominal species, Compsophis albiventris Mocquard, 1894, from the Montagne d'Ambre, and Geodipsas boulengeri (Peracca, 1892) from near Androngoloaka, are probably based on mis-identified Geodipsas heimi (Domergue, in litt., 27 June 1983):

MADAGASCAR AMPHIBIA

(T) = Type locality. Geographic distribution of several species apparently not known in full, or published data not available. References are provided in Part V.3. Blommers-Schlösser has been abbreviated to B.-S.

Family HYPEROLIIDAE
*Note: there are probably no true Hyperolius species in Madagascar; species listed by Guibé, 1978, appear to be assignable to either Heterixalus (Hyperoliidae) or Boophis (Rhacophoridae) (B.-S., 1979 II, and 1982).

'Hyperolius' arnoulti Guibé, 1975
Manompana (T), east coast, opposite Nosy Borah. Probably a Heterixalus species, B.-S., 1982.

'Hyperolius' friedrichsi Ahl, 1930
'Madagascar' (T). Probably a Boophis species, B.-S., 1982.

'Hyperolius' nossibeensis Ahl, 1930 R
Nosy Bé (T).

Heterixalus alboguttatus (Boulenger, 1882)
South-east Betsileo (T), also dunes at Mananjary (east coast) and Ranomafana (highroad R.N.25).

Heterixalus betsileo (O. Boettger, 1881)
Imerina (T), centre of Madagascar, Andanolava. A very common sedge frog, in savannah like areas and cleared forest in the central plateau and west. Synonym: H. renifer, fide B.-S., 1982.

Heterixalus boettgeri (Mocquard, 1902)
? Removed from synonymy of H. tricolor, B.-S., 1982.

Heterixalus madgascariensis (Dum. et Bib., 1841)
'Madagascar' (T), Salavaratse.

Heterixalus mocquardi (O. Boettger, 1913)
Taolanaro (T), another specimen collected on leaf in Taolanaro.

Heterixalus rutenbergi O. Boettger, 1881
Imerina (T), also collected in grassland 20 km west of Antananarivo. Removed from Hyperolius, B.-S., 1982.

Heterixalus tricolor (O. Boettger, 1881)
Nosy Bé (T), Isaka, and east coast. A very common sedge frog, in dunes, savannah-like areas and cleared forest on the east coast.

Family MICROHYLIDAE: Subfamily COPHYLINAE (endemic).

Anodonthyla boulengeri F. Müller, 1892
Madagascar, Anevoka. Known from the East Region, the Anosyennes chain including Andohahela. Also collected near Fenoarivo Atsinanana, Périnet, Ranomafana (Fianarantsoa), Foulpointe and 25km north of Toamasina. Many of these were collected in hollow leafstalks of young Ravenala, which often harboured antnests; ants were the only food items recovered from these specimens. Larval development similar to other Cophylines.

Anodonthyla montana Angel, 1925
Andringitra mountains (T), abundant at altitude.

Anodonthyla rouxae Guibé, 1974 K
Anosyenne chain (T), in bamboos (poss. type loc. only).

Cophyla phyllodactyla O. Boettger, 1880 K
Nosy Bé (T), known from Nosy Bé, Nosy Komba and Mt. d'Ambre.

Madecassophryne truebae Guibé, 1974 K
Anosyenne chain (T), known only from the type locality.

Mantipus bipunctatus Guibé, 1974
Forest of Fivahona (T), Andringitra mountains (prob. type loc. only).

Mantipus guentherpetersi Guibé, 1974
Tsaratanana mountains (T), 2600m (prob. type loc. only).

Mantipus inguinalis (Boulenger, 1882)
East Betsileo (T), known from east and north-east Madagascar, including the Andringitra mountains.

Mantipus laevipes (Mocquard, 1895)
Montagne d'Ambre (T), type locality only.

Mantipus minutus Guibé, 1975
Marojejy mountains (T), (prob. type loc. only).

Mantipus serratopalpebrosus Guibé, 1975
Marojejy mountains (T) (prob. type loc. only).

Paracophyla tuberculata Millot & Guibé, 1951 R
Périnet Forest (T); where reported in leaf axils of Pandanus and Crinium firmifolium.

*Platyhyla alticola (Guibé, 1974)
Tsaratanana mountains (T) (poss. type loc. only). *Guibé considers Platyhyla a synonym of Platypelis.

Platypelis barbouri Noble, 1940
Fanovana Forest (T).

Platypelis cowani Boulenger, 1882
East Betsileo (T).

Platypelis grandis (Boulenger, 1889)
Madagascar (Taolanaro, Sakana), known from East Region and mountain massifs. Recently collected near Anjozorobe (alt 1300m, 60km north of Manjakandriana); near Périnet (alt. 900m); and near Ampasinambo (alt 500m, 55km west of Nosy Varika). Specimens were collected in pairs in water holes in tree trunks (Ficus sp.) and a water filled axil of Ravenala. A resting male was collected beneath rotting wood in the forest. Calling males, always hidden in tree holes, are heard at night from September to October. Eggs are laid in water inside these holes, the female leaves the nest several days after oviposition but the male remains until the brood have developed into froglets. It is possible that the nursing father provides the larvae with fungicidal protection.

Platypelis milloti Guibé, 1950 R
Nosy Bé (T), known only from Lokobe Forest on Nosy Bé (where it lives in leaf axils of Typhonodorum lyndleianum).

Platypelis pollicaris Boulenger, 1888
Madagascar, known from East and Centre Regions and Tsaratanana mountains. Collected by B.-S. near Périnet and near Tampoketsa d'Ankazobe in leaf axils. May feed on ants.

Platypelis tsaratananaensis Guibé, 1974
Tsaratanana mountains (T) in bamboo forest 2600m, (prob. type loc only).

Platypelis tuberculata (Ahl, 1929)
North-west Madagascar (T).

Platypelis tuberifera (Methuen, 1920 (1919))
Ambatoharanana (T). Later collected at Périnet, Fenoarivo Atsinanana and Foulpointe. All specimens were found in water-filled axils of Pandanus. Food items recovered include ants. Larval development likely to be similar to other Cophylinae described.

Plethodontohyla alluaudi (Mocquard, 1901)
Taolanaro (T).

Plethodontohyla brevipes Boulenger, 1882
East Betsileo (T), a pair were collected by Peyrieras under decaying wood in forest near Ampasinambo. The stomachs contained beetles.

Plethodontohyla coudreaui Angel, 1938
Betampona Reserve (T).

Plethodontohyla laevis (O. Boettger, 1913)
Sakana (T), (Tsihanovoha Forest); a specimen was collected by Peyrieras near Tampoketsa d'Ankazobe (alt. 1600m) from a burrow.

Plethodontohyla notosticta (Günther, 1877)
Mahanoro and Anzahamara, known from forest areas in East Region and at low altitude in the Andringitra and Marojejy mountains. Collected by B.-S. near Ranomafana, Fenoarivo Atsinanana and Foulpointe. Larval development similar to that of Platyhyla grandis.

Plethodontohyla ocellata Noble & Parker, 1926
Antsihanaka (T), known from the East Region and Marojejy mountains. One gravid female collected by Peyrieras under decaying wood in forest near Ampasinambo (alt. 500m, 55km west of Nosy Varika). The stomach contained a large beetle.

Plethodontohyla tuberata (Peters, 1883)
'Madagascar' (T), (Manjakatompo). Found on the high plateaus, common at 1500-2000m in the Andringitra and Ankaratra mountains. A fossorial form inhabiting forest humus. 'Sahondokoro'.

Rhombophryne testudo O. Boettger, 1880
Nosy Bé, Marojejy and Réunion.

Stumpffia grandis Guibé, 1974
Marojejy mountains (T) 1300m, (possibly type locality only).

Stumpffia psologlossa Boettger, 1881
Nosy Bé (T). Known from East Region, also Sambirano and Tsaratanana and Marojejy mountains.

Stumpffia roseifemoralis Guibé, 1974
Only known from Marojejy mountains (T), 1300m.

Stumpffia tridactyla Guibé, 1975
Marojejy mountains (T).

Family MICROHYLIDAE: Subfamily DYSCOPHINAE (Dyscophus is endemic genus).
Dyscophus antongili Grandidier, 1877 I
Antongil Bay (T), localised at Antongil Bay (Moroantsetra, Foizana) and south of Toamasina (Andevoranto). A well known species, dull red-orange in colour, growing to large size (c 9cm). 'Sahongongona', derived from the distinctive call.

Dyscophus guineti (Grandidier, 1875)
Sambava (T), known from Soalala (north-west), Sambava (north-east) and Antsihanaka (centre).

Dyscophus insularis Grandidier, 1872
Antsouhy (T) near Trabouzy, (south-west Madagascar, Belo, Soalala). Reported from the west and south-west, specimens recently received from the Marojejy massif (300 m), others from Ankarafantsika. Includes in synonymy: D. quinquelineatus.

Family MICROHYLIDAE: Subfamily SCAPHIOPHRYNINAE (endemic) (NB., sometimes placed in RANIDAE)
Pseudohemisus calcaratus (Mocquard, 1895)
Madagascar, south-west, Ambongo, West Region.

Pseudohemisus granulosus Guibé, 1952
Andranoboka, Mahajamba Bay north of Mahajanga, also near Ampijora in the Ankarafantsika forest, west Madagascar. Adult specimens collected on the forest floor, tadpoles have been found in shallow temporary pool in the shade of large mango tree in January.

Pseudohemisus madagascariensis (Boulenger, 1882)
East Betsileo, Andringitra mountains. One of the most strikingly coloured Malagasy frogs; bluish to olive green with sinuous brown dorsal stripes.

Pseudohemisus pustulosus Angel et Guibé, 1945
Madagascar, Ankaratra mountains.

Scaphiophryne marmorata Boulenger, 1882
East Betsileo, Foizana, forest species in East Region.

Family MICROHYLIDAE: Subfamily MICROHYLINAE
Microhyla palmata Guibé, 1974
Ambana (T) (90m), Anosyenne chain.

Family RANIDAE
*Ptychadena mascareniensis (Dum. & Bib., 1842)
NON-ENDEMIC, occurs elsewhere in East Africa. Ile Bourbon (T); very common in all regions, notably in modified habitats (e.g. rice fields).

*Rana tigrina Daudin, 1803
NON-ENDEMIC, an asiatic species introduced to north-west coastal Madagascar from the Indian region. Increasingly invading the high plateau.

Tomopterna labrosa Cope, 1868
Madagascar (T); A fossorial form, absent from the eastern forests. Known from the west (regions of Mahajanga, Belo, Soalala, Antseranana) and the south (around Toliara and Taolanaro). Has been found on the foothills of the Ankaratra range.

Family RANIDAE: Subfamily MANTELLINAE (endemic).
Laurentomantis horrida (O. Boettger, 1880) R
Nosy Bé (T). Found since in Marojejy mountains.

Laurentomantis malagasia (Methuen & Hewitt, 1913) R
Folohy (T).

Laurentomantis ventrimaculata (Angel, 1935) R
Isaka Ivondro (T), Taolanaro area.

N.B. The above three species formerly assigned to the genus Trachymantis.

Mantella aurantiaca Mocquard, 1900 V
Madagascar, only known from the forest of Périnet (Antaniditra). Occurs in distinctive swamp rain forest with Pandanus species. The species has been collected for many years for zoos and terrarium-keepers (B.-S., in litt., Jan. 1983). Orange-red, probably poisonous, active during the day when great numbers may be seen jumping on the forest floor. (See Arnoult 1966 and Oostveen 1978 for ecology, also B.-S., 1975.)

Mantella betsileo (Grandidier, 1872)
Betsileo (T), (Nosy Bé), forested regions of the east. (Widespread; map of localities in Busse 1981).

Mantella laevigata Methuen & Hewitt, 1913 V
Folohy (T), east Madagascar. (NB., map in Busse 1981 indicates Nosy Mangabe as only site).

Mantella madagascariensis (Grandidier, 1872)
Incl. M. cowani Boulenger, 1882 (part) plus M. pulchra Parker, 1925. Three ssp., widespread (Busse 1981).

Mantidactylus acuticeps Ahl, 1929
'Central Madagascar' (T); type lost. Found at Périnet (highroad R.N.2) alt. 900-1100m, in the evening in dense thicket in forest, far from water.

Mantidactylus aerumnalis (Peracca, 1893)
Andrangoloaka (T)(type lost); Andringitra. Known from central region and Andringitra and Ankaratra mtns. Found in forest beside brooks and in more open areas beneath shrubs near forest. Tadpoles found in quiet parts of the same streams.

Mantidactylus aglavei (Methuen et Hewitt, 1913)
Anamalazotra (T); Moramanga, Andringitra and Moramanga forest, East Region. Tree frogs. Males found calling in trees in the evening. Tadpoles found in a shallow brook in open land near forest.

Mantidactylus albofrenatus (F. Müller, 1892)
'Madagascar' (T); known from the eastern forests, Foulpointe, also found in the West Region (forest of Mohajeby, region of Morafenobe). Found along a brook in the forest during the day, the males calling in dense vegetation. Surface-feeding tadpoles found in the same brook adhere to the surface by the tail in dense aquatic vegetation.

Mantidactylus alutus (Peracca, 1893)
Andrangoloaka (T); East Region, Central Region. Collected in and along rice fields and pools. Tadpoles were in nearby ditches and pools. Also found in small brooks in open land.

Mantidactylus ambohimitombi Boulenger 1919
Ambohimitombi forest (T); East Region. A specimen was found on the bank of a clear brook with a stony bottom in forest.

Mantidactylus argenteus Methuen, 1920 (1919) R
Folohy, east Madagascar (T); Andringitra mountains.

Mantidactylus asper (Boulenger, 1882)
East Betsileo (T); Known from the eastern region and the Marojejy, Andringitra and Tsaratanana mountains. Occurs in well-developed forest and dense shrubwood. Adults climb like tree-frogs, but are also found on the ground. Most active at dusk and in early morning. Eggs deposited singly or in pairs; direct development. Reproductive season probably limited to a few months (end Oct. - early Jan.) in the wettest period of the year (the egg needs a permanently damp atmosphere and the tiny froglet a choice of small prey, these conditions are only met in the rainy midsummer).

Mantidactylus bertini (Guibé, 1947)
Isaka Ivondro (T); known from East Region and Anosyenne chain.

Mantidactylus betsileanus (Boulenger 1882)
Betsileo (T); west Madagascar. Common in all areas except the south. Common in boggy places in open degraded forest, sometimes mixed with M. biporus. Tadpoles found in shallow pools, often with those of M. liber. Egg mass found fixed to a leaf on ground in wet grassland.

Mantidactylus bicalcaratus (Boettger, 1913)
Nosy Borah (T). Apart from type locality the species is known from the Marojejy mountains and Taolanaro. Also 25km north of Toamasina, sea level; Foulpointe (60km north of Toamasina), sea level; midway between Foulpointe and Fenoarivo Atsinanana, sea level; Ambila-Lemaitso (near Brickaville), alt. 7m; Mananjary, alt. 13m. Very abundant on the east coast. Adults found in the leaf axils and leaves of Pandanus dauphinensis in dunes near the sea and around lagoons, and in Typhonodorum lindleyanum in coastal swamps. Tadpoles in leaf axils.

Mantidactylus biporus (Boulenger, 1889)
'Madagascar' (T). A forest species from the East Region. Occurs in small shallow muddy pools, slow flowing water in open land adjacent to forest, gutters of roads, shallow water between Rapphia palms and small pools along streams.

Mantidactylus blanci Guibé, 1974
Andringitra (T); Known only from Andringitra mtns.

Mantidactylus blommersae (Guibé, 1975)
Moramanga and Périnet forests (T). Known from type localities, also Périnet (highroad R.N.2) alt. 900-1100m, Mandraka Valley (highroad R.N.2 at km 69), rivulet Vokanatezandava and adjacent ponds, nursery garden of the city of Antananarivo, alt. 1200m., between Ranomafana and Ifanadiana (highroad R.N.25) alt. 800m. Adults collected in November - April at breeding sites near sunlit pools (often temporary) 1cm - 1m deep, together with egg masses (attached to leaves a few feet above the water) and tadpoles. At other times adults were captured on the ground in forest.

Mantidactylus brevipalmatus E. Ahl. 1929
North-west Madagascar (T) - type lost. There is some doubt over the validity of this species since the type has been lost.

Mantidactylus boulengeri Methuen, 1920 (1919)
Folohy (T), (Fort Carnot). Common in forests in the East Region. Occurs on the forest floor in dense vegetation. Males do not form choruses when calling but are widely dispersed. This may indicate direct development of the egg and possibly parental care. They are particularly vulnerable to exposure to the sun.

Mantidactylus bourgati Guibé, 1974.
Andringitra (T). Known only from the type region, including:- Boby basin (2500m), Marositry stream (2000m), Amparabatosoa plateau (2100m), Antanfotsy village (1450m), Ampanasana River; Ambohambatomanara col (2100m); Ambalamaisinjo plateau: Riambouy River (2000m); Akiseasea (1500m); Ambalamarovandana (1500m).

Mantidactylus curtus (Boulenger, 1882)
East Betsileo (T). Known from the East Region and mountain areas. Adults are found in and along streams, mainly in open areas but sometimes in forest. Tadpoles are found in the lentic sidepools of the same streams.

Mantidactylus decaryi (Angel, 1930)
South Midongy and Andringitra mtn., Befotaka. Known from the East Region and mountain areas.

Mantidactylus depressiceps (Boulenger, 1882)
Betsileo (T); Sahembendrana, Akkoraka. Known from the eastern region. Rests during the day and the dry cool season on leaf axils of Pandanus, Typhonodorum lindleyanum, Musa and tree ferns. Egg masses are attached to leaves 1-2 metres above pools.

Mantidactylus domerguei (Guibé, 1974) R
Andringitra (T). Also found at Manjakotompo forest station (near Ambatolampy), Ankaratra mountains, alt 1800-2400m. Ground dwelling. Found on forest floor near temporary pools.

Mantidactylus elegans (Guibé, 1974)
Massif de l'Andringitra (T); known from the Andringitra and Tsaratanana mountains.

(Mantidactylus elegans (Guibé, 1974))
* NB., replacement name: Mantidactylus guibei, B.-S., in press. Anosyenne chain (T).

Mantidactylus eiselti Guibé, 1975 R
Périnet Forest (T); known only from type locality. Calling males found during the day in brushwood in hillside forest, sitting on small branches just above the ground; heard calling only during the rainy season, always singly and metres apart, far from open water. Particularly vulnerable to exposure to the sun. Wide dispersal of calling males and distance from water may indicate direct development of the eggs and possibly parental care.

Mantidactylus femoralis (Boulenger, 1882)
East Betsileo (T), (Mt. d' Ambre); region de Rogez, Isaka-Ivondro. Common in the eastern forests. Always found on the ground or in shrubs, along clear forest brooks, tadpoles found in side pools.

Mantidactylus flavicrus (Boulenger, 1889)
Madagascar (T); known from the eastern regions, Sambirano and Montagne d'Ambre.

Mantidactylus flavobrunneus B.-S., 1979
On the road from Moramanga to Anosibe at km 25, alt 900m.; Périnet (highroad R.N.2) alt. 900-1100m. Rainforest on eastern escarpment. Found in water in Pandanus axils.

Mantidactylus glandulosus Methuen & Hewitt, 1913 R
Folohy (T); known only from type locality, type lost. NB., M. pseudasper is probably a synonym, (B.-S., in litt).

Mantidactylus grandidieri Mocquard, 1895
East coast (T). Collected in and along brooks in open land next to forest. Ground dwelling. Tadpoles unknown.

Mantidactylus grandisonae Guibé, 1974 R
Ambana (T), Anosyenne chain; known only from type locality, alt. 1000m, low altitude forest.

Mantidactylus guttulatus (Boulenger, 1881)
South-east Betsileo (T); East Madagascar, Ikongo forest. Eastern region.

Mantidactylus granulatus (O. Boettger, 1881)
Nosy Bé (T); Found in the eastern forests, Montagne d'Ambre, Tsaratanana mountains. Also known from Mayotte, Comores.

Mantidactylus inaudax (Peracca, 1893)
Andrangoloaka (T); East Region.

Mantidactylus klemmeri (Guibé, 1974) R
Marojejy mountains (T); known only from type locality.

Mantidactylus liber (Peracca, 1893)
Widely distributed in the central highlands, at 800-1300m; this area is characterised by medium altitude rainforest, now (1975) confined to isolated patches and a fringe on the steep escarpments on the east side of the highlands. Most of the collections were made in more or less degraded forest of this type. In Tampoketsa d'Ankazobe some of the last vestiges of high altitude forest are preserved. M. liber was found in no other region. Localities: Andrangoloaka, near Manjakandriana, Périnet, Itremo, along the road from Ranomafana to Ifanadiana at 5km, along the road from Moramanga to Anosibe at 25km, Périnet at an altitude of 900-1100m, Mandrake valley along the road from Antananarivo to Moramanga at 69km, Anjozorobe alt. 1300m, and Tampoketsa d' Ankazobe alt. 1600m. Annual rainfall 1500-2000mm, falling almost entirely in the hot season, between the end of October - beginning of December until the end of March - mid May. The aridity of the dry season is moderated by abundant dew formation, condensation and frequent fogs. An arboreal frog, inactive during the day. Rests in axils of the larger Pandanus, Typhonodorum lindleyanum (Araceae), Banana and Ravenala madagascariensis (Musaceae), as well as some Amarillidaceae (Crinium firmifolium), palms (Rapphia) and arborescent ferns. The axils nearly always contain some water, even in the dry season. Specimens are found in quantity when resting sites near water, together with M. methueni and M. pulcher. Becomes active at dusk, feeds primarily on small insects such as mosquitoes and flies. Apparently breeds from November to May. Exhibits unusual mating behaviour which may extend to other members of the genus. Eggs are deposited in a gelatinous mass on leaves overhanging shady shallow pools, in which the hatching larvae develop.

Mantidactylus lugubris (A. Duméril, 1853)
'Madagascar' (T); Betsileo. Common in the eastern region and the mountain ranges (Andringitra, Marojejy, Montagne d'Ambre). Always found on banks of faster flowing currents, or on boulders in rapids.

Mantidactylus luteus Methuen & Hewitt, 1913
Folohy, east Madagascar (T). Forest species from the eastern region. Found on the forest floor, probably also climbs.

Mantidactylus madecassus (Millot & Guibé, 1950)
Andringitra (T). Described from the Cirque Boby in the Andringitra massif, has been found since at the same site.

Mantidactylus majori Boulenger, 1896
Ivohimanita (T). A forest form from the eastern region.

Mantidactylus microtympanum Angel, 1935
Isaka-Ivondro (T). Known form the eastern region (Isaka forest, Taolanaro region) and has recently been found in the Andringitra massif and the Anosyennes mountains.

Mantidactylus opiparis (Peracca, 1893)
Andrangoloaka (T), near Moramanga. Also Périnet (highroad R.N.2 at km 142), alt 900-1100m, Mandraka Valley (highroad R.N.2 at km 69), rivulet Vokanatezandava and adjacent ponds, nursery garden of the city of Antananarivo, Tampoketsa d'Ankazobe, forest station alt. 1600m. Collected in or near forest. Adults jump strongly. Tadpoles collected among debris in quiet corners of streams.

Mantidactylus pauliani Guibé, 1974
Ankaratra massif:- Nosiarivo & Betay forest, Manjakotompo (a forest station nr. Ambatolampy), alt 2200 m, under boulders in rapids. So far only known from the type region.

Mantidactylus peraccae (Boulenger, 1898) R
Ivohimanita (T); also at Tampoketsa d'Ankazobe, forest station, alt 1600m; captured from the axil of Pandanus. Related to M. depressiceps. Tree frogs, rest in leaf axils. Not observed in open water.

Mantidactylus pliciferus (Boulenger, 1882)
East Betsileo (T). Common in mountain ranges.

Mantidactylus pulcher (Boulenger, 1882)
Betsileo (T); Andrangoloaka, Ambila & Lake Aloatra, Périnet Forest, Itremo. Very common in all forest regions. Inhabits leaf axils. Eggs deposited in one mass above the water, in leaf axils.

Mantidactylus punctatus B.-S., 1979 R
All specimens collected in axils of Pandanus at Tampoketsa d' Ankazobe, forest station alt. 1600m in the relict forest in the gulleys of the Tampoketsa.

Mantidactylus pseudoasper Guibé, 1974 R
Massif du Marojejy (T). Found in low altitude forest (300m). NB., probably a synonym of M. glandulosus, B.-S., in litt.

Mantidactylus redimitus (Boulenger, 1889)
'Madagascar' (T). Known from the eastern region and the massifs of Andringitra, Marojejy and the Anosyenne chain.

Mantidactylus tornieri (Ahl, 1928)
Anhoraka, Sahambendrana, central Madagascar, also Périnet (highroad R.N.2 at km 142), alt. 900-1100m, Foulpointe (60km north of Toamasina), sea level. Use axils of plants such as Ravenala and Typhonodorum lindleyanum. In the evening they emerge onto the leaves. Egg masses are attached to leaves 30cm - 3m above permanent pools.

Mantidactylus tricinctus (Guibé, 1947)
Befotaka and Vondrozo. Known from the eastern forest, in the Andringitra mountains and the Anosyenne chain.

Mantidactylus ulcerosus (Boettger, 1880)
Nosy Bé (T); Montagne d'Ambre, Akkoraka. A very common species in all forest areas. Found in shallow pools and slow running water in marshy land or forest.

Mantidactylus webbi (Grandison, 1953) R
Nosy Mangabe, Antongil Bay (T). Two individuals from the Farankariana forest station have been assigned to this species.

Mantidactylus wittei Guibé, 1974
Surroundings of d'Ambanja (T); also Nosy Bé, Ampijora, Ankarafantsika forest and other western sites. Adults found on the forest floor, and in low vegetation near temporary pools. Egg masses attached to leaves overhanging water. Ground dwelling.

Family RHACOPHORIDAE
Aglyptodactylus madagascariensis (A. Duméril, 1853)
'Madagascar' (T); Anzahamaru, north-west Madagascar. Very common, found in all forested regions. Ground dwelling. B.-S. (1979a) excludes this monotypic genus from the Mantellinae.

Boophis albilabris (Boulenger, 1888) R
East Imerina (T). Known from the eastern forests.

Boophis brygooi (Guibé, 1974)
Andringitra mountains (T); known only from type region. An altitude form, appears very common in the Andringitra mountains, where it was collected in abundance as adults and at various stages of metamorphosis in Nov, Dec, and Jan.

Boophis callichromus (Ahl, 1928)
North-west Madagascar, central Madagascar.

Boophis difficilis (Boettger, 1892)
Foizana, east Madagascar (T), also Périnet. Never heard or seen during daytime. Males were found on rainy evenings in forest, calling in vegetation beside brooks.

Boophis erythrodactylus (Guibé, 1953)
Forest of Mahajeby (T), close to Morafenobé, west Madagascar. Also collected in Mandraka Valley, Manjakotompo forest station, Ankaratra Mts, and near Périnet. Males call from leaves of shrubs and trees alongside rapids, in the evening.

Boophis goudoti Tschudi, 1838
'Madagascar' (T). Geographically variable, distributed over the whole island. Found in or near stagnant or slow running water in forests and ricefields. Pairs in axillary amplexus found in August. Tadpoles found in slow running water and adjacent pools. Feed on large prey e.g. grasshoppers, moth and beetle larvae. Also found in trees although in general a poor climber. Eggs are deposited in clumps of 30, attached to rocks in water. Reproduction starts at the end of November. Valued as a dietary item. 'Sahabakaka'.

Boophis granulosus (Guibé, 1975)
Moramanga Forest (T). Young and tadpoles have been collected near Périnet, at 900m and 1100m altitude. Adults found on leaves of shrubs and trees around a pool, near forest; tadpoles found in same pool.

Boophis hillenii B.-S., 1979
Near Périnet (T); also near Ranomafana. Males found calling during a rainy night in shrubbery around temporary pool in forest. Tadpoles found in a temporary pool. Sympatric with B. granulosus and B. idae.

Boophis hyloides (E. Ahl. 1929)
Central Madagascar (T). Known only from type region.

Boophis idae (Steindachner, 1867)
Madagascar, (east Betsileo, Fianarantsoa). Known from East Region, Also Mandraka Valley, and near Périnet. Males were heard calling in October and November in the evening, near stagnant sunlit pools.

Boophis laurenti Guibé, 1947
Andringitra (T), Cirque Boby. Known only from Andringitra mountains. Uncommon.

Boophis leucomaculatus (Guibé, 1975) R
Nosy Mangabe, Antongil Bay. Known only from type specimen.

Boophis luteus (Boulenger, 1882)
Ankafana, Betsileo, (Moramanga, Antsihanaka). Not rare in forests in the East Region. During rainy nights males are heard calling from the leaves of trees & shrubs beside rapids in the forest. Tadpoles occur in swiftly flowing waters.

Boophis madagascariensis (Peters, 1874)
Madagascar, (Nosy Bé, Akkoraka), East Region. Males call in the evening in low vegetation less than 1m above small shallow muddy streams. During the day occasionally found in leaf axils of large plants. A true forest species.

Boophis majori (Boulenger, 1896)
Ambohimitombi forest (T). A forest species of the East Region.

Boophis mandraka B.-S., 1979
Mandraka Valley (T), probably type locality only. Altitude 1200m. Males were caught calling in shrubbery alongside rapids, on rainy nights. Tadpoles found in flowing water.

Boophis microtis (Guibé, 1974) R
Anosyenne chain (T). Known only from type locality.

Boophis microtympanum (Boettger, 1881)
Imerina (T), east Betsileo, known from mountain areas - Ankaratra, Andringitra. Collected in clear mountain brooks with stony bottoms, in wooded country with ericoid bushes. Jumps and climbs poorly. Tadpoles and eggs found in the same brooks as the adults. Eggs (clutch of about 100) are attached to a twig in fast flowing stream. Axillary amplexus.

Boophis miniatus (Mocquard, 1902)
Forest between Isaka and valley of Ambobo near Taolanaro, south Madagascar. Also near Périnet. Alt. 900m. Not observed during the day. Males found calling in the evening in the vegetation beside forest brooks.

Boophis opisthodon (Boulenger, 1888)
'Madagascar' (T); forest areas in East Region. A large species, probably breeds in temporary pools. Males found calling in shrubbery 30-50cm above shallow pools in February (these pools had disappeared by July). Calling males were around 10m apart.

Boophis pauliani (Guibé, 1953)
Forest of Moramanga and Périnet.

Boophis rappiodes (Ahl, 1928)
Sahambendrana (T); also near Périnet, Mandraka Valley, Moromanga-Anosibe road. Stream breeding.

Boophis reticulatus B.-S., 1979
Near Périnet (T), probably type locality only. Males were found on rainy evenings, calling on leaves of shrubs and trees by running water in open woodland.

Boophis rhodoscelis (Boulenger, 1882)
East Betsileo (T), (Andrangoloaka, north-west Madagascar), East Region.

Boophis tephraeomystax (A. Duméril, 1853)
Madagascar. Very common in forest areas in the East Region. Common in all coastal areas. Probably the only Boophis sp. occurring in the south-west (the driest part of island) where it is found in the irrigated area around Toliara. A secretive species, sheltering in leaf axils of plants during the dry season. Has the greatest tolerance of drought and heat of all Boophis spp., but is also very prominent in the humid eastern forests. Tadpoles are found in sunlit temporary rainpools with abundant vegetation.

Boophis untersteini (Ahl, 1928)
Central Madagascar (T), also north-west Madagascar, Mandraka valley, near Périnet, forest station, Tampoketsa d'Ankazobe and the road from Moramanga to Anosibe. Tadpoles collected in slow running water near forest.

Boophis viridis B.-S., 1979
Near Périnet (T), probably type locality only. Males were found on a rainy evening, calling on leaves of shrubs and trees, beside running water, in forest.

Boophis williamsi (Guibé, 1974)
Ambohimirandana (T), Ankaratra mountains. Known only from type localities. Also Manjakotompo forest station, Ankaratra mounatins altitude 2200 m. Tadpoles were collected in clear mountainous brooks with stony bottoms in wooded country. Development may take 2 years as in other montane spp.

ENDEMIC FISHES OF MADAGASCAR

* = Freshwater species

A. ENDEMIC SPECIES

Family ARIIDAE

*Ancharius brevibarbis Boulenger, 1911.
Found in the eastern coastal region and rivers at low altitude, the type specimen comes from Ambohimanga. Particularly common in rivulets of the eastern escarpment, especially around Fort Carnot, Ifanadiana and Ambohimanga du Sud. Prefers warm waters.

*Ancharius fuscus Steindacher, 1880.
Found in the eastern coastal region and rivers at low altitude preferring small riffles and rocky zones. Type specimen found at Tohizona. There are also records from Fenoarivo Atsinanana, the rivers Vohitra and Rianila near Brickaville, River Ranafotsy near Toamasina, Ambanambalo and Tohizona (Baie d'Antongil). Little is known about reproduction or the ecology of this fish. Easily captured by line, the flesh, containing little fat, is widely acclaimed.

Arius madagascariensis Vaillant, 1894.
Found more or less throughout the coastal regions, but particularly abundant in the lakes and rivers of the west. Type locality is Morondava R., W. Madagascar, other records being Lake Kinkony and St. Augustin, near Tulear. Numerous in lakes and rivers of the west from Sambirano to Onilahy, this fish is known from the following water courses: Betsiboka within the region of Maevatanana, lakes of the central-west coastal region (Sahapy, Tsianaloka, Bemamba), the Mahajanga region and St Augustin near Toliara. Known also from the Pangalanes. On the east coast, it is much rarer and is usually caught singly. A. madagascariensis apparently mounts water courses but is often stopped by the first waterfalls. Biology: Anadromous, entering freshwater to breed, although a period in salt water is necessary for maturation. Migrations are not as regular as some other species and take place in large clean western rivers. Mature fish measure 25-30cm. A mouth brooder which only breeds once a year, producing 45-80 spherical eggs from October to the end of November. Fishing takes place using fixed and movable traps, nets and occasionally by line. Very important fishery, catches may be smoked or sold fresh but are rarely salted. Markets in Antananarivo are an important outlet for smoked fish. In 1983, the sale price was about Mg F 1000/kg. The fishery is decreasing.

Family CYPRINODONTIDAE

*Pachypanchax homolonotus (Dumeril, 1861).
Found in small streams and the 'matsabory' of the central west and north-west of the island. Considered rare, it is localized in the west from Antseranana and Nosy Bé to Morondava. Records exist from Lac Kinkony, River Maroparosy by Mevatanano, a brook at Andrafiavilo, Manitrano, freshwaters at Ankarana, brook at Antikotozo, marsh at Mihilaka, marsh at Ankirihitra, Maevatanana. Aquarium species (11).

*Pantanodon madagascariensis (Arnoult, 1963).
Formerly Oryzias. Found in a few forested hill streams around Mahambo, Tampolo-Fenoarivo Atsinanana, and the east coast in acid water of pH 6. It is likely to be more widely distributed than this in the eastern coastal forest region without being anywhere abundant. Considered rare.

Family ATHERINIDAE

*Bedotia geayi Pellegrin, 1907.
Has a wide distribution from the north to the south of the island on the eastern side between the coast and 600 m altitude. Specific records include: Fort Carnot (River Sandranata) Befotaka, (600 m altitude), Karianga (500 m altitude), Toamasina, Mahambo, Taolanaro, River Mananana (100 m altitude) and the mountain streams of Mananjory. It is thought to prefer acid waters. An attractive and sought after aquarium species, which is also eaten locally. Possibly conspecific with B. tricolor.

*Bedotia longianalis Pellegrin, 1914.
Found in similar regions to B. geayi, although preferring higher altitudes, ca 450-750 m; recorded from Mahambo to Fenoarivo Atsinanana. It generally prefers fresher water than B. geayi. Fished in freshwater and brackish water.

*Bedotia madagascariensis Regan, 1903.
Freshwater but no type locality known. Found in regions of low-mid altitude on the east coast. Records exist for Maroansetra and Ambodivoangy. Thought to be rare, this fish has a limited distribution. Kiener lists it from the coasts of the east-central region, although Arnoult and Bauchot found it in abundance in the north-east of the island.

*Bedotia tricolor Pellegrin, 1932.
Regions of low-mid altitude on the east coast. Recorded from rivulets flowing into the River Faraony (Mahakara Province). Attractive species - may be caught for aquarium specimens. Possibly conspecific with B. geayi.

*Rheocles alaotresis (Pellegrin, 1914).
Found in the shallow basin of Alaotra, high Maningory the Ambatondrazaka basin, Mangoro and the region of Anjozorobe. It reproduces in the spring, females producing 100-200 eggs. Formerly fished in the Lake Alaotra basin, in particular the rivers in the north and northwest of the basin during the wet season; this fishery has since collapsed. This fish was not eaten fresh and is usually dried.

*Rheocles sikorae (Sauvage, 1891).
Central Madagascar and mountain streams in eastern Madagascar including the forested region of Périnet. Also freshwaters around Mangoro. Caught in baskets and occasionally by line but it does not play an important economic role.

*Rheocloides pellegrini Nichols and La Monte, 1931.
Monotypic genus. Considered rare, it is found in the Andapa basin in north-east Madagascar, Lake Alaotra and the district of Ambatondrazaka.

Family AMBASSIDAE

*Ambassis fontoynonti Pellegrin 1932.
Relatively uncommon, found in a limited geographical location in the central/east and south-east coastal region of Madagascar. Known from the region of Manakara, Faraony, Rianila and coastal rivulets.

Family CICHLIDAE

*Oxylapia polli Kiener & Mauge, 1966.
Very limited distribution at Marolambo, Toamasina province at about 450 m. Strict ecological niche. Considered likely to be threatened due to its very restricted distribution. An archaic cichlid in a monotypic genus.

*Paratilapia polleni Bleeker, 1868.
The most widely distributed native cichlid of Madagascar. It exists throughout Madagascar except A) extreme south; B) Isalo and plateau of Horombe; C) above 1400-1600 m altitude; D) some semi permanent rivers of the southwest and certain western zones. There are probably several geographical races. Records exist for Toamaisna, Mahanova, Imerina, Morafena, Befotako (600 m altitude), Midongy au sud (700 m altitude), River Manampetra (500-900 m altitude), Karianga (500 m altitude), Antananarivo (1000-1100 m altitude), Lake Alaotra, Ankarana, Mantasoa, Antsirabé and Rasaobe. Its range has been increased by introductions to waters where it would otherwise have been extirpated by exceptional cold spells e.g. Lake Itasy, although it has since disappeared from the latter. Quite common, but not prolific, it is considered to be vulnerable. Habitat: The most widespread endemic cichlid and most euryhaline, this fish can be found in semi-permanent watercourses, streams and rivers, lakes, lagoons and marshes, in fresh and brackish waters although it does not approach the mouths of rivers. Biology: An adaptable species which can cope with large changes in climate and water chemistry. In mountainous areas, it is limited by temperature, not

Paratilapia polleni (contd.)
living in waters below 12-13°C. Sexually dimorphic, males have blue and green/yellow colouring. Slow growers, they may reach a maximum of 30 cm and 800 grammes. At the first spawning, 800-900 eggs are produced and on subsequent spawnings this may rise up to a maximum recorded of 3610. Guarded by the parents, incubation is controlled by temperature and lasts for 12 days at 22°C. The nest may be a hollow dug out of the bank. Young fish become independent 4-5 weeks after hatching. Parents may cannibalize the young. Its diet comprises plankton when young, later becoming omnivorous and taking mainly insects and aquatic larvae as well as algae. Fisheries: Prized food fish which was dominant in fisheries of the past, but now of reduced importance as new introduced species compete. Notable fisheries were at Alaotra and around Antananarivo. Experimental aquaculture has taken place in the paddy fields. It is a luxury fish well received in the markets. Introduced tilapias have reduced the numbers of this fish.

*Paretroplus dami Bleeker, 1868.
Occurs in the north-west at low altitudes. The type specimen was collected from Imerina and records exist for River Sambirano, Ampombilava, Mahanaro and Ambalomainty, Betsiboka, Kamoro, and Mahajamba, Nosy Bé and Lake Ambanga. In the north, the distribution overlaps with P. petiti and in the centre with P. kieneri and P. maculatus. Considered vulnerable. Biology: Little known, likely to be similar to its congeners. Fisheries: In the north-west region this fish does not form an appreciable part of the catch. Some smoked fish were exported to Antananarivo.

*Paretroplus kieneri Arnoult, 1960.
Fairly widespread being abundant in Lake Kinkony and also found in the regions of Maevatanana, Ambato-Boeni, Tsaramandroso and Kamoro. Overlaps with P. maculatus and P. petiti in Kamoro. Less common than P. petiti in Lake Kinkony. Considered vulnerable. Habitat: Typically freshwater species. In Lake Kinkony it is largely found in areas where vegetation is encroaching or where the lake is very deep. Biology: Thought to reproduce several times per year, the eggs are laid on aquatic vegetation. A tough species, it is surviving where P. petiti has disappeared. Fisheries: Important fisheries in Lake Kinkony, taken by net and occasionally line. Regulated throughout the course of the year. Most of the catch is smoked at Mitsinjo, Mahajanga and Antananarivo and then will keep up to two months. Attempts have been made at aquaculture in the west and in warm interior regions, but it is probable that clean water, a large space and abundant natural food are required.

*Paretroplus maculatus Kiener & Mauge, 1966.
The most localised member of this genus, being found in the central north-west. Currently known from the region of Lake Amparihibe-Sud (where it was abundant in 1966), Tsaramdroso, Betsiboka and Kamoro. Overlaps in the north of its range with P. dami and with P. kieneri and P. petiti in Kamoro. Considered vulnerable.

*Paretroplus petiti Pellegrin 1933.
This fish has a wide fragmented range, being known from the north-west coastal area down almost as far south as the Iles Barrren. Type from the River Maintimaso (Mahajanga Province). Records from Maintirano, in Ambanja and in the interior of the country around Tsamandroso, in particular in the small lake of Ampijoroa. It is absent however from several intermediate zones eg. Lake Sahapy, Lake Amparihy, and Matsabory south of Soalala. In Kamoro, P. petiti may previously have been common but is now absent from many lakes and rivers. This is probably due to the degradation of the water by the lateritic mud carried from the Hauts Plateaux as they become increasingly degraded by fire. Abundant in Lake Kinkony, neighbouring lakes and in the region of Tsaramandroso. Overlaps with P. kieneri and P. maculatus in the Kamoro. Considered vulnerable. Habitat: Has a preference for thickly vegetated areas and the edges of lakes. Typically freshwater. Biology: Grows rapidly, reaching 35 cm and exceptionally 40 cm.

Paretroplus petiti (contd.)
Reproduces prolifically; a female of 25 cm may produce 2000 eggs which are pink and are laid in aquatic vegetation. Breeding occurs during most of the year and fishermen think that the females lay 2-3 times a year. Parents care for the young over two to three months. An omnivore, P. petiti feeds on plankton, algae, insects and small crustaceans as well as the pulp of the tubercles of waterlilies.

*Paretroplus polyactis Bleeker, 1878.
Limited to an extensive coastal band from Antseranana to Taolanaro and is more common in the canals of the Pangalanes. Occupies freshwater except in the rainy season when it may enter littoral zones. Type collections were made in Toamasina and Imerina. Common in freshwater and estuaries. Habitat: Only species of this genus found on the east coast where it occurs in rivers, streams, coastal lakes and lagoons but rarely enters into the mouths of rivers which are too saline. P. polyactis does not range above an altitude of 250-300 m. Found in fresh and brackish waters, preferring warm, clean, still waters. Biology: Grows rapidly and may attain 40 cm in length. Reproducing throughout November to March, adults make a hollow depression beneath a stump, branch or other object and eggs are laid on the underside. The diet is based on plankton, molluscs and small shrimps. This probably explains the pink colour of the fish flesh. Fisheries: A full bodied good food fish, it is much sought after, especially in the markets of Toamasina which are supplied by fisheries in Ivoloina, Ivondro, Mahatsara and the Pangalanes. In the Pangalanes this fish plays a definite economic role. However, the methods of capture never bring in large hauls - possibly best as the fish appears to have a limited resistance to overfishing. May be raised in ponds and many attempts have been made at Ambila-Lemaitso. It is likely that this clean water fish, which requires space and abundant, natural food, may not be suitable for intensive aquaculture.

*Ptychochromoides betsileanus (Boulenger, 1899).
Confined to the central and southern central parts of Madagascar, this fish is named after the site of its discovery in Betsileo. It is also known from Lake Itasy, Ambalavao-Fianarantsoa, Mandoto, Haut Matsiatra, Ampamaherana, Manantantanana, Zamandao and Ivohibe. Abundance: Reportedly in decline. In 1933 it was reported that this fish constituted 40% of the species in Lake Itasy but has now effectively disappeared as a result of competition with introduced tilapine fishes Declines are also occurring elsewhere following introductions of tilapia. A further introduction, of the water hyacinth, Eichhornia crassipes, may also be affecting it by reducing the amount of flowing water and preventing reproduction in favoured rocky areas. Deforestation in the Hauts Plateaux has changed the water regime, reducing the water quality, particularly after heavy rain when laterite soil is brought down. It seems likely that this fish may have been exterminated in several areas and is considered threatened. Habitat: Preferring clean oxygenated waters, it may be found in rocky passages (around Fianarantsoa) and in waterfalls (near Manantanana). This species is mainly found in rivers, rarely in lakes. Biology: This fish needs clean, cool, well oxygenated water. In rivers it is most abundant in waterfall pools up to 2-3m deep and in Lake Itasy it does not occur in areas of warm water which are less oxygenated. An omnivore P. betsileanus feeds on larval insects, vegetation, small fish and shrimps, and is considered to grow more rapidly in rivers. There is one spawning period in October and the start of November, when females lay up to several hundred eggs, by preference on rocks up to 1.5 m diameter but, failing that, on sandy shores. Fisheries: One of the best freshwater fishes for eating, it has a delicate taste, this fish is not suitable for aquaculture due to its exacting requirements. Partly due to its slow growth and limited reproductive capability, it is rare for fisherman in Lake Itasy to capture fish exceeding 300 g or 22 cm in length. A further problem is that it is a difficult fish to transport.

*Ptychochromis oligacanthus Steindachner 1880.
There are 4 distinct geographical races. (A = extreme east coast, B = north-west and Nosy Bé, C = Basin of Mandritsara, D = south-west around Tulear). This fish is found almost throughout the island and records exist from Toamasina, Mahanova, Imerina, Fenoarivo Atsinanana and Lake Tongobory, Taolanaro, River Manampatra (500-900 m altitude), Ambila Lemaitso, Antikotoza, River Sambirano, Mahambo, Tampino, Maroramalona and Lake Rasaobe. This fish is the most common of the cichlids after P. polleni, although tilapia have greatly reduced its numbers. Considered vulnerable. Habitat: Lives in fresh and brackish waters, preferring warm or lukewarm water. Although tolerant of salty water, it rarely enters river mouths. Typical of coastal zones and of the foothills, it is found in rivers, streams lakes and lagoons of the east coast. Least stenohaline of the cichlids. Prefers large tracts of freshwaters which explains its absence from small coastal marshes although it is found in intermediate areas. It does not penetrate above 300-350 m altitude. An initially successful introduction to the small Lake Ambohibao (1150 m altitude) failed due to harsh winter conditions. It is polymorphic, coastal specimens differing from inland specimens by being fatter. Biology: Reaching a maximum of 27 cm and weight of 500 grammes. A nest of 5-10 cm diameter is scooped out of the sandy substrate and incubation of the eggs occurs under the supervision of the parents. Egg laying continues from November to March and egg incubation takes 8-10 days. The alevins stay in shoals which may venture outside the nursery area. Omnivorous, taking small insects (and also plankton). In the Pangalanes shrimps are favoured. Fisheries: In the whole of the east coast this fish constitutes an important part of the fisheries and may reach 25% of the catch in certain areas. P. oligacanthus has been raised in artificial lagoons eg at Ambila-Lemaitso. By virtue of its small growth and limited resistance, this species is of less value to aquaculture than the tilapias.

Family ELEOTRIDAE
*Eleotris tohizonae (Steindachner,1880).
Found along the east coast and on the northwest coast, known locations are Antsirabe, Nosy Lava, source of the Amboboko, Ivoloina, Fenoarivo Atsinanana, Mahambo, River Tohizona (Foizona), Toamasina, basin of the River Mananara, River Faroiny, Mahambo Province and the Taolanaro region. It prefers small rivulets at low altitudes. Too small to be of economic importance but is nevertheless taken.

*Eleotris vomerodentata Maugé, 1984.
Known from the Pangalanes to Andevoranto on the east coast of Madagascar.

*Ratsirakia legendrei (Pellegrin, 1919).
Recently changed genus from Eleotris. Found strictly in freshwater at high altitudes (750-1400 m) (11), this fish is widely distributed in the Imerina region. It is known from Tsaratanana, Mangoro, Lake Alaotra, Périnet, and Midongy du Sud although it is rarer in the central south of the island. Females lay about 200 eggs, which are guarded by the males. Preyed upon by the introduced Micropterus salmoides. It is too infrequent to be of economic importance.

*Typhleotris madagascariensis Petit, 1933.
This blind fish inhabits caves and subterranean waters in the southwest of the island. Records exist from Ambilahilalika, Malazomanga, Mitoho, Lalio, Andramanaetse, Nikotsy. Tsimanampetsotsa, Mitono, Betioky to Soalara, Efoetsy to Itampolo. Very limited distribution in the west, therefore any disturbances could affect the fish. Considered threatened. Eats crustacea and cave insects.

*Typhleotris pauliani Arnoult. 1959.
Caves and subterranean waters in the southwest of the island. Blind. Caves Safara, Andranomaly, Ankilivona, Morombe, Baie d'Assassains. Very limited distribution in the west, therefore any disturbances could affect the fish. Considered as threatened. Feeds on small aquatic insects.

Family GOBIIDAE
*Acentrogobius therezieni Kiener, 1963.
Type locality is a rising spring of fresh calcareous water (tsingy) at Antsonjo and is also known particularly from limestone formations south of Soalala including the river Andranomavbakely (tributary of the Andranamavo) which enters the Mozambique channel by Soalala. A scarce fish, considered rare.

Bathygobius samberanoensis (Bleeker, 1867).
Recorded from Ambavombé (littoral zone) and Bay of Bombetake east of Bastard and near Taolanaro. Especially in the northwest, it prefers brackish waters.

Chonophorus macrorhynchus (Bleeker, 1867).
Thinly distributed throughout most of the island and principally known from the Sambirano region and north of the island. Two forms are known, one from coastal regions which may mount rivers for considerable distances having been found in the Tsibidy near to Kandreho. Possibly euryhaline, it is relatively common. It is strictly freshwater and is probably adapted to high altitude. It is preyed upon by the introduced Micropterus salmoides.

Gobius polyzona Bleeker, 1867.
Coastal areas. Sambirano River.

*Platygobius hypselosoma (Bleeker, 1867).
Known from the west and north, including the River Sambirano and Ivondro. It is infrequently encountered and does not play any economic role.

Platygobius madagascariensis (Bleeker, 1867).
Occurring throughout most coastal zones, most densely in the River Sambirano, this fish occurs in the bay of Ampasindava including Nosy Bé. It has a secondary economic role.

*Stenogobius vergeri (Bleeker, 1867).
Maromandia. Lives in the east coastal region.

Family KRAEMERIDAE
Gobitrichinotus arnoulti Kiener, 1964.
In Madagascar this species is known from the mouths of rivers along the central/eastern coast, notably Rianila where it is abundant. Appears to inhabit more or less salt free sands leaving these to feed when rising water covers them. They rebury themselves as the water withdraws. Not of economic interest, but known to the fishermen of Betsimisaraka.

B. ENDEMIC SUBSPECIES

Family ANGUILLIDAE
*Anguilla nebulosa labiata (Peters 1952) - In Madagascar only found in the Lake Itasy region.

Family CYPRINODONTIDAE
*Pachypanchax playfairi (Gunther 1866) - Known from Zanzibar and the Seychelles. An attactive species found in many localities. Var. sakaramy Holly described as endemic. Considered a subspecies of the Seychelles species. Found in the extreme north east particularly in the Ambre region. Locations include the Foret d'Ambre and Antseranana - very localized and needs attention.

Family ATHERINIDAE
Hepsetia duodecimalis (Cuvier and Valenciennes, 1837) - Known from Ceylon, Malaysia. Var. waterloti Pellegrin, 1932 - Described from Ruisseau d'Antikotozo, additional records are Ambilobe (Antseranana) and the Toamasina region. It will extend for many miles upstream and is found throughout the Pangalanes Est. It has also been found at Ambila-Lemaitso. It is found in mangroves, brackish waters, coastal marshes and lagoons. A shoaling species, it can only be caught in baskets.

Family KUHLIIDAE

Kuhlia rupestris (Lacepede, 1802) - Comores and Madagascar. Var. sauvagei Regan considered endemic to Madagascar. Found frequently in Onilahy and will enter the Sept Lacs and Ambohimatiavelona. Many young have been found at Sarodrano (north of St. Augustin) and along the west coast. Additional records include Imerina, River Ranobé (50km from its mouth), the east coast and the region of Toliara. Carnivorous. Reproduction has never been observed in freshwater. Their preference for rocky passages is utilized by fishermen: traps are set in calm water near small waterfalls above which are fixed ant or termite nests. The insects fall into the water and attract the fish. Also caught in nets.

Family MUGILIIDAE

*Agonostomus telfairii Pellegrin, 1932 - Exists on Comoros, Réunion, Mauritius and the Seychelles. Var. catalai Pellegrin, is considered endemic and is found in a band parallel to the east coast including the basin of Ankaibé between 100 and 400 m altitude. Also found in Haut Mananaire and in rapids on the Mananano. Habitat: This is a species which requires strongly oxygenated waters and is frequently found in low lying foothill rivers. Typical of clear water. Herbivorous. May be caught by line or by net and certain fishermen capture large specimens by harpoon. Prized flesh and a good sports fish.

Family ELEOTRIDAE

Eleotris ophiocephalus (Cuvier and Valenciennes, 1837) - Zanzibar, Mozambique, Comores, Seychelles. In Madagascar found in coastal zones including Nosy Bé, Nosy Lava. Var. madagascarensis is considered endemic and is found in coastal waters reproducing in freshwater.

Family GOBIIDAE

Gobius criniger (Cuvier and Valenciennes, 1837) - Known from E. Africa, India and Malaysia. This is a marine species which enters coastal freshwaters. Var. decaryi Pellegrin is considered endemic, and has been described from marais Fort Dauphin and Mananara. There is no economic interest in this subspecies.

Periophthalmus koereuteri (Pallas, 1770) - Large distribution and found from the west coast of Africa to Polynesia including Madagascar, Seychelles, India and Malaysia. Var. papilio Bloch & Sneider 1801 - In Madagascar it is found throughout coastal and brackish waters especially around rocks and mangroves. An amphibious species, it is carnivorous eating insects, small crustacea and fish.

C. REGIONAL ENDEMICS

Family KUHLIIDAE

Kuhlia splendens Regan, 1913 - Suggested endemic but also found on Rodrigues and Mauritius. Occasionally found on the west side of Madagascar, more rarely on the east side. May be fished for although not commonly so.

Family MUGILIIDAE

Agonostomus dobuloides (Cuvier and Valenciennes, 1836) Considered endemic by, Pellegrin also reports this fish from Réunion. Found in the coastal zones of the extreme north and north-east of Madagascar. A rarer species found at lower altitudes than A. telfairii, some have been captured in the river Ankaviabe in the region of Antalahia. Others have been found near Antseranana.

Family BLENNIIDAE

Salarias monochrous Bleeker, 1869 - Listed as endemic. Known from Réunion and River Sambirano, Madagascar. Not of economic interest.

Family GOBIIDAE

Sicyopterus acutipinnis (Guichenot, 1874) - Also found in freshwaters in the Mascarenes and in Réunion.

Sicyopterus fasciatus Day 1875 - Found on Mauritius and Réunion, it has been considered rare on Madagascar, infrequent and abundant in rocky parts of east coast rivers. In Madagascar, this fish inhabits rivers in the foothills of the east coast usually up to 500 m. Found in strongly oxygenated waters often in association with plants such as Aponogeton fenestralis and Hydrostachys sp. Migrates to the coast. Unusuallly, this fish may use aerial respiration and feed on benthic microphages. Fished, but of lesser importance than S. lagocephalus.

Sicyopterus lagocephalus (Pallas. 1770) Found in the freshwaters of the Mascarenes. This species has a regular migration, entering larger watercourses in large numbers at the new moon and for up to 2-3 days afterwards. Found in large shoals in coastal waters in the sea and at river mouths. Recruitment appears to be variable. Fry are often harvested in large numbers and eaten fresh or dried.

Sicyopterus laticeps (Cuvier & Valenciennes, 1837) - Known from River Anjouan (Comoros) and the Mascarenes.

MADAGASCAR BUTTERFLIES (except HESPERIDAE)

Madagascan endemics are indicated by * and Malagasy sub-regional endemics are indicated by **.

Family PAPILIONIDAE

Graphium evombar Boisduval, 1836
*Common over the whole island; not at risk. Endemic to Madagascar.

Graphium cyrnus Boisduval, 1836
*Common over the whole island; not at risk. Endemic to Madagascar.

Graphium endochus Boisduval, 1836 - RARE
*An uncommon species which flies on forest edges, often feeding on Lantana. Biology unknown but it may breed inside the forest. Abundant on Montagne d'Ambre. Its status should be monitored. Endemic to Madagascar.

Atrophaneura (Pharmacophagus) antenor Drury, 1773
*Pharmacophagus is an endemic and monospecific subgenus, but the genus Atrophaneura is widespread in the Oriental region. A. (P.) antenor is an important endemic, being the only Afrotropical representative of the tribe Troidini, the Aristolochia-feeding swallowtails of South America (Parides, Battus) and the Orient (Atrophaneura, Troides, Ornithoptera etc.). It is probably Madagascar's most beautiful butterfly and is sought by collectors. However, it is well distributed outside the rain forests and not presently at risk. Its status should be carefully monitored.

Papilio demodocus Esper, 1798
An introduced panafrican species, minor pest of citrus.

Papilio erithonioides Grose-Smith, 1891
*Mainly in the west and central areas. Not particularly uncommon, not threatened. Endemic to Madagascar.

Papilio grosesmithi Rothschild, 1926 - RARE
*Mainly in the west. Commercially collected. Requires monitoring. Endemic to Madagascar. See data sheet.

Papilio morondavana Grose-Smith, 1891 - VULNERABLE
*The rarest of the Malagasy endemics. Threatened by loss of habitat and vulnerable to commercial collectors. See data sheet.

Papilio dardanus Brown, 1776
A panafrican species represented in Madagascar by a special race meriones. Not uncommon in the north, east, south and south-west. Forest edges.

Papilio oribazus Boisduval, 1836
*Quite common and well distributed, except in the west. Endemic to Madagascar.

Papilio epiphorbas Boisduval, 1833
**Well distributed in Madagascar and not at risk; also on the Comoros.

Papilio delalandei Godart, 1824
*Well distributed in forests, especially in the east. Endemic to Madagascar.

Papilio mangoura Hewitson, 1875 - RARE
*An endemic species distributed in the eastern rain forests and usually regarded as rare. At present it may not be in danger, but deforestation could quickly alter its status. Careful monitoring required. Local catchers decoy P. mangoura with females of the more common P. delalandii, which has similar yellow-barred wings. See data sheet.

Family PIERIDAE

Catopsilia florella F., 1775
Afrotropical and Oriental.

Catopsilia thauruma Reakirt, 1866
**Madagascar and Mauritius.

Eurema hecabe L., 1758
Afrotropical except Cape Province.

Eurema brigitta Stoll, 1780
Afrotropical. Ssp. pulchella Boisduval in Madagascar, Mauritius, Comoro and Aldabra.

Eurema hapalae Mabille, 1882
Marshy grassland in tropical Africa and Madagascar.

Eurema desjardinisi Boisduval, 1833
**Madagascar, Comoro Is.

Eurema floricola Boisduval, 1833
**Madagascar, Aldabra, Comoros, Mauritius, Réunion. Ssp floricola Boisduval, Madagascar endemic.

Pinacopteryx eriphia Godart, 1819
South Africa, Zimbabwe, Botswana, Mozambique, Malawi, Tanzania, Madagascar (ssp. mabillei Aurivillius), Sudan, Ethiopia, Somali Republic, Kenya, Uganda, Mauritania to Senegal, Upper Volta, Niger, Chad, Arabia, Zaire.

Nepheronia buquetti Boisduval, 1836
Senegal to Sudan and Ethiopia (ssp. in Niger), north of forest belt, Somali Republic to Mozambique, Zimbabwe and Natal (South Africa). Ssp. pauliani Bernardi endemic to western and southern dry areas of Madagascar.

Colotis calais Cramer, 1775
Africa south of the Sahara and southern Arabia; absent from Cape. Ssp. crowleyi Sharpe in Madagascar.

Colotis zoe Grandidier, 1867
*Madagascar endemic.

Colotis guenei Mabille, 1878
*Madagascar endemic.

Colotis evanthe Boisduval, 1836
**Madagascar and Comoro Is.

Colotis mananhari Ward, 1870
*Madagascar endemic.

Gideona lucasi Grandidier, 1867
*Madagascar endemic monospecific genus.

Belenois grandidieri Mabille, 1878
**Madagascar and Aldabra, replacing B. zochalia, of which it could be a race.

Belenois aurota F., 1793
Afrotropical and parts of Palaearctic and Oriental. Speciemens from Madagascar are strongly marked with yellow.

Belenois creona Cramer, 1776
Senegal to Nigeria, Sudan, Ethiopia, Somalia, Comoros, Arabia, East Africa and Zaire to Cape, Madagascar (endemic ssp. prorsus Talbot).

Belenois helcida Boisduval, 1833
*Madagascar endemic.

Belenois antsianaka Ward, 1870
*Madagascar endemic.

Belenois mabella Grose-Smith, 1891
*Madagascar endemic.

Dixeia charina Boisduval, 1836
Kenya to southern Africa. Ssp. narena Grose-Smith endemic to Madagascar.

Appias sabina Felder & Felder, 1865
Western Uganda to Nigeria and Sierra Leone, East Africa to Malawi and Zimbabwe, Comoros (ssp. comorensis Talbot), Madagascar (ssp. confusa Butler).

Appias epaphia Cramer, 1779
Senegal to Zaire, Uganda, eastern and southern Africa, Comoros, and Madagascar (endemic ssp. orbona Boisduval).

Mylothris splendens Le Cerf, 1926
*Madagascar endemic.

Mylothris smithii Mabille, 1879
*Madagascar endemic.

Mylothris phileris Boisduval, 1833
*Madagascar endemic.

Leptosia nupta Butler, 1873
Nigeria to Angola, Zaire, Uganda, Tanzania, Ethiopia, and endemic ssp. viettei in Madagascar.

Leptosia alcesta Stoll, 1784
West Africa, Ethiopia, Sudan, Uganda, Zaire, Kenya, Tanzania to Natal (South Africa). Ssp. sylvicola Boisduval endemic to Madagascar.

Family NYMPHALIDAE: Danainae
Danaus chrysippus L., 1758
A common cosmopolitan species.

Amauris nossima Ward, 1870 - RARE
*One of the great rarities of Madagascar, distributed mainly in the eastern rain forests. Three forms are known. Montagne d'Ambre an important locality for disjuncta. Believed to be endemic to Madagascar, but D'Abrera lists it as possibly occurring in the Comoros.

Amauris phoedon F., 1798
**Mauritius and possibly Madagascar. Common around the coast in Mauritius, but only doubtfully recorded from Madagascar.

Family NYMPHALIDAE: Charaxinae
Charaxes is a genus of large tailed butterflies, much sought by collectors. Almost exclusively forest-dwellers, their biology is very poorly known. Adults seek ripe fruits and excrement and are trapped by baiting. Their distribution in Madagascar is poorly known. Their status needs to be carefully monitored as the felling of rain forest proceeds.

Charaxes cacuthis Hewitson, 1863
*A subspecies in Paulian (1956) but given full species rank in D'Abrera (1980). Well distributed except in the north. Endemic to Madagascar.

Charaxes andara Ward, 1873
*Well distributed in woodlands and montane areas, but apparently not in the forests of the east. Endemic to Madagascar.

Charaxes andranodorus Mabille, 1884
*Very large (10-12 cm wingspan). Central and northern forests, including Montagne d'Ambre. Insufficient data. Endemic; restricted in range.

Charaxes phraortes Doubleday, 1847
*A forest species. No information available except descriptions. Possibly rare. Endemic to Madagascar.

Charaxes analava Ward, 1872
*Well distributed except in the south. Apparently a forest species. Little information. Endemic to Madagascar.

Charaxes antamboulou Lucas, 1872
*Well distributed except in the north. Endemic to Madagascar.

Charaxes cowani Butler, 1878 - RARE
*Apparently very restricted in range, known only from the central region, 35 km south of Amboistra at 1700 m. More data required. Endemic to Madagascar.

Charaxes zoolina Westwood, 1850
Panafrican with a subspecies, betsimisaraka in Madagascar. Not at risk, particularly common in the eastern forest (valley of Faraony, etc.), and reaching high altitudes in Sambirano.

Euxanthe madagascariensis Lucas, 1843 - RARE
*A forest species, rare and with unknown biology. Currently well distributed but requires monitoring as deforestation proceeds. Endemic to Madagascar.

Family NYMPHALIDAE: Nymphalinae
Smerina manoro Ward, 1871 - RARE
*Endemic monospecific genus. Found in cliffs above Toamasina. More data needed.

Phalanta phalantha Drury, 1773
Asia and Afrotropical cosmopolitan. P. p. aethiopica occurs widely on Indian Ocean islands, including Madagascar.

Phalanta madagascariensis Mabille, 1887
*Endemic to Madagascar. Widespread except in the south.

Phalanta eurytis Doubleday, 1847
Throughout tropical Africa, south to Natal, including Madagascar and Comoros.

Apaturopsis kilusa Grose-Smith, 1891 - RARE
*A strictly forest species found only in north-western Madagascar. Very rare and poorly known. Endemic to Madagascar.

Hypolimnas misippus L., 1764
A Panafrican, Oriental and Australian species. Common in the eastern and central areas, of Madagascar, especially on the plateaux.

Hypolimnas bolina L., 1758
A Panafrican, Oriental and Australian species, common in east and central Madagascar. Also on Socotra and Mauritius.

Hypolimnas dexithea Hewitson, 1863
*Endemic, but common and widespread in Madagascar. In Montagne d'Ambre and elsewhere it flies on the forest edge.

Hypolimnas deceptor Trimen, 1873
Coastal forests of eastern Africa from Natal (South Africa) to southern Somali Republic, inland to eastern Zimbabwe and Malawi, with a separate ssp., deludens Grose-Smith, from central and south-western Madagascar.

Hypolimnas dubius Palisot de Beauvois, 1806
Panafrican, Hypolimnas d. drucei flies on Madagascar, the Comoros and Mauritius. Common.

Salamis anteva Ward, 1870
*Widespread endemic in the forests of Madagascar.

Salamis angustina Boisduval, 1833
**The nominate ssp. is from Réunion, with a few doubtful records and or occasional vagrants to Madagascar. Ssp. vinsoni Le Cerf is very rare and possibly extinct in Mauritius.

Salamis dupréi Vinson, 1863
*Widespread Madagascar endemic.

Junonia (=Precis) oenone L., 1758
Entire Afrotropical region, with ssp. epiclelia Boisduval on Madagascar, Aldabra, Astove, Assumption and Cosmoledo Is.

Junonia hierta F., 1798 (P. lintengensis in Paulian 1956)
Oriental and Afrotropical regions, with ssp. paris Trimen flying in central, southern and south-eastern Madagascar.

Junonia eurodoce Westwood, 1850
*In forest clearings. Widespread except in the west. Endemic to Madagascar.

Junonia rhadama Boisduval, 1833
**Madagascar, Mascarene, Comoro and Astove Is. Doubtfully recorded from Mozambique.

Junonia goudoti Boisduval, 1833
**Madagascar and Comoro Is. Widespread.

Junonia natalica Felder, 1860
Cosmopolitan. Recorded once from Madagascar.

Junonia andremiaja Boisduval,. 1833
*A forest species widespread except in the west. Endemic to Madagascar.

Junonia (Precis) orythyia L., 1758
Cosmopolitan. Widespread.

Vanessa cardui L., 1758
Cosmopolitan and common.

Antanartia borbonica Oberthür, 1880
**Nominate ssp. on Réunion and Toamasina region of eastern Madagascar. A separate ssp., mauritiana Manders, is found in Mauritius.

Antanartia hippomene Hübner 1823
Cape Province to Natal and Transvaal in South Africa, with a separate ssp., madegassorum Aurivillius, confined to Madagascar.

Byblia anvatara Boisduval, 1833
Panafrican, the nominate Malagasy subspecies also occurs in the Comoros and Glorioso Is.

Neptidopsis fulgurata Boisduval, 1833
Coastal forest-savanna mosaic in Kenya and Tanzania, with the nominate ssp. endemic to Madagascar. Widespread.

Eurytela dryope Cramer, 1775
Sub-Saharan Africa and south-western Arabia, with ssp. lineata Aurivillius confined to Madagascar.

Eurytela narinda Ward, 1872
*Widespread in Madagascar except in the east. Closely related to E. dryope, possibly a race, in which case E.d. lineata would become a race of narinda.. Endemic to Madagascar.

Sallya (= Crenis) howensis Staudinger, 1886
*Endemic to Madagascar. Well distributed.

Sallya amazoula Mabille, 1880
*Well distributed. Endemic to Madagascar.

Sallya madagascariensis Boisduval, 1833
*Forests of Madagascar, and probably woodlands too. Well distributed. Endemic to Madagascar.

Cyrestis camillus F., 1781
A Panafrican species with a Malagasy endemic subspecies elegans. Widely distributed in Madagascar.

Neptis decaryi Le Cerf, 1928 - RARE
*Biology of the Malagasy Neptis species unknown. N. decaryi is only known from the type specimen from Tsantsany. More data required. Endemic to Madagascar.

Neptis saclava Boisduval, 1833
Widespread in sub-Saharan Africa. Subspecies saclava well distributed and common throughout Madagascar.

Neptis metella Doubleday & Hewitson, 1850 - RARE (in Madagascar only)
Panafrican species, but endemic subspecies gratilla only known from Toamasina in eastern Madagascar. Very rare.

Neptis kikideli Boisduval, 1833
*Well distributed except in the north. Endemic to Madagascar.

Neptis sextilla Mabille, 1882- INDETERMINATE
*Only known from the eastern forests of Madagascar and apparently very rare. Very little preserved material is available. More study required of this rather enigmatic species.

Cymothoe lambertoni Oberthür, 1923
*A forest species from Sambirano, Montagne d'Ambre and the south-east. Biology unknown. Endemic to Madagascar.

Aterica rabena Boisduval, 1833
*A forest and woodland species with a wide distribution in Madagascar. Endemic to Madagascar.

Pseudacrea lucretia Cramer, 1775
Panafrican. Subspecies apaturoides Felder is confined to Madagascar, where it is widespread in woodlands.

Pseudacraea glaucina Guenée, 1864
*Eastern and southern Madagascar. Presumably a woodland and forest species. Apparently common. Endemic to Madagascar.

Family NYMPHALIDAE: Acraeinae
The genus Acraea is essentially restricted to woodlands and forests, but does well in bushy gardens.

Acraea ranavalona Boisduval, 1833
**Very common and widespread in Madagascar. Also on the Comoros and Aldabra group (Astove Island).

Acraea hova Boisduval, 1833 - RARE
*Eastern, central and Sambirano districts. Apparently always rare. Endemic to Madagascar.

Acraea dammii Vollenhoven, 1869
**Widespread on Madagascar and the Comoros.

Acraea cuva Grose-Smith, 1889
Coastal districts of Kenya and Tanzania to Mozambique and Malawi. The endemic ssp. villetei flies in Madagascar.

Acraea igati Boisduval, 1833
**Very common within its range in Madagascar. Also on the Comoros.

Acraea fornax Butler, 1879
*Widespread, ecept in the north. Endemic to Madagascar.

Acraea strattipocles Oberthür, 1893
*More limited distribution in eastern and central areas. Endemic to Madagascar.

Acraea masamba Ward, 1872
*Widespread except in the north. Endemic to Madagascar.

Acraea silia Mabille, 1886
*Limited distribution in Sambirano and central areas. Endemic to Madagascar.

Acraea sambavae Ward, 1873 - RARE
*Eastern and central regions of Madagascar. A rare endemic.

Acraea lia Mabille, 1879
*Widespread Madagascar endemic.

Acraea obeira Hewitson, 1863
Panafrican, with the nominate subspecies endemic to Madagascar.

Acraea zitja Boisduval, 1833
*Marshy areas throughout Madagascar. Endemic to Madagascar.

Acraea eponina Cramer, 1780
Common throughout the Afrotropical region, including Madagascar and the other islands.

Acraea encedon L., 1758
Very widespread throughout the Afrotropical region, including Madagascar.

Acraea turna Mabille, 1877
*Fairly common and widespread. Endemic to Madagascar.

Acraea mahela Boisduval, 1833
**Widespread in Madagascar and the Iles Glorieuses. May be included in A. terpsicore Sharpe, 1902.

Pardopsis punctatissima Boisduval, 1833
Very common in most dry, open habitats throughout the Afrotropical region, including Madagascar.

Family NYMPHALIDAE: Satyrinae
Gnophodes betsimena Boisduval, 1833
Endemic ssp. betsimena in Madagascar. Kenya, Ethiopia, Uganda, Sudan, Zaire, Angola, Cameroon, West Africa, Cape and Natal Provinces in South Africa, Mozambique, Zimbabwe, Malawi, Tanzania.

Of the 56 species recorded by D'Abrera for the genus Henotesia, three are endemic to the Comoros, one to Réunion, 41 to Madagascar. One is found in Mauritius, Réunion and Anjouan as well as Madagascar, and ten are restricted to eastern and southern Africa.

Henotesia anganavo Ward, 1871
*Endemic to Madagascar.

Henotesia exocellata Mabille, 1879
*Endemic to Madagascar.

Henotesia sabas Oberthür, 1923
*Endemic to Madagascar.

Henotesia bicristata Mabille, 1878
*Endemic to Madagascar.

Henotesia erebina Oberthür, 1916
*Endemic to northern Madagascar.

Henotesia strigula Mabille, 1877
*Endemic to Madagascar.

Henotesia subsimilis Butler, 1879
*Endemic to Madagascar.

Henotesia pallida Oberthür, 1916
*Endemic to Madagascar.

Henotesia turbata Butler, 1880 (= ornata Oberthür)
*Endemic to Madagascar.

Henotesia parva Butler, 1879
*Endemic to Madagascar.

Henotesia angulifascia Butler, 1879
*Endemic to Madagascar.

Henotesia avelona Ward, 1870
*Endemic to Madagascar.

Henotesia uniformis Oberthür, 1916
*Endemic to Madagascar.

Henotesia oxypteron Oberthür, 1916
*Endemic to Madagascar.

Henotesia parvidens Mabille, 1879
*Endemic to Madagascar.

Henotesia iboina Ward, 1870
*Endemic to Madagascar.

Henotesia anceps Oberthür, 1916
*Endemic to Madagascar.

Henotesia turbans Oberthür, 1916
*Endemic to Madagascar.

Henotesia cowani Butler, 1880
*Endemic to Madagascar.

Henotesia wardiana Oberthür, 1916
*Endemic to Madagascar.

Henotesia curvatula Oberthür, 1916
*Endemic to Madagascar.

Henotesia antsianakana Oberthür 1916
*Endemic to Madagascar.

Henotesia ankovana Oberthür, 1916
*Endemic to Madagascar.

Henotesia ankova Ward, 1870
*Endemic to Madagascar.

Henotesia vola Ward, 1870
*Endemic to Madagascar.

Henotesia undulans Oberthür, 1916
*Endemic to Madagascar.

Henotesia undulata Oberthür, 1916
*Endemic to Madagascar.

Henotesia pauper, Oberthür, 1916
*Endemic to Madagascar.

Henotesia ankaratra Ward, 1870
*Endemic to Madagascar.

Henotesia laetifica Oberthür, 1916
*Endemic to Madagascar.

Henotesia grandis Oberthür, 1916
*Endemic to Madagascar.

Henotesia laeta Oberthür, 1916
*Endemic to Madagascar.

Henotesia houlbertia Oberthür, 1923
*Endemic to Madagascar.

Henotesia narcissus F., 1798
**Mauritius, Réunion, Madagascar and Anjouan (Comoros).

Henotesia strato Mabille, 1878
*Endemic to Madagascar.

Henotesia fuliginosa Mabille, 1878
*Endemic to Madagascar.

Henotesia undulosa Oberthür, 1916
*Endemic to Madagascar.

Henotesia obscura Oberthür, 1916
*Endemic to Madagascar.

Henotesia menamena Mabille, 1877
*Endemic to Madagascar.

Henotesia maeva Mabille, 1878
*Endemic to Madagascar. Possibly synonymous with H. narcissus fraterna.

Henotesia aberrans Paulian, 1951
*Endemic to the Sambirano region of north-western Madagascar.

Henotesia benedicta Paulian, 1951
*Endemic to central Madagascar.

The genus Houlbertia Oberthür, 1910 has eight species, all endemic to Madagascar.

Houlbertia pasandava Ward, 1871
*Endemic to Madagascar. Possibly synonymous with the following species. Females unknown to D'Abrera.

Houlbertia masikoro Mabille, 1877
*Endemic to Madagascar. Females unknown to D'Abrera.

Houlbertia andrivola Mabille, 1877
*Endemic to Madagascar. Females unknown to D"Abrera.

Houlbertia cingulina Mabille, 1880
*Endemic to Madagascar.

Houlbertia perdita Butler, 1878
*Endemic to Madagascar.

Houlbertia wardi Mabille, 1877
*Endemic to Madagascar.

Houlbertia narova Mabille, 1877
*Endemic to Madagascar.

Houlbertia erebennis Oberthür, 1916
*Endemic to Madagascar. A distinctive species, bright blue on the recto.

The genus Masoura Hemming, 1964 has five species, all endemic to Madagascar.

Masoura benacus Mabille, 1884
*Endemic to Madagascar.

Masoura antahala Ward, 1872
*Endemic to Madagascar.

Masoura ankoma Mabille, 1878
*Endemic to Madagascar.

Masoura alaokola Oberthür, 1916
*Endemic to Madagascar.

Masoura masoura Hewitson, 1875
*Endemic to Madagascar.

The genus Admiratio, Hemming, 1964, is a monospecific genus endemic to Madagascar.

Admiratio paradoxa Mabille, 1879
*Endemic to Madagascar.

The genus Heteropsis has two species, both endemic to Madagascar.

Heteropsis drepana Westwood, 1850
*Endemic to Madagascar.

Heteropsis antsianakana Oberthür, 1916
*Endemic to Madagascar.

The genus Strabena Mabille, 1877, has 41 species, all endemic to Madagascar.

Strabena smithi Mabille, 1877
*Endemic to Madagascar.

Strabena goudoti, Mabille, 1885
*Endemic to Madagascar.

Strabena tamatave Boisduval, 1833
*Endemic to Madagascar.

Strabena zanjuca Mabille, 1885
*Endemic to Madagascar.

Strabena argyrina Mabille, 1878
*Endemic to Madagascar.

Strabena sufferti Aurivillius, 1898
*Endemic to Madagascar.

Strabena albivittula Mabille, 1879
*Endemic to Madagascar.

Strabena excellens Butler, 1884
*Endemic to Madagascar.

Strabena albivilttuloides Paulian, 1951
*Endemic to Madagascar.

Strabena corynetes Mabille, 1885
*Endemic to Madagascar.

Strabena niveata Butler, 1879
*Endemic to Madagascar. Treated by Carcasson as a synonym of batesii.

Strabena batesii Felder & Felder, 1867 (= nepos Oberthür)
*Endemic to Madagascar.

Strabena parens Oberthür, 1916
*Endemic to Madagascar.

Strabena propinqua Oberthür, 1916
*Endemic to Madagascar.

Strabena affinis Oberthür, 1916
*Endemic to Madagascar.

Strabena frater Oberthür, 1916
*Endemic to Madagascar.

Strabena ibitina Ward, 1973
*Endemic to Madagascar.

Strabena vinsoni Guenée, 1872
*Endemic to Madagascar.

Strabena consobrina Oberthür, 1916
*Endemic to Madagascar.

Strabena germanus Oberthür, 1916
*Endemic to Madagascar.

Strabena martini Oberthür, 1916
*Endemic to Madagascar.

Strabena dyscola Mabille, 1880
*Endemic to Madagascar.

Strabena andriana Mabille, 1885
*Endemic to Madagascar.

Strabena rakoto Ward, 1870
*Endemic to Madagascar.

Strabena vicina Oberthür, 1916
*Endemic to Madagascar. Doubtful species.

Strabena soror Oberthür, 1916
*Endemic to Madagascar.

Strabena triophthalma Mabille, 1885
*Endemic to Madagascar.

Strabena aurivilliusi D'Abrera 1980
*Endemic to Madagascar.

Strabena consors Oberthür, 1916
*Endemic to Madagascar.

Strabena mopsus Mabille, 1878
*Endemic to Madagascar.

Strabena perroti Oberthür, 1916
*Endemic to Madagascar.

Strabena impar Oberthür, 1916
*Endemic to Madagascar.

Strabena modesta Oberthür, 1916
*Endemic to Madagascar.

Strabena modestissima Oberthür, 1916
*Endemic to Madagascar.

Strabena io Paulian, 1950
*Endemic to Madagascar.

Strabena cachani Paulian 1950
*Endemic to central Madagascar.

Strabena isaolensis Paulian, 1951
*Endemic to western Madagascar.

Strabena andilabe Paulian, 1951
*Endemic to the Sambirano region of north-west Madagascar.

Strabena tsaratananae Paulian, 1951
*Endemic to the Sambirano region of north-west Madagascar.

Strabena perrieri Paulian, 1951
*Endemic to the Sambirano region of north-west Madagascar.

Strabena mandraka Paulian, 1951
*Endemic to central Madagascar.

Family LIBYTHEIDAE
Libythea labdaca Westwood, 1851
A widespread species in the western and central forest blocks of Africa, known to migrate in large swarms. Ssp. tsiandava occurs in north-western Madagascar.

Libythea ancoata Grose-Smith, 1891
*Endemic to Madagascar. Carcasson (in litt. to D'Abrera) suggests that ancoata may be a race of L. cyniras Trimen, 1866. However, the latter, a Mauritian endemic, is most probably extinct.

Family RIODINIDAE
The genus Saribia, with three species, is endemic to Madagascar.

Saribia tepahi Boisduval, 1833
*Endemic to Madagascar.

Saribia perroti Riley, 1923
*Endemic to Madagascar. Three ssp. are recognised, perroti in central regions, fiana Riley in the south-west and ochracea Riley in the north-west.

Saribia decaryi Le Cerf, 1922
*Endemic to Madagascar. Flies in forests above 500m.

Family LYCAENIDAE
Spalgis tintinga Boisduval, 1833
*Endemic to Madagascar.

The genus Trichiolaus Aurivillius, 1898, with two species, is endemic to Madagascar.

Trichiolaus mermeros Mabille, 1878
*Endemic to Madagascar.

Trichiolaus argentarius Butler, 1879
*Endemic to Madagascar.

In the genus Hemiolaus Aurivillius, 1923, five of the six species are endemic to Madagascar.

Hemiolaus ceres Hewitson, 1865
*Endemic to Madagascar.

Hemiolaus cobaltina Aurivillius 1898
*Endemic to northern and north-western Madagascar.

Hemiolaus varnieri Stempffer, 1944
*Endemic to northern and north-western Madagascar.

Hemiolaus maryra Mabille, 1887
*Endemic to Madagascar.

Hemiolaus margites Mabille, 1899
*Endemic to Madagascar.

Hypolycaena phillipus F., 1793
Entire Afrotropical region. Ssp. ramonza occurs in Madagascar, Aldabra, Cosmoledo and probably the Comoro Islands.

Leptomyrina phidias F., 1793
*Endemic to Madagascar.

Virachola antalus Hopffer, 1855
Very common, especially in open situations, throughout the Ethiopian region, including Madagascar and the Comoro Islands. The genus is also represented in the Oriental and Australian regions.

Virachola renidens Mabille, 1884
*Endemic to Madagascar.

Virachola batikeli Boisduval, 1833
*Endemic to Madagascar.

Virachola dinochares Grose-Smith, 1887
Open woodland and thorn bush in Natal (South Africa) to Botswana, Zimbabwe, Mozambique, Malawi, Zambia, Tanzania, Kenya and Uganda. Also recorded from northern Nigeria and Madagascar.

Virachola wardii Mabille, 1878
*Endemic to Madagascar.

Anthene princeps Butler, 1876
Deciduous woodland and Acacia scrub throughout most of Africa south of the Sahara. Subspecies smithi Mabille is endemic to woodlands in Madagascar.

Cupidopsis jobates Hopffer, 1855
Nominate ssp. in moist woodlands from Kenya and Uganda to Cape Province (South Africa), Angola and Zaire. An isolated population occurs in Togo, Benin and Guinea, with another in Madagascar. Sssp. uranochroa is found in Ethiopia.

Cupidopsis cissus Godart, 1822
Moist grassy areas throughout Africa and Madagascar.

Petrelaea sichela Wallengren, 1857
Savanna and woodland throughout sub-Saharan Africa, with ssp. reticulum Mabille confined to Madagascar.

The genus Rysops Eliot, 1973, is a monospecific taxon endemic to Madagascar.

Rysops scintilla (Mabille, 1877)
*Endemic to Madagascar.

Uranothauma artemenes Mabille, 1880
*Endemic to Madagascar.

Cacyreus darius Mabille, 1877
**Endemic to Madagascar and the Comoro Islands.

Leptotes pirithous L., 1767
Very common throughout Africa, Madagascar and much of Asia and Europe.

Leptotes rabenafer Mabille, 1877
*Endemic to Madagascar.

Zizeeria knysna Trimen, 1862
Entire continent of Africa, Madagascar and the Seychelles.

Zizina antanossa Mabille, 1877
Entire continent of Africa, Madagascar and Réunion.

Actizera atrigemmata Butler, 1878
*Endemic to Madagascar.

Actizera lucida Trimen, 1883
Open woodland and disturbed habitats throughout southern and eastern Africa, as well as Madagascar. Also Cameroon and Benin.

Zizula hylax F., 1775
Entire continent of Africa, also Madagascar.

Azanus soalalicus Karsch, 1900
*Endemic to Madagascar.

Azanus sitalces Mabille, 1899
**Nominate ssp. on Madagascar only, ssp. mayotti D'Abrera on Mayotte in the Comoros.

Eicochrysops hippocrates F., 1793
Shady places near streams throughout Africa and Madagascar.

Eicochrysops pauliani Stempffer, 1950
*Known only from the type locality, Mt Tsiranana (1500 m), Antseranana, northern Madagascar.

Eicochrysops sanguigutta Mabille, 1879
**Madagascar and Grande Comoro only.

Euchrysops malathana Boisduval, 1833
Common in open habitats throughout all Africa, Arabia and Madagascar.

Euchrysops osiris Hopffer, 1855
Open habitats throughout all of Africa, Madagascar and the Comoros.

Euchrysops decaryi Stempffer, 1947
*Endemic to Madagascar.

Lepidochrysops turlini Stempffer, 1971
*Known only from the type locality, Toliara, south-western Madagascar.

Lepidochrysops caerulea Tite, 1961
*Endemic to Madagascar.

Lepidochrysops leucon Mabille, 1879
*Toamasina, Madagascar.

Lepidochrysops azureus Butler, 1879
*Toamasina, Antananarivo and Fianarantsoa, Madagascar.

Lepidochrysops grandis Talbot, 1937
*Antananarivo and Fianarantsoa, Madagascar.

Freyeria minuscula Aurivillius, 1909
*Endemic and widely distributed in Madagascar.

ENDEMIC NONMARINE MOLLUSCS OF MADAGASCAR

(T) = known only from type locality
(A) = known also from Comores

Locality data for widespread species are not necessarily complete.

N.B. The following authorities have been abbreviated: Bedoucha (Be); Blanc (B); Fischer-Piette (F.-P.); Garreau de Loubresse (G. de L.); Salvat (S); Vukadinovic (V).

I. TERRESTRIAL MOLLUSCS

MESOGASTROPODA
Family HYDROCENIDAE
Georissa aurata (Odhner, 1919)
Funereal caves at Catsepe and Tsingy de Namoroka, Mahajanga; Cap Diego; stream bank detritus.

Georissa detrita Bavay & Germain, 1920 (T)
Cap Diego.

Georissa petiti Germain, 1935
L. Manampetsa.

Family PUPINIDAE
Madecataulus goudoti F.-P. & Be., 1965
Betsimisaraka; forest.

Madecataulus (petiti) undescribed
Ianzamaly (Toliara); ravines.

Family DIPLOMMATINIDAE
Diplommatina decaryi Bavay & Germain, 1920
Single broken specimen. Cap Diego.

Malarinia hova Haas, 1961
Chutes de la Mort.

Family CYCLOPHORIDAE
Acroptychia aequivoca (Pfeiffer, 1857)
Central & north-east: Ankaratra; Ambohivoangy (Maroantsetra); forest.

Acroptychia bathiei F.-P. & Be., 1965
Antsingy, Andranamavo, grottes de Salapango (all in Ambongo).

Acroptychia bigoti F.-P., B. & S., 1969
South: Fieherenna, Toliara; mangroves.

Acroptychia culminans F.-P. & Be.,1965
North: Mt Tsaratanana; 2000m.

Acroptychia grandidieri F.-P. & Be., 1965
South-west and west: St. Augustin (cave); Tsingy de Namoroka; Antalaha.

Acroptychia metablata (Crosse & Fischer, 1873)
North and north-east: Ambanje; reserve de Marojejy; Antalaha region; as far south as Antsiranamatso. 2 varieties; (700-2000m).

Acroptychia milloti F.-P. & Bedoucha 1965
Ambongo; Ankarafantsika; Mahajanga.

Acroptychia pauliani F.-P. & Bedoucha 1965
North: Mt Tsaratanana; 750-1400m.

Acroptychia pauper F.-P., B. & S., 1969 (T)
North: Mt Tsaratanana. Single specimen.

Acroptychia pyramidalis Sykes, 1900
No locality data.

Acroptychia tubulare (Morelet, 1861)
No locality data.

Boucardicus albocinctus (Smith, 1893)
Central-east and east: Mahanovo (?Mahonoro); Périnet; Anosibe.

Boucardicus angavokelensis F.-P., B. & V., 1974 (T)
Central east: Angavokely. Under dead branches; single specimen.

Boucardicus beananae F.-P. & Be., 1965
North-east: Beanana and Maroantsetra in the bay of Antongil; forest.

Boucardicus boucardii F.-P. & Be.,1965
Single specimen; no locality data.

Boucardicus milloti F.-P. & Be.,1965 (T)
2 specimens only. Ambatofitorahana.

Boucardicus nanus F.-P. & Be.,1965 (T)
3 specimens only. Ambohivoangy.

Boucardicus notabilis (Smith, 1892) (T)
Single specimen. Toamasina.

Boucardicus petiti F.-P. & Be.,1965
West: Bemahara (near R. Nameroko); Ambongo.

Chondrocyclus mamillaris (Odhner, 1919)
West: Katsepe (funereal cave), Mahajanga, l'Ambongo, Antsingy, gorges de Salapango; Amparimgidro; cave and gorges.

Cyathopoma diegoensis F.-P., B. and V., 1974 (T)
North: Cap Diego.

Cyathopoma pauliani S., 1968
North: Andamy on Mt Tsaratanana; 750m.

Cyathopoma waterloti F.-P., B. and V., 1974 (T)
North: Cap Diego, baie des Amis.

Cyclotus milloti F.-P. & Be., 1965
Single specimen. Ambohivoangy; forest.

Hainesia arborea (Crosse & Fischer, 1871)
R. Tsidsoubou (or Tsiribihina); banks of river.

Hainesia litturata (Morelet, 1877)
Single specimen; no locality data.

Family POMATIASIDAE
Cyclotopsis milloti F.-P., B. and V., 1974 (T)
North: cave entry, south of massif de l'Ankara, Mananjeba; single specimen.

Tropidophora alluaudi (Dautzenberg, 1895)
North: Mt d'Ambre; Cap d'Ambre; Mt des Francais (Antseranana).

Tropidophora alternans (Pfeiffer, 1853)
Single specimen; no locality data.

Tropidophora ambilobeensis F.-P., B. & S., 1969
Two specimens. North: Ambilobe opposite Nosy Bé.

Tropidophora andrakarakarensis F.-P. & Testud, 1973 (T). Single specimen. Forest of Andrakaraka (Antalaha).

Tropidophora andrapanga F.-P., B. & S., 1969
North-east: Andrapangy, Ambanitaza, Marokosa (Antalaha).

Tropidophora aspera (Potiez & Michaud, 1838)
Mainly extreme north: Nosy Bé; Antseranana; Cap Diego; Orangea Port Leven; Mt des Francais; Tsiribihina.

Tropidophora balteata (Sowerby,1873)
South: Taolanaro and Andrahomana (abundant in south); Ambongo; Ambila (Toamasina); Sainte-Lucie; Faux Cap; Cap Sainte Marie; plateau Mahofaly; Manombo; Betioky; Beloha; Tsiombe; Behara.

Tropidophora bathiei F.-P., 1949
Morondava, Iabohazo south of Mahajanga.

Tropidophora bemaraensis F.-P., 1949
Bemaraha (200m); Ambongo.

Tropidophora besalampiensis F.-P., 1949
West coast: Antsingy, Besalampy (Cap St Andre); woods.

Tropidophora betsiloensis (Smith, 1882)
May not be valid species; Betsileo; woods near L. Alaotra.

Tropidophora carnicolor (Fulton, 1902)
South: Andrahomana, Taolanaro.

Tropidophora castanea (Pfeiffer, 1851)
No locality data.

Tropidophora cavernarum F.-P., B. & S., 1969 (T)
Single specimen. Anjohibe; cave.

Tropidophora chavani F.-P., 1949
Gorges de Salapango (Bemaraka); Antsingy.

Tropidophora chromium (Morelet, 1877)
No locality data.

Tropidophora cincinna (Sowerby, 1843)
No locality data.

Tropidophora consocia (Pfeiffer, 1852)
Widespread. Antseranana; Orangea; Toliara; Mananjary; Windsor Castle; Mt des Francais; grotte de Cap Diego. Trees.

Tropidophora coquandiana (Petit de la Saussaye, 1852)
South: Androka and Andrahava (Toliara); Mahofaly coast dunes and coastal woods.

Tropidophora crenulata Fulton, 1902
South: Taolanaro.

Tropidophora cuvieriana (Petit de la Saussaye, 1841)
North: Nosy Bé; Ampotsehy; grottes de l'Ankarana; plateau de l'Ankara et de l'Anamera; grotte de Simiar (massif de l'Ankara), Nosy Mitziou.

Tropidophora deburghiae (Reeve, 1861)
East coast: Mananara.

Tropidophora deliciosa (Sowerby, 1850)
North: Antseranana; Mt d'Ambre; cirque de Fanitrys (Ankarana); Windsor Castle.

Tropidophora denisi F.-P., 1949
South: Antaramaitsy (n.w. of Cap Ste Marie); Andrahomana. Coast.

Tropidophora denselirata F.-P., B. & S., 1969
Massif de l'Ankara.

Tropidophora deshayesiana (Petit de la Saussaye, 1844)
North: Nosy Bé; grottes de l'Ankarana; Ampotsehy; Ankara-Analamera; cirque de Fanitrys (Ankarana). Cave entries.

Tropidophora diegoensis F.-P., 1949 (T)
Cap Diego.

Tropidophora dingeoni F.-P., B. & S., 1969 (T)
Single specimen. Mt Tsaratanana.

Tropidophora eustola (Crosse & Fischer, 1887)
No locality data.

Tropidophora felicis F.-P. & Be.,1965
Nosy Bé.

Tropidophora filopura F.-P., 1949
Gorges de Salapango (Bemeraha); Ambongo; woods.

Tropidophora filostriata (Sowerby, 1873)
South: Taolanaro.

Tropidophora fivanonensis F.-P. & Be.,1965
Fivanona.

Tropidophora formosa (Sowerby, 1849)
East coast: Foulpointe; Fenoarivo Atsinanana; Mananara.

Tropidophora fulvescens (Sowerby, 1843)
North: Ramena on the coast (Antseranana); Cap Diego; Orangea; Port Leven; Mt des Francais; Ambohibe (Ambilobe); Antalaha region.

Tropidophora fuscula (Pfeiffer, 1851)
Nosy Bé; massif du Manongarivo (Sambirano) (1000m).

Tropidophora gallorum F.-P., B. & S., 1969 (T)
Two specimens. Mt des Francais (Antseranana); under trees.

Tropidophora goudotiana (Sowerby, 1843)
North east near baie d'Antongil: Beanana, Ambohivoangy, Ambohitsitondrona (all in Maroantsetra); Ambodirafia, Ambodilalona (both near Antalaha); forest.

Tropidophora grisea (Pfeiffer, 1853)
No locality data.

Tropidophora humberti F.-P., 1949
Plateaux of Ankara-Analamera; Ankarana.

Tropidophora interrupta F.-P., B. & S., 1969
South and north-east: Miary (Toliara); Vohimarina to Sambave.

Tropidophora ivongoensis F.-P., B. & V., 1974 (T)
East coast: Soanierana-Ivongo, south of bay of Antongil; single specimen.

Tropidophora johnsoni (Smith, 1882)
Central north-west: south of Trabonjy.

Tropidophora lamarcki (Petit de la Saussaye, 1841)
North: Antseranana; Windsor Castle; Mt des Francais.

Tropidophora ligatula (Grateloup, 1840)
North: at least 25 sites from Vohimarina to Antalaha.

Tropidophora lirata Pfeiffer, 1852
No locality data.

Tropidophora microchasma (Pfeiffer, 1856)
South: Toliara.

Tropidophora milloti F.-P., 1949
North and west: Ankarana (cave entry); Nosy Bé; Nosy Mamoko; isle de Ambaritelo; Antalaha (several localities); old walls and ruins; (280m).

Tropidophora morondavensis F.-P., 1949 (T)
Single specimen. Morondava.

Tropidophora moulinsii (Grateloup, 1840)
North: Nosy Faly, Mananjary, Mt des Francais, Antseranana, Sambirano; caves.

Tropidophora multifasciata (Grateloup, 1840)
North, north-east and south: Toliara; Andavadoaka; Vohimarina; south Sambave; Beraty (Maromandia).

Tropidophora occlusa (Morch, 1832)
Extreme north: Ankara-Analamera (forest & cave entries); cirque de Fanitrys (Ankara).

Tropidophora oppessulata F.-P., B. & S., 1969 (T)
Single specimen. Antseranana.

Tropidophora perfecta Fulton, 1903
South: Taolanaro.

Tropidophora perinetensis F.-P. & Be.,1965
east: Anosibe; Ikongo; Périnet; Ambohivoangy; forest, 100-1100m.

Tropidophora petiti F.-P., 1949
Gorges de Salapango (Bemaraha).

Tropidophora philippiana (Pfeiffer, 1852)
Widespread in south: Faux Cap; Toliara; Antsepoke; Miary; Cap ste Marie; L. Manampetsa (dunes); Androka; Andrahava; Onilahy; grotte de Lovenobato (on bank of Onilahy); St Augustin; Sarodrano; Nosy Katafana; Miandrarah (Manombo); banks of Fieherenana; Morombe; Mangoky; Nosy Andramona; Beloha; Efoetsa. Coastal dunes.

Tropidophora principalis (Pfeiffer, 1859)
No locality data.

Tropidophora propeconsocia F.-P. & Be.,1965 (T)
Single specimen. Mt d'Ambre.

Tropidophora puerilis F.-P. & Be., 1965 (T)
Single specimen. Mt Tsaratanana; 1400m.

Tropidophora pulchella (Sowerby, 1843)
North-east: Ranolanina (n.w. of Ivontaka); Ambohitsitondrona (near bay d'Antongil); 10 localities near Antahala; forest, 400-700m.
Tropidophora pyrostoma (Sowerby, 1843)
West, central west and north east: Morondava, Bemaraha (near Miandrivazo); Antalaha region on coast; Maintirano; woods.

Tropidophora reesi F.-P., 1949 (T)
Ambongo; calcareous woods.

Tropidophora reticulata (Adams & Reeve, 1850)
No locality data.

Tropidophora salvati F.-P. & Be., 1965 (T)
Single specimen. Amparimgidro (Mahajanga).

Tropidophora sarodranensis F.-P., B. & S., 1969 (T)
3 specimens. Saint-Augustin (Sarodrane); region of Antalaha.

Tropidophora secunda F.-P. & Be., 1965
Antsingy.

Tropidophora semidecussata (Pfeiffer, 1847)
Many varieties. Widespread: Toliara; Miary; Andavadoaka; Bejangoa; Faux Cap; plateau and coast of Mahofaly; plateau de Miandraraha; L. Manampetsa (fossil); Onilahy; grotte de Lavenambato; Andranovaha (cliff); Morondava; Ampotaka; Cap Ste Marie (dunes); ravines d'Ianzamaly; Bemaraha; Namoroka; Ambongo; Mahajanga; Sambirano; Manambato; Efoetsa; gorges de Manambolo; Antsingy; Tsiribihina; Betioky; Bas Fiherana; grotte de Sarandrano (St Augustin); Ambatofinandrahana; cliffs, calcareous woods.

Tropidophora semilirata F.-P., B. & S., 1969
Andranohinaly (Toliara).

Tropidophora sikorae (Fulton, 1901)
South and north-west: Taolanaro; Amboaniou (Mahajanga); Ananalava caves.

Tropidophora soulaiana F.-P. & Testud, 1973
Area around Antalaha: Andrakata in vanilla plantations; Marolambo; Analamaho; Ampampamena.

Tropidophora surda F.-P., B. & S., 1969
Two specimens. Mt d'Ambre; Ankarana.

Tropidophora tenuis (Sowerby, 1843)
No locality data.

Tropidophora thesauri F.-P., 1949
Orangea (Antseranana).

Tropidophora tomlini F.-P., 1949
Massif de l'Ankara (south of Menemjeba); cave.

Tropidophora tricarinata (Muller, 1774)
At least 29 varieties, see F.-P., 1949, p. 41. Mainly east coast: Nosy Borah; Cap Est; Foulpointe; Antsingy; Andrapangy; Morovare (Farafanga); Ranolalina; Nosy Bé; massif de Manongarivo (Sambirano); Nosy Komba; Midongy (Farafanga); Mananjary forests of Tintingue and Toamasina; Befevona; Ambohitsitondrova (700m) Ambohivoangy; Karianga (Farafanga); Mananara; Ivontaka; Fenerive; Betampona; Haut Sambirano; Zahamena; Manambato (Ambotondozaka); Taolanaro; Orangea; Tanala; massif de Mangarivo; foret de Beanana; col d'Ivohibe; Ambinanitelo (Mahajanga); Tampolo; Mt Tsaratanana; Manantely.

Tropidophora tulearensis F.-P., 1949
South: Ravines d'Ianzamaly in valley of Fiherenana (Toliara).

Tropidophora vesconis (Morelet, 1860)
Antseranana; Port-Leven.

Tropidophora vexillum (Sowerby, 1873)
No locality data.

Tropidophora vignali F.-P., 1949
West and north: Mt d'Ambre; gorges de Salapango (Bemaraha); Antsingy; Ambongo; Antalaha region; caves.

Tropidophora virgata (Sowerby, 1843)
North: Mt des Francais, Anosiravo (Antseranana) south of Sambave.

Tropidophora virgo (Pfeiffer, 1853)
North: Mt des Francais, Antsirane (Antseranana); cave.

Tropidophora vittata (Sowerby, 1843)
Islands and coast off Port-Leven; Nosy Bé. woods and sandy areas.

Tropidophora vittelina (Pfeiffer, 1852) or Sowerby 1843?.
No locality data.

Tropidophora vuillemini F.-P., B. & S., 1969
Mt Tsaratanana; 1600-1800m.

Tropidophora winckworthi F.-P.,1949
Mt d'Ambre; massif de l'Ankara, south of Manemjeba; caves and trees, 1100m.

Tropidophora zonata (Petit de la Saussaye, 1850)
Extreme south to Antsingy in west and Didy in east: incl. Reserve de Marojejy and Ambodilalona (Antalaha); Mangabe; forest of Ankaroaka.

Family ASSIMINEIDAE
Acmella parvula (Morelet, 1877)
Centre and east: Taolanaro; Toamasina; Nosy Bé; Anjouan; Ananalava; Antsirabe, (peat-bog); Vatomandry; Mananara; Mananjary; often coastal.

'Assiminea' geayi Lamy, 1909
Toliara coast.

Omphalotropis arbusculae F.-P., B. & S., 1969 (T)
Ambohivoangy; bushes.

Omphalotropis madagascariensis Germain, 1921
East & south: Andrahomana, Antseranana, Ambovombe, several localities around Antalaha, Taolanaro; forest.

Omphalotropis ripae F.-P., B. & S., 1969 (T)
Sandrangato (Moramanga); bushes near waterfall.

STYLOMMATOPHORA
Family VERONICELLIDAE
Desmocaulis subaspera (Fischer, 1883)
Nosy Bé; Nosy Komba.

Drepanocaulis plateia (Simroth, 1913)
Nosy Bé.

Drepanocaulis tetragonalis (Simroth, 1913)
Nosy Bé.

Imerinia excisa (Simroth, 1913)
East: Sakana.

Imerinia fischeri (Dupouy, 1966)
Mountainous region north of Antananarivo; Andringitra.

Imerinia geayi (Germain, 1918)
Fiherenana.

Imerinia grandidieri (Crosse & Fischer, 1871)
Morondava; Nosy Bé; Antokofotsy; vallee du Saint Augustin.

Imerinia hovarum (Robson, 1914)
Toamasina; Marodotatia.

Imerinia laevimarginata (Simroth, 1913)
North and west: Mahajanga.

Imerinia madagascariensis (Simroth, 1913)
East: Alaotra.

Imerinia margaritifera (Heynemann, 1885)
Central region.

Imerinia ochracea (Simroth, 1913)
South west: Fiananarantsoa.

Imerinia sulfurea (Heynemann, 1885)
Nosy Bé and central region.

Imerinia verrucosa (Heynemann, 1885) (A)
Nosy Bé; Mayotte (Comores).

Laevicaulis ocellata (Odhner, 1919)
Toamasina.

Sarasinula densinerva (Simroth, 1913)
Fenoarivo Atsinanana.

Semperula lilacina (Simroth, 1913)
West: Sakana; Ste Marie.

Family VERTIGINIDAE

Nesopupa decaryi F.-P. & Be.,1965 (T)?
Baie des Amis, Antseranana; bushes.

Nesopupa minutalis (Morelet, 1881) (A)
May be widespread: recorded from Antananarivo and Nosy Bé. Also Comoros.

Nesopupa waterloti F.-P. & Be.,1965 (T)
Bank of Baie des Amis, Antseranana; bushes.

Nesopupa sp.
Nosy Komba (see F.-P. et al. 1975).

Family ORCULIDAE

Fauxulus milloti F.-P. & Be., 1965
North-east: Ambohitsitondrona; forest, 700m.

Family CHONDRINIDAE

Gastrocopta seignaciana (Crosse & Fischer, 1879) (A)
(includes G. madagascariensis Bavay & Germain, 1920). Probably widespread: Nosy Komba and Nosy Bé, Cap Diego, Imorona, Ambovombe, Morombe, Taolanaro; also Comoros (= G. tripunctum) and Europa I.

Family VALLONIDAE

Pupisoma waterloti F.-P., B. & V., 1974 (T)
Antananarivo.

Family ENIDAE

Edouardia rufoniger (Reeve, 1849)
North: Mt d'Ambre; Antankaratra (? = Antankara); bay of Antseranana; cave at Orangea.

Edouardia vesconis (Morelet, 1860)
Single specimen. Port-Leven on north point; sandy beach under dead leaves.

Rachis ambongoensis F.-P., 1964
central west coast: Ambongo, Maintirano, Morondava.

Rachis nigrilineatus (Reeve, 1849)
East coast: Betsileo and Toamasina.

Rachis tulearensis F.-P., 1964
South-west coastal area: Toliara; Fieherenna; ravines d'Ianzamaly; Andavadoaka (between Morombe and Morondava); Mangoky; Miary; banks of Onilahy; plateau of Mahofaly; Ampotaka; often calcareous cliffs.

Family FERRUSSACIIDAE

Cecilioides mariei (Crosse, 1880)
North: Nosy Bé; Antseranana: in piles of twigs.

Family SUBULINIDAE

Opeas decaryi F.-P., B. & V., 1974
Single specimen. Unknown locality.

Opeas soulaianus F.-P. & Testud, 1973
North-east: Ambodirano & other localities around Antalaha; Nosy Bé; baie des Amis (Antseranana).

Subulina manampetsaensis F.-P. & Testud
South-west: Lake Manampetsa (in reserve, wooded dunes); grottes de Lavenombato (Toliara); l'Onilahy (between Toliara and Manampetsa).

Family ACHATINIDAE

Leucotaenius adami F.-P., 1963
Ampotaka, near Cap Sainte-Marie; river banks, woods.

Leucotaenius bathiei F.-P., 1963
South-west: Androaka; coastal dunes.

Leucotaenius crassilabris (Gray, 1834)
South: Onilahy; wood on calcareous rocks.

Leucotaenius favannii (Lamarck, 1822)
South mainly, also few records from east and west: Ikongo; Mananjary Bemaraha; Betioky; St. Augustin; Cap Ste-Marie (fossil); Faux-Cap; Itampolo; Antaramaitsy; Betaimbolo; west shore of Lake Manampetsa; Lanivato; Androka; Beloha; Ambovombe.

Leucotaenius heimburgi (Kobelt, 1901)
Andrahamana only.

Leucotaenius laevis F.-P., 1963
No locality data.

Leucotaenius procteri (Sowerby, 1894)
South-west: Onilahy; L. Manampetsa; Toliara; Efoetsa; Anakao (Toliara); Miandraraha (Manombo); coastal dunes and woods.

Family STREPTAXIDAE

Edentulina alluaudi (Dautzenberg, 1894)
North: Mt d'Ambre (foret des Rousettes); Antseranana; cave entries south of River Manemjeba (south of massif de l'Ankara); Cap d'Ambre; Vohimarina; Windsor Castle; Mt des Francais.

Edentulina arenicola (Morelet, 1860)
North: Windsor Castle; Port Leven (under dead leaves); Orangea (cave).

Edentulina battistini F.-P., B. & S., 1975
West: Toliara; Amparimgidro (Mahajanga); Salapango; Bemaraha; Antsingy.

Edentulina gaillardi F.-P. & Be., 1965 (T)?
North: forest of Ankarafantsika, on banks of Lake Tsimaloto.

Edentulina intermedia (Morelet, 1851) (T)
North: Port Leven.

Edentulina metula (Crosse, 1881)
North: Nosy Komba; Mt Tsaratanana; Ambabovaky (Antalaha).

Edentulina minor (Morelet, 1851)
Extreme north, coastal: Port Leven; Nosy Komba; Vohimarina.

Edentulina montis F.-P., B. & S., 1975 (T)
Single specimen, north: Mt des Francais.

Edentulina nitens (Dautzenberg, 1984)
North: Mt d'Ambre; Antseranana.

Edentulina stumpfii Kobelt, 1905
North: Nosy Bé; grottes de Salapango (Bemaraha); Antsingy.

Gulella andreana F.-P., B. & V., 1974
Ravines of Ianzamaly (Toliara); caves of Lavenombato (Toliara); Antananarivo (on old wall); Morondava (woods).

Gulella bouchardi F.-P., B. & V., 1974 (T)
Single specimen. North-east: Andasibe (Antalaha).

Gulella cerea (Dunker, 1848)
Comoros; Bruggen (1981) gives this species as endemic to Madagascar but F.-P. & V. (1964) doubt the records.

Gulella gallorum F.-P., B. & S., 1975
Single specimen. Mt des Francais.

Gulella miaryi F.-P. & Be., 1965 (T)
Miary - calcareous plateau.

Gulella soulaiana F.-P., 1973 (T)
Single specimen, north-east: Virembina (Antalaha).

Pseudelma madagascariensis F.-P., B. & V., 1974 (T)
Elma.

Family ACAVIDAE

Ampelita alluaudi (Dautzenberg, 1894) (T)
North: Mt d'Ambre.

Ampelita atropos (Ferussac-Deshayes, 1851)
North and south: Antseranana; Mt d'Ambre (1100m, foret des Rousettes) Toliara; forest.

Ampelita bathiei F.-P., 1952
North: Mt Tsaratanana; 1200-1800m

Ampelita battistini F.-P. & G. de L., 1965
Ambarobe, Andrahomana.

Ampelita bizonalis Odhner, 1919
Catsepe; Mahajanga; caves.

Ampelita caduca F.-P., B. and S., 1975 (T)
North: Mt Tsaratanana.

Ampelita calida F.-P., B. and S., 1975 (T)
North-east: Sambava.

Ampelita calypso (Pfeiffer, 1861)
Mananjary; Farafangana; Manakara; Marovare; Antseranana.

Ampelita capuroni F.-P., B. & S., 1975
Central north-east: Manerinerina, Anosibe.

Ampelita cerina (Morelet, 1877)
North-east coast: Foulpointe, Maroantsetra.

Ampelita chlorozona (Grateloup, 1839) (T)
Beloha; forest; suspended by spiders.

Ampelita clotho (Deshayes-Ferussac, 1851)
North: Antseranana; Mt des Francais.

Ampelita consanguinea (Deshayes-Ferussac, 1851)
North coast: Antseranana.

Ampelita covani (Smith, 1879)
Pic d'Hivohibe (2100m); Ankavana (Betsileo); forets de Fivavona, Vakoana and Amindramiova, Andringitra. Forest.

Ampelita culminans F.-P., 1952
North: Mt Tsaratanana only; 2200-2350m.

Ampelita decaryi F.-P., 1952
West: Antsingy.

Ampelita denisi Dautzenberg, 1928
Farafangana.

Ampelita dingeoni F.-P., B. & S. 1975
North and south: Toliara, Mt d'Ambre.

Ampelita duvalii (Petit de la Saussaye, 1844)
Several localities in south: Toliara; forest of Andranovory (Toliara); ravines d'Ianzamaly (Fieheranana); bay of St Augustin; foret d' Ambatofitoharana; foret de Mangidy (Fianarantsoa); Mahofaly (dunes); Onilahy (calcareous cliffs); forest, woods, calcareous cliffs.

Ampelita fulgurata (Sowerby, 1838)
North-east: Ambohitsitandrona (700m), Marofinaritra, Ambohifamotsy and Ambatovaky in Antalaha; Ranolalina; Fenoarivo Atsinanana.

Ampelita funebris (Morelet, 1877)
No locality data.

Ampelita futura F.-P. & G. de L., 1964
Manogarivo (Sambirano); Mt Tsaratanana; woods, 700-1400m.

Ampelita galactostoma (Pfeiffer, 1849)
Nosy Bé.

Ampelita gaudens (Mabille, 1884)
North & south west: Nosy Bé; Mt Tsaratanana; reserve de Marojejy, Antalaha region; Toliara.

Ampelita globulus F.-P., B. & V., 1974 (T)
Reserve de Marojejy (1500-2000m).

Ampelita grandidieri F.-P., 1952
No locality data.

Ampelita granulosa (Deshayes-Ferussac, 1851)
North: Mt des Francais (Antseranana); in dead leaves at foot of rocks.

Ampelita hova (Angas, 1877)
Mananara; Ile des Nattes (Pandanus); Manambato; Ranolalina; Fenoarivo Atsinanana; Tampolo; Amparafaravolo; west of Lake Alaotra; Andratambe; Marovare; forest.

Ampelita julii F.-P. & G. de L., 1965
North: Ambanje, Maroantsetra, several localities around Antalaha.

Ampelita katsaensis F.-P. & G. de L., 1965
Haut-Bemarivo; plateau du Katsa; woods, 700-1000m.

Ampelita lachesis (Deshayes-Ferussac, 1851)
Orangea; Mt des Francais; Antseranana.

Ampelita lamarei (Pfeiffer, 1853)
West, from south to baie d'Antongil: Marovare; Ambohitsitandrona; Beanana; Ambohivoangy; reserve de Marojezy (1500-2000m); Mt Tsaratanana, many localities around Antalaha (one of dominant species) Ambanja. Forest.

Ampelita lamothei (Dautzenberg, 1894)
Mt d'Ambre.

Ampelita lancula (Ferussac, 1821)
Foret de Beanana, Fenoarivo Atsinanana (Tampolo); Nosy Borah; Ranolalina; Soanierana-Ivongo. Forest.

Ampelita lanx (Ferussac, 1822)
North-east: Betampona reserve; Fenoarivo Atsinanana; Mananara; Ranolalina; Ambohivoangy (Maroantsetra); Mt Tsaratanana; Nosy Borah; foret de Beanana; Foulpointe. Woods and forest.

Ampelita madagascariensis (Lamarck 1822)
South and north-east: Taolanaro; Andrahomana; Behara; Mananjary. Forest.

Ampelita milloti F.-P., 1952
Gorges de Salapango (Bemaraha). Woods, chalk.

Ampelita namerokoensis F.-P., 1952
Gorges de Salapango (Bemaraha); Tsingy de Namoroka (Ambongo).

Ampelita omphalodes (Pfeiffer, 1846)
Widespread: Haut Bemarivo; Farafanga; Mahajanga; Nosy Bé (Lokobe); Taolanaro; Andrahomana; Amparimgidro; Ankarafantsika (100 km south of Mahajanga). Woods, 600-1000m.

Ampelita parva F.-P. & G. de L., 1965
North: Mt Tsaratanana; 750-2200m.

Ampelita pauliani F.-P., 1952
North: Mt Tsaratanana (Sambirano). Woods, 1700-2000m.

Ampelita perampla Dautzenberg, 1907 (T)
North west: reserve de Marojejy (1500-2000m); Analalava; Mt Tsaratanana.

Ampelita percyana (Smith, 1880)
Ankafana (Betsileo).

Ampelita petiti F.-P., 1952
Massif de l'Andringitra (up to 2500m) (Fianarantsoa).

Ampelita pfeifferi F.-P., 1952
Orangea (Antseranana); Ankarafantsika.

Ampelita pilosa F.-P. & G. de L., 1965 (T)
North: Antsirana.

Ampelita robillardi (Angas, 1876)
South: Taolanaro, Andrahomana.

Ampelita sepulchralis (Ferussac, 1822)
Many varieties. East and south west: Lake Zanavorany; Ambila Le Maitso; Betampona reserve; Sihanaka; Soanierana-Ivongo; south of Mahofaly plateau.

Ampelita shavi (Smith, 1879)
South-east: Tanala.

Ampelita soulaiana F.-P. & Testud, 1973
North-east: region of Antalaha.

Ampelita stephani F.-P. & Testud, 1973 (T)
Single specimen. Forest of Ambohimitsinjo (Antalaha).

Ampelita stilpna (Mabille, 1884)
No locality data.

Ampelita stragulum (Crosse & Fischer, 1873)
Forests of Ambohivoangy, Maroantsetra, Beanana. Forest.

Ampelita stumpfii (Kobelt, 1880)
Nosy Bé (Lokobe). Woods.

Ampelita suarezensis (Crosse & Fischer, 1877)
North; Antseranana.

Ampelita subatropos (Dautzenberg, 1894)
Mt d'Ambre (forêt des Rousettes). Forest.

Ampelita subfunebris (Mabille, 1886)
No locality data.

Ampelita subsepulchralis (Crosse, 1868)
Several forms with no locality data, but one from Ste Marie.

Ampelita sylvatica F.-P. & G. de L., 1965
North-west: Bevazaha (Ankarafantsika). Forest.

Ampelita unicolor (Pfeiffer, 1846)
No locality data.

Ampelita vesconis (Morelet, 1851)
Port-Leven. Trees among dunes, under dead leaves.

Ampelita viridis (Deshayes, 1832)
St-Marie de Madagascar, Ambatouro, Tsaraka. Dry marshes.

Ampelita watersi (Angas, 1877)
South-east coast: Ekongo.

Ampelita xystera (Pfeiffer, 1846)
From south to Périnet and Antananarivo and l'Ambongo, also north east: Toamasina; Antananarivo; Mangoro; Ambongo; Chutes de la Mort and Anosibe; Taolanaro; Matitana; Karianga; Andrapangy in north-east; Antalaha region; Mandraka; Mananjary; Zahamena. Woods.

Ampelita zonata F.-P. & G. de L., 1965
Masakoamena & plateau du Katsa (Haut-Bemarivo). Woods, 600-1000m.

Clavator anteclavator Germain, 1913
South: Mahofaly coast; Ankoba-Andrahomana. Dunes.

Clavator bathiei F.-P. & S., 1963
Central mountains: Massif d'Ankaratra; Manjakatompo; Tsiafajavona. Forest, 1800-2000m.

Clavator clavator (Petit de la Saussaye, 1844)
South-west: Andranohinaly; Toliara; St Augustin; Mangoky; Fiherana; Onilahy; Benenitra.

Clavator dingeoni F.-P., B. and S., 1975 (T)
North: Tsaratanana.

Clavator eximius (Shuttleworth, 1852)
Central-east: Ekongo; Imerina; Antankaratra; Périnet; Analamazaotra forest, 300-800m.

Clavator grandidieri (Crosse & Fischer, 1868)
South, mainly near coast: Cap Ste Marie (fossil); Taolanaro; Andrahomana; Mangoky; gorges du Manombo; Fiherana; Manampetsa; Mahofaly coast; Ikonka; Tsiobe; Behara-Bevia; Mananjary; Beloha.

Clavator johnsoni (Smith, 1882)
Centre: Antananarivo; Anonive; Ambositra. Forest, 1800m.

Clavator moreleti Deshayes- Ferussac, 1851
North-west from Tsaratanana to Nosy Komba & Mt d'Ambre (foret des Roussettes); Antankaratra (=Ankaratra); Ranolalina region; Nosy Bé; Antalaha region; Maroantsetra; Sambirano. Forest, 700m.

Clavator obtusatus (Gmelin, 1790)
South coast and centre: Antananarivo; Taolanaro; Andrahomana; Faux Cap; Cap Ste Marie; Mahofaly plateau; Betaimbolo.

Clavator pauliani F.-P. & S., 1963
North: Mt Tsaratanana; 1500-2200m.

Clavator praecox F.-P. & S., 1963
South: Toliara.

Clavator watersi (Angas, 1878)
No locality data.

Helicophanta amphibulima (Deshayes-Ferussac, 1851)
East: Fenoarivo Atsinanana to Maroansetra; Nosy Bé; Sambirano; reserve de Marojejy (1500-2000m); Chutes de la Mort; Bevahara (forest of Ankarafantsika); several localities around Antalaha; Périnet; Maroantsetra; Beanana; Ranolalina; Mananara. Forest.

Helicophanta betsiloensis (Angas, 1879)
Tanala, south east of Betsileo.

Helicophanta bicingulata (Smith, 1882)
East coastal area: Mananjary; Ekongo; Marovary; Taolanaro; forest of Ranomafana.

Helicophanta echinophora (Deshayes-Ferussac, 1851)
South: Taolanaro; Andrahomana.

Helicophanta farafanga (Adams, 1875)
Farafanga; Ekongo. Forest, sand plains.

Helicophanta geayi F.-P., 1950
South-east: Betioky; south of Mahofaly plateau; Toliara; Beloha; St Augustin; Ambovombe. Coastal dunes and bushes.

Helicophanta gloriosa (Pfeiffer, 1858)
South: Toliara; Andrahomana; Faux Cap; Tsiribihina; Ambovombe; Beloha Taolanaro; forest of Fivanona (Andringitra); Mangidy. Dunes, bushes, crops and forest.

Helicophanta guesteriana (Crosse, 1868)
East: Marovare (Farafangana).

Helicophanta ibaraoensis (Angas, 1879)
May be widespread. East: Périnet; Maintirano; Betsileo; Tanala; Ankarampotsy (950m) (Fianarantsoa). Forest.

Helicophanta magnifica (Ferussac, 1819)
Central-east and east: Lake Alaotra; Soanierana-Ivongo, Tampolo; Antsiatsiaka (Antalaha); Mandraka; marsh of Sifotra; Imerina; banks of Marambato; Betampona; Analamazoatra (1000m, forest); Zahamena.

Helicophanta oviformis (Grateloup, 1839)
West: Bevahara (forest of Ankarafantsika); Maintirano; Ambongo; Ste Marie de Marovoay; Ankara-Analamera; Antseranana; Mananjeba; massif de l'Ankara (S. Manamjeba); Nosy Bé; Haut Sambirano; Mahilaka; massif de Monongarivo; Mahajanga; Ankatsepe; Ankarantsika (? = Anakarafantsika); Tsingy de Nameroko; Antsingy; gorges de Salapango; Tsiribihina; Morondava; Beloha. Forest.

Helicophanta petiti F.-P., 1950
South-east; Faux Cap; Mangoky; plateau Miandraraha (Manombo); Anakao (Toliara); plateau Mahofaly; valley Mandrare (Ifotaka). Coastal dunes.

Helicophanta socii F.-P., B. & S., 1975 (T)
Ankarana. Rocky calcareous region, probably cave dweller.

Helicophanta souverbiana (Fischer, 1860)
Central-east: Ekongo; Marovary (Farafanga); Mangoro; Matitana; Ifandana. Forest.

Helicophanta vesicalis (Lamarck, 1822)
South & south-west: Ankazoabo; Ifandana; plateau Maindraraha (Manombo); ravines d'Ianzamaly (Toliara); Toliara; Andrahomana; Fort dauphin; Manantantely. Woods and ravines.

Family CHAROPIDAE
Pilula excavata F.-P., B. & S., 1975 (T)
Single specimen. Mt Tsaratanana.

Pilula madecassina F.-P., B. & S., 1975 (T)
Mt Tsaratanana.

Family EUCONULIDAE
Euconulus micra (Morelet, 1882) (A)
Nosy Bé; forest of Ankarafantsika; also Comoros.

Microcystis bathiei F.-P., B. & S., 1975
Single specimen. Dunes at Lake Tsimanampetsotsa (Mahafaly coast).

Microcystis madecassina F.-P. & S., 1966 (T)
North: Mt Tsaratanana; 1600m.

Microcystis nitelloides F.-P., B. & S., 1975 (T)
North: Mt Tsaratanana.

Microcystis tangens F.-P., B. & S., 1975 (T)
Single specimen. North: Mt Tsaratanana.

Family HELICARIONIDAE
Bathia madagascariensis Robson, 1914 (T)
Nameroko (Ambongo).

Kaliella ahitsitondronae S., 1966 (T)
North-east Madagascar: Ahitsitondrona (?=Ambohitsitondrona); wood, 700m.

Kaliella milloti S., 1966 (T)
Antananarivo; bushes.

Kaliella soulaiana F.-P., 1973
Cap Est; forest of Andrakaraka (Antalaha).

Malagrion paenelimax Tillier, 1979 (T)
Marojejy Mountains 600m; slug-like, reduced shell.

Tachyphasis milloti F.-P., B. & S., 1975 (T)
Single specimen. Forest, massif of l'Andringitra, south-east.

Vitrina madagascariensis Smith, 1882
Betsileo; Mt Tsaratanana (1400-2000m); forest of Ambohitantely; forest of Manjakatompo; Ivohibe (2100). High forest.

Family ARIOPHANTIDAE
Kalidos aequivocus (Robson, 1914)
Ambongo, Tsingy de Namoroka.

Kalidos ambilensis F.-P. & Be.,1966 (T)
Single specimen. Central east coast: Ambila (Toamasina).

Kalidos amicus F.-P., B. & S., 1975 (T)
North: Mt Tsaratanana.

Kalidos anceyanus F.-P. & S., 1966 (T)
North: Mt d'Ambre.

Kalidos andapaensis F.-P., B. & S., 1975
Widespread in north-east: Andapa; Mt des Francais; Périnet; Tsaratanana (1500-2000); Fenoarivo Atsinanana; Tampolo; Mt d'Ambre; forest

Kalidos androkae F.-P. & S., 1965
South-west and Toliara; dunes.

Kalidos anobrachis (Dohrn, 1882)
South-west but no locality data.

Kalidos antsepokensis F.-P., B. & V., 1974 (T)
South west: Antsepoke (Toliara). Coastal dunes.

Kalidos balstoni (Angas, 1877)
Central and south-east; Sandrogato (n. Anosibe); Ranomafana; (e. of Fianarantsoa); Ekongo?; Farafangana; Mamatantely (Antananarivo); Anosibe; Mandraka (bushes); Ivohibe (bushes, col & pic at 2100m). Forest.

Kalidos basalis (Dohrn, 1882)
No locality data.

Kalidos bathiei F.-P. & S., 1965
South and south-west: Morondava; Betioky; Andranohinaly; Toliara; Ankazoaba; Befandriana (cap St Vincent). Woods.

Kalidos bournei Robson, 1914
Central-west area: Tsingy de Namoroka; other woods and forests in Ambongo; gorges de Salapanga; Atsingy; Bekopaka; Bemaraha; Betampona; forest.

Kalidos calculus F.-P. & Be.,1966 (T)
South-west: Andranovaha; cliffs.

Kalidos capuroni F.-P., B. & S., 1975
Cap Est and several localities around Antalaha.

Kalidos chastelli (Deshayes-Ferussac, 1851)
Extreme south-west, coastal: calcareous mountains of Bas Fiherana; St Augustin; Andranohinaly; Miary; Fiherana; Onilahy; Andranovaha; dunes near Lake Manampetsa; Andringy.

Kalidos cleamesi (Smith, 1882)
South-central: Ambohimitombo, Ankafana (Betsileo); Sahana (west Madagascar); Mt Tsaratanana; forest.

Kalidos dautzenbergianus (Ancey, 1902)
North: Mt d'Ambre.

Kalidos decaryi F.-P., B. & S., 1975 (T)
North: Mt Tsaratanana.

Kalidos delphini F.-P., S. & V., 1974 (T)
Taolanaro; forest.

Kalidos ekongensis (Angas, 1877)
Apparently widespread but only known from a few primary forest localities: Ekongo; Kandani; Bongolava (forest, under dead wood and bark); Lake Alaotra (primary forest); Mahajanga.

Kalidos eos (Dohrn, 1882)
Central but no locality data.

Kalidos eucharis (Deshayes-Ferussac, 1851)
North-east: Sambirano; woods.

Kalidos fallax F.-P., B. & S. 1975 (T)
Single specimen. Mt d'Ambre.

Kalidos feneriffensis (Adams, 1876)
North-east: Maroantsetra and Fenoarivo Atsinanana; woods.

Kalidos fuscoluteus (Grateloup, 1840)
No locality data.

Kalidos glessi F.-P., B. & S., 1975 (T)
North: Mt d'Ambre; single specimen.

Kalidos hestia (Dohrn, 1882)
Tampolo (Fenoarivo Atsinanana); Ahitsitondrona; forest.

Kalidos hildebrandti (Dohrn, 1892) (T)
Single specimen. South Betsileo.

Kalidos hova (Odhner, 1919)
Small area on north-west coast: Catsepe; Amparimgidro.

Kalidos humbloti (Ancey, 1902)
Widespread from north to south: Mt d'Ambre; Tsaratanana; Antankaratra; Fanitrys (Ankarana); Ambohivoangy (bushes, 50-200m); Tampolo forest (Fenoarivo Atsinanana); coast between Toamasina and Nosy Borah; Périnet (under bark); Mandraka (under stones); ravines d'Ianzamaly (Toliara); woods, bushes.

Kalidos lamyi F.-P. & Be.,1966
North: Mt des Francais; Anosiravo; Sakaramy; Locoube; Antseranana.

Kalidos lapillus F.-P. & Be., 1966
South-west: Andranovaha; Mangoky; Morombe; Miandraraha; Nosy Katafana; Onilahy; Lake Tsimanampetsotsa; Mahofaly; Amotaka; cliffs.

Kalidos mangokyanus F.-P. & S., 1965
South-west: Antaramaitsy; Reantengy; Andavadoaka; dunes and calcareous cliffs.

Kalidos merschardti F.-P., B. and S., 1975 (T)
North: Mt Tsaratanana.

Kalidos microlamyi F.-P., B. and V., 1974
Cap Diego; Mt des Francais; Amparimgidro (Mahajanga).

Kalidos milloti F.-P. & S., 1966 (T)
North: Mt Tsaratanana; 1400 -2000m.

Kalidos montis F.-P. & Be.,1966 (T)
North: Mt Tsaratanana; 1500m.

Kalidos oleatus (Ancey, 1902)
North-east; reserve of Marojejy (700-2000m); Mananara forest (1800m); Mt Tsaratanana; several localities around Antalaha; Antsianaka; Zahamena.

Kalidos oxyacme (Ancey, 1908)
Antankaratra.

Kalidos piperatus (Fulton, 1901)
Extreme south-east: Taolanaro; Tranomaro (n-e of Androy); Amboisarabe; dunes, forest.

Kalidos profugus (Ancey, 1902)
Widespread but few specimens have been found: Antankaratra; Farafanga; coast between Toamasina & Ste Marie.

Kalidos prominens F.-P. & S., 1966
Single specimen; no locality data.

Kalidos propeanobrachis F.-P. & Be.,1966 (T)
Massif du Manongarivo (Sambirano)(1000m); Maheva (Farahalana).

Kalidos rufescens (Grateloup, 1840)
Forest; no locality data.

Kalidos secans F.-P., B. & S., 1975 (T)
Single specimen. Mt Tsaratanana.

Kalidos soulaiana F.-P., 1973
No locality data.

Kalidos tenebricus F.-P., B. & S., 1975 (T)
North: Mt d'Ambre.

Kalidos thalia (Dohrn, 1882)
No locality data.

Kalidos tranomarensis F.-P., B. & V., 1974 (T)
Tranomaro, north-east of Androy.

Kalidos tsaratananensis F.-P. & S., 1966
North: Mt Tsaratanana; 1500 - 1800m.

Kalidos tsialangiensis F.-P., B. & V., 1974 (T)
South west: Tsialangy.

Kalidos tulearensis F.-P. & S., 1966 (T)
Single specimen; south: Ianzamaly, Toliara; ravines.

Macrochlamys stumpfii Boettger, 1889
Widespread, but mainly in north; forest of Manjakatompo; reserve de Marojejy (700-2000m); several localities around Antalaha e.g. forest of Andrakaratra; Antseranana; cave at Orangea; Mt des Francais; Ankara-Analamera; massif de l'Ankara; cirque de Fanitrys; Nosy Bé; Mt Tsaratanana (2500m); Bas Sambirana; Mahilaka; Ambohivoangy (bushes); Amparimgidro; Toamasina (under stones); station Ivohina; banks of Ivondro; Betampona; Bongolava (in dead wood); Zahamena; Andringitra; forest; a pest species.

Sitala acuta F.-P. & S., 1966
North: Mt Tsaratanana only; 1400-1800m.

Sitala amabilis F.-P. & S., 1966
Central-east: Manjakatompo & Mandraka; bushes.

Sitala ambovombeensis F.-P., B. & V., 1974 (T)
South of Ambovombe: detritus on dunes.

Sitala ankasakasensis F.-P., B. & V., 1974 (T)
Single specimen: Ankasakasa (Ambongo).

Sitala antsingiana F.-P., B. & S., 1966 (T)
Antsingy.

Sitala brancsiki Boettger, 1892 (T)
Nosy Bé (Lokobe).

Sitala culminis (F.-P. & S. in F-P, B, & S 1966)
North: Mt Tsaratanana only; 1500-2200m.

Sitala delaportei F.-P., B. & S., 1975 (T)
North: Mt Tsaratanana.

Sitala elevata (F.-P. & S. in F-P, B, & S, 1966)
Mt Tsaratanana (2000m); Sambirano; Ambanja.

Sitala filomarginata Boettger, 1892 (T)
Lokobe (Nosy Bé).

Sitala gaudens F.-P. & S., 1966
Central-east: Manjakatompo; forest.

Sitala roedereri F.-P., B. & S., 1975 (T)
North: Mt Tsaratanana.

Sitala soulaiana F.-P. & Testud, 1973
Ansahantangata; Amboafotsy; Ambodirano.

Family UROCYCLIDAE
Elisolimax bella (Heynemann, 1882) (A)
Nosy Bé; Nosy Komba; Mayotte (Comoros).

Elisolimax madagascariensis (Poirier, 1887)
North east: Toamasina; Ivolohina; Fenoarivo Atsinanana; Antasibe; banana trees.

Trochonanina milloti F.-P., B. & V., 1974 (T)
Ahitsitondrona, north of bay of Antongil.

Trochonanina tulearensis F.-P., B. & V., 1974 (T)
Single specimen. Ravines of Ianzamaly (Toliara).

II FRESHWATER MOLLUSCS

ARCHAEOGASTROPODA
Family Neritidae
Clithon spiniperda (Morelet, 1860)
Antseranana, Nosy Bé.

MESOGASTROPODA
Family Truncatellidae
Truncatella guerini Villa, 1841
Nosy Bé; baie des Amis, Antseranana.

Family Ampullariidae
Lanistes (olivaceus) grassetti Morelet, 1863
Mahajanga; freshwater. Common in lower Mangoky region and found elsewhere in Madagascar. May be a form of L. ovum.

Pila cecillei (Philippi, 1848)
Antseranana, Mahajanga, Antananarivo, Fianarantsoa, Toamasina; freshwater.

Family Thiaridae
Cleopatra colbeaui (Craven, 1880)
Antseranana, Toamasina, Nosy Bé. Found most frequently in central and northern regions. Freshwater; small streams in forest.

Cleopatra grandidieri (Crosse & Fischer, 1872
Eastern central Madagascar and isolated localities on west coast; Toamasina, Fianarantsoa, Mahajanga; freshwater, forest stream poor in dissolved salts.

Cleopatra madagascariensis Crosse & Fischer, 1872
Antseranana, Mahajanga, Toamasina; freshwater.

Melanatria fluminea (Gmelin, 1767)
Throughout Madagascar, including Antseranana, Toamasina, Antananarivo, Fianarantsoa, Toliara, Mangoky area, L. Alaotra; freshwater, small streams and lakes.

Melanatria madagascariensis (Grateloup, 1841)
Antseranana, Toamasina; freshwater.

Family Potamididae
Cerithidea decollata (Bruguiere, 1838) ?
Antseranana, Toamasina; freshwater.

BASOMMATOPHORA
Family Lymnaeidae
Radix hovarum (Tristram, 1863) ?
Widespread; freshwater.

Family Planorbidae
Afrogyrus starmuhlneri Brown
Freshwater (Brown, 1978).

Afrogyrus (apertus) (Martens, 1896)
Antananarivo; freshwater.

Anisus crassilabrum (Morelet, 1860) ? = Afrogyrus crassilabrum ?
Widespread. Also Comores; freshwater.

Bulinus bavayi (Dautzenberg)
Widespread. With B. mariei, is included as synonym of B. forskali (Wright, 1971). Also on Aldabra.

Bulinus liratus (Tristram, 1863)
Widespread, common in central and south-eastern areas but some records may refer to B. obtusispira. Freshwater; irrigation channels but comparatively rare in rice fields.

Bulinus mariei (Crosse, 1879) = B. forskali ? E ?
Widespread; freshwater. Taxonomic status not clear and may be same as B. forskali from Africa. If a separate species, it may supplant B. bavayi eventually (Wright, 1971).

Bulinus obtusispira (Smith)
Extensive range in western region including lower Mangoky district, Mahajanga, Basybasy (in s.w.), Tanararive. Common in rice fields and capable of aestivation for at least seven months; rarely found with B. liratus but the two species are easily confused.

Family Ancylidae
Ferissia modesta (Crosse, 1880) ?
Antseranana, Antananarivo; freshwater.

NONMARINE CRUSTACEA OF MADAGASCAR

ANOSTRACA and CONCHOSTRACA

Several species have been found, but from the information currently available it is not possible to draw biogeographic conclusions (Paulian, 1961).

CLADOCERA

About 20 taxa are listed for Madagascar, but it is emphasised that these undoubtedly represent at maximum a third of the total species present (D.G. Frey, unpublished report). None are known to be definitely endemic, but studies on other members of this group are revealing that many species, while not restricted to particular lakes, are restricted to relatively small geographical regions.

OSTRACODA

Endemic species include (Decary, 1950):
Cypris decaryi Gauthier, 1933

Cyprinotus imus Gauthier, 1934

CALANOIDA

5 endemic species in 2 genera; one subgenus is endemic and includes a cave variety (Paulian 1961).

Family PSEUDODIAPTOMIDAE
Pseudodiaptomus pauliani Brehm 1951.
Canal des Pangalanes, Mananjary. Found only once in stagnant water and dense vegetation of Eichhornia.

Pseudodiaptomus batillipes Brehm 1954
Taolanaro. Found once with cladocerans.

Family DIAPTOMIDAE
Tropodiaptomus (Anadiaptomus) madagascariensis (Rylov, 1922)
Taolanaro, Antananarivo. Considered characteristic of plankton of high plateau lakes: Lake Mandroseza, Lake Andrianotapahina.

Tropodiaptomus (A.) madagascariensis poseidon Brehm 1952
Rivers and lakes north of Mananjeba and near Ambilobe.

CYCLOPOIDA

18 endemic species in 9 genera, 3 of which are endemic (Dussart, 1982).

Family CYCLOPINIDAE
Allocyclopina madagassica Kiefer 1954
In sand on beach, lagoon at Maroantsetra.

Family CYCLOPIDAE
Halicylops pusillus Kiefer 1954
In sand in lagoon of Maroantsetra.

Halicylops denticulatus Kiefer 1960
Found once. Brackish water, Manambato.

Afrocyclops pauliani Lindberg 1951
Found once. Antananarivo, Besarety.

Bryocyclops (Rybocyclops) pauliani Lindberg 1954
Cave of Andranoboka near Mahajanga. Subterranean in stagnant water.

Bryocyclops (B.) mandrakanus Kiefer 1955

Bryocyclops ankaratranus Kiefer 1955
Found once. Waterfall, in moss. Forest of Ambahona in massif d'Ankaratra.

Bryocyclops (Haplocyclops) gudrunae Kiefer 1952
Found once. Interstitial water in alluvial sand on bank of Menarandra at Tranoroa.

Bryocyclops (H.) neuter Kiefer 1955
Banks of lagoon at Maroantsetra, east Madagascar.

Bryocyclops (H.) correctus Kiefer 1960
Occurs in interstitial fauna of phreatic water of Sisaony and Faratsiho rivers.

Cochlacyclops ateles Kiefer 1955
Known only from type locality. Interstitial water of rich alluvium in small mountain waterfall at Faratsiho.

Goniocyclops primus Kiefer 1955
Wet moss on edge of Cascade du Foly, massif de l'Andohahela, 1500m, Taolanaro. Known only from type locality.

Goniocyclops alter Kiefer 1955
Known only from type locality. Wet moss, Cascade d'Ankaramena, on road between Ambalavao and Ankaramena at km 506.

Psammocylops excellens Kiefer 1955
Known only from type locality, on road from Ihosy to Betroka at km 300 in tributary of upper Onilahy.

Mesocyclops annae Kiefer 1930
Antananarivo.

Mesocyclops insulensis Dussart 1982
Lake Bemapazo at Nosy Bé.

Mesocyclops pilosus (Kiefer 1930).
Edge of shallow lakes with rich vegetation; Lake d'Andrianotapahina near Ivato, Antananarivo; grotte Andranomaly near Mozombi-Andalambazo. Known only from Madagascar.

Thermocyclops neglectus f. major Dussart 1982.
Several localities; known only from Madagascar.

Thermocyclops consimilis pusillus Dussart 1982.
Parc de Tsimbazaza at Antananarivo; known only from Madagascar.

HARPACTICOIDEA

Family CANTHOCAMPTIDAE
A very interesting, if not particularly diverse group, found mainly in streams on rocks and in humid moss (Paulian 1961).

Echinocamptus pauliani Chappuis 1956
Known only from type locality; moss, massif de l'Andohahela, Taolanaro.

Attheyella (Mrazekiella) meridionalis Dussart 1982.
Taxonomic status uncertain. Known from type locality only; edge of Lac de Mantasoa.

Elaphoidella aberrans Chappuis 1954
Moss, forest of Isaka, Taolanaro and waterfall at Mandraka.

Family PARASTENOCARIDAE
Parastenocaris variolata Chappuis 1952
Phreatic water of Menarandra river at Tranoroa.

Parastenocaris pauliani Chappuis 1952
Phreatic water of Menarandra river at Tranoroa.

Parastenocaris forficulata Chappuis 1952
Sand (psammic), edge of lagoon of Maroantsetra at Ambodivoangy.

Parastenocaris madagascariensis Chappuis 1952
Sand, edge of lagoon of Maroantsetra at Ambodivoangy.

Parastenocaris macaco Chappuis 1952
Sand, edge of lagoon of Maroantsetra at Ambodivoangy.

Parastenocaris trisaetosa Chappuis 1954
Lagoon, Lanirano near Taolanaro.

Parastenocaris arenicola Chappuis 1954
Sand, rivers Sisaony and Zazafotsy, on road to Ihosy.

Parastenocaris pusillus Chappuis 1954
Sand, lagoon, Lanirano near Taolanaro.

Parastenocaris gracilis Chappuis 1954
Sand, lagoon of Maroantsetra.

BATHYNELLACEA

3 species of syncarids (Parabathynellidae) known from littoral phreatic water (Paulian, 1961).

ISOPODA

The main group of terrestrial crustaceans, the wood lice. 52 species were listed by Barnard (1958) who considered that there are still probably many more to be discovered. The Ankaratra mountains are especially rich for Isopoda but this is probably largely because this area has been most intensively studied. A large volume of isopod material is still awaiting study (Paulian, 1983). There are several cave species.

Family STYLONISCIDAE
Styloniscus albidus Vandel 1952
Forest of Manjakatompo, Ankaratra Mountains, 2000m.

Styloniscus vandeli Barnard 1958
Ambatolaona and Ambanja, 75m.

Family CIROLANIDAE
Anopsilana poissoni Paulian & Delamare Deboutteville, 1956
Subterranean. Cave of Mitoho, south of Toliara. Blind and unpigmented, may be parasitic on blind fish.

Family TRICHONISCIDAE (ONISCIDAE)
Madoniscus termites Paulian de Felice, 1950
East: forest of Tampolo. May be an endemic genus; found in termite galleries of Eutermes nigrita, associated with Captotermes truncatus.

Suarezia heterodoxa Dollfus 1895
Fenoarivo Atsinanana; Mount d'Ambre.

Suarezia differens Barnard, 1958
Forest of Manjakatompo (Ankaratra Mountains, 2000m); Périnet.

Didima humilis Budde-Lund, 1909
Antananarivo; forest of Manjakatompo; Périnet.

Philoscia reducta Barnard 1958
Périnet.

Tura testacea Budde-lund 1902
Mahajanga; Aldabra.

Ankaratridium caecum Paulian de Felice, 1950
Massif de l'Ankaratra; found under stones near pisciculture station at Manjakatompo. Blind; endemic genus.

Microcercus rotundifrons Barnard 1958
Forest of Manjakatompo.

Microcercus mascarenicus Barnard 1958
Forest of Manjakatompo.

Armadillo otion Barnard 1958
Périnet.

Armadillo fenerivei Barnard 1958
Fenoarivo Atsinanana.

Armadillo euthele Barnard 1958
Fenoarivo Atsinanana.

Armadillo silvivagans Barnard 1958
Forest of Tsaramandroso, Ankarafantsika.

Armadillo ankaratrae Barnard, 1958
Forest of Manjakatompo.

Bethalus carinatus Budde-Lund 1904
Antananarivo; Manjakatompo; Antanimeno.

Bethalus bipunctatus Barnard 1958
Périnet.

Akermania sylvatica Barnard 1958
Manjakatompo.

Akermania hystrix Barnard 1958
Périnet.

Calmanesia erinaceus Barnard 1958
Périnet; forest of Niagarakely (Anosibe).

Calmanesia lonchotes Barnard, 1960
East central; Moramanga district on edge of forest road.

AMPHIPODA

At least 6 endemics (Paulian, 1961).

Family GAMMARIDAE
Austroniphargus bryophilus Monod 1925
Pic Boby in the massif of Andringitra, confined to surface layers of water in pools of thick moss among granitic rocks (Paulian, 1961; Griveaud, 1981); small, blind.

Austroniphargus starmuehlneri Ruffo
Springs near Taolanaro; crenophilic.

Dussartiella madegassa Ruffo 1979
Spring water, central Madagascar.

Family AORIDAE
Grandidierella mahafalensis Coutiere 1904
Moheli; Lake Tsimanampetsotsa.

Family TALITRIDAE
Orchestia ancheidos Barnard 1916
Lake Tsimanampetsotsa on banks and in pools with vegetation; Itampolo, a small, brackish lagoon separated from the sea by a dune, with dense vegetation.

Family MELITIDAE
Melita nitidula Ruffo 1958
Soalava (south).

Family ISAEIDAE
Photis distinguenda Ruffo 1955
Anove River, north of Toamasina; variable salinity.

DECAPODA

Family ATYIDAE
20 species in genus Caridina, most of which are endemic; 2 troglobytic genera, Typhlopatsa and Parisia (Paulian, 1961) which include several unique species. Some of the species in the genus Caridina are used for food.

Caridina angulata Bouvier 1905
Ranofotsy River, near Fianarantsoa and Lake Itasy.

Caridina calmani Bouvier 1919
Ambatonharanana, near Lake Alaotra, (restricted range).

Caridina edulis Bouvier 1904
Malagasy caridina, Saltarelle malgache. Large numbers sold cooked in markets.

Caridina hova Nobili 1905
Taolanaro.

Caridina isaloensis Coutière 1899
Several localities.

Caridina lamiana Holthuis 1965
North-east and east.

Caridina madagascariensis Bouvier (probably synonym of Caridina isaloensis)
Toliara; Mahafaly.

Caridina norvestica Holthuis 1965
Mahajanga and Lake Mahajamba.

Caridina petiti Roux 1929
Known only from type locality near Ambila, eastern Madagascar.

Caridina troglophila Holthuis 1965
Known only from type locality; Ambovonomby Cave, Namoroka, north-west Madagascar.

Caridina xiphias Bouvier 1925
Several localities.

Parisia edentata Holthuis 1956
Antsingy Mountains, near Bekopaka, Mahajanga Province.

Parisia macrophthalma Holthuis 1956
Grotte des Fanihy, Ankarana Mountains, north of Ambilobé.

Parisia microphthalma (Fage 1946)
Grotte des Fanihy, Ankarana Mountains, north of Ambilobé.

Typhlopatsa pauliani Holthuis 1956
Mitoho Cave, north-east corner of Lake Tsimanampetsotsa, Mahafaly Province.

Family PALAEMONIDAE
Macrobrachium hildebrandti (Hilgendorf, 1893)
Endemic.

Macrobrachium petiti (Roux, 1934)
Endemic. Vatomandry.

Macrobrachium patsa (Coutiere, 1899)
(= Macrobrachium lepidactylus)
Patsa river prawn, Bouquet patsa, 'orana', 'camaron'. Endemic. Andampy; Manahara River; Onilahy; Bay d'Antongil.

Family POTAMONIDAE (endemic species)
Gecarcinautes antongilensis antongilensis (Rathbun 1905)
Baie of Antongil, Toamasina, Ambilobe, Manambato.

Gecarcinatus antongilensis vondrozi Bott, 1965
Known only from type locality, Vondrozo (700-800m).

Gecarcinatus goudoti (Milne-Edwards 1853)
Antananarivo, Ivoloina River, Chambendiana River.

Hydrothelphusa agilis agilis Milne-Edwards 1872
Several localities and rivers in areas including Sakaleony, Antananarivo, Toamasina, Bombetok, Ambodrina stream at Périnet, Ambetolamy stream, Ranomafana, Beforona, Schambendrama.

Hydrothelphusa agilis madagascariensis (Milne-Edwards 1872)
Antseranana, Mount d'Ambre, Bombetoke, Sakaleony River, Antananarivo, Sakavalana, Betampona reserve.

Hydrothelphusa humbloti (Rathbun, 1904)
Woods. Toamasina, Taolanaro, Andrafialava, Sakalava, Ambohitantely (1700 m).

Madagapotamon humberti Bott, 1965
Known only from type locality. Woods between Ankara and Analamera.

Madagapotamon gollhardi Bott, 1965
Known only from type locality. Cave at Ankara.

Macrobrachium ankaraharae (Nobili, 1906)
Ankaraha, Antseranana.

Family PARASTACIDAE
Astacoides m. madagascarensis (H. Milne Edwards & Audouin, 1839)
Around Antananarivo. This subspecies occurs most commonly in the market at Antananarivo.

Astacoides madagascarensis caldwelli (Bate, 1865)
Streams on eastern slopes of Ankaratra Mountains, i.e. to south and slightly to south-west of m. madagascarensis.

Astacoides madagascarensis granulimanus Monod & Petit, 1929
South-east, distinct from madagascarensis and caldwelli but coincides with betsileoensis.

Astacoides madagascarensis betsileoensis Petit, 1923
('orambanonga' or 'orambato')
South: Betsileo, Fianarantsoa, Ikongo Mountains and forest.

Family SIDIDAE
Pseudosida bidentata Herrick, 1884

Latonopsis australis Sars, 1888

Latonopsis orientalis Sars, incertae sedis

Diaphanosoma paucispinosum Brehm, 1933

Family DAPHNIIDAE
Daphnia carinata King, 1852

Ceriodaphnia laticaudata P.E. Müller, 1867

Ceriodaphnia rigaudi Richard, 1894

Ceriodaphnia c. quadrangula (O.F. Müller, 1785)

Simocephalus serrulatus (Koch, 1841)

Family MOINIDAE
Moina hartwigi Weltner, 1898

Moina cf. dubia de Guerne & Richard, 1892 likely to be conspecific with M. hartwigi

Moinodaphnia macleayi (King, 1852)

Family MACROTHRICIDAE
Echinisca odiosa (Gurney, 1907)

Echinisca orbicularis (Brehm, 1930)

Echinisca madagascariensis (Brehm, 1933)

Echinisca chevreuxi de Guerne & Richard, 1892

APPENDIX 3. SPECIES ACCOUNTS

This appendix contains individual accounts for selected groups of Madagascan animal species, most of them threatened or possibly so. Classifications of degree of threat follow the IUCN definitions set out below, though it should be noted that in some cases designations are preliminary and should *not* be taken as official IUCN categories.

The categories are defined as follows:

Extinct (Ex)
Species not definitely located in the wild during the past 50 years (criterion as used in The Convention on International Trade in Endangered Species of Wild Fauna and Flora - CITES).

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. Also included are taxa that are possibly already extinct but have definitely been seen in the wild in the past 50 years.

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 has not yet been assured; and taxa with populations which are still abundant but are under threat from severe 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 Endangered, Vulnerable, or Rare but where there is not enough information to say which of the three categories is appropriate.

Insufficiently Known (K)
Taxa that are suspected but not definitely known to belong to any of the above categories, because of lack of information.

Out of Danger (O)
Taxa formerly included in one of the above categories, but which are now considered relatively secure because effective conservation measures have been taken or the previous threat to their survival has been removed.

N.B. In practice, Endangered and Vulnerable categories may include, temporarily, taxa whose populations are beginning to recover as a result of remedial action, but whose recovery is insufficient to justify their transfer to another category.

APPENDIX 3.A. BIRDS

Data sheets for the following species are provided, extracted from: Collar, N.J. and Stuart, S.N. (1985) *Threatened birds of Africa and related islands: the ICBP/IUCN Bird Red Data Book, 3rd edition, part 1.* ICBP/IUCN, Cambridge.

K	*Tachybaptus pelzelnii*	I	*Tyto soumagnei*
E	*Tachybaptus rufolavatus*	R	*Brachypteracias leptosomus*
K	*Ardea humbloti*	R	*Brachypteracias squamiger*
V	*Anas bernieri*	R	*Atelornis crossleyi*
E	*Aythya innotata*	R	*Uratelornis chimaera*
E	*Haliaeetus vociferoides*	I	*Neodrepanis hypoxantha*
E	*Eutriorchis astur*	R	*Phyllastrephus apperti*
R	*Mesitornis variegata*	R	*Phyllastrephus tenebrosus*
K	*Mesitornis unicolor*	R	*Phyllastrephus cinereiceps*
R	*Monias benschi*	R	*Xenopirostris damii*
I	*Sarothrura watersi*	I	*Xenopirostris polleni*
K	*Amaurornis olivieri*	R	*Monticola bensoni*
R	*Charadrius thoracicus*	I	*Crossleyia xanthophrys*
Ex	*Coua delalandei*	I	*Newtonia fanovanae*

A full reference list is provided at the end of this section.

MADAGASCAR LITTLE GREBE — INSUFFICIENTLY KNOWN

Tachybaptus pelzelnii (Hartlaub, 1861) — Podicipediformes: Podicipedidae

SUMMARY This endemic Madagascar waterbird, common and widespread in the recent past, is known to have suffered a considerable decline in certain areas and, in view of the variety of threats it faces, it is treated here as a case requiring precautionary or preventive measures.

DISTRIBUTION The Madagascar Little Grebe is endemic to Madagascar where it is widespread from sea-level to 1800 m, and absent only from the subdesert region in the south, including Lake Tsimanampetsotsa (Delacour 1932a, Rand 1936, Milon *et al.* 1973), although there is a specimen in NHMW from the south-west coast (H. Schifter *per* Z. J. Karpowicz *in litt.* 1983).

POPULATION The species was considered common, 1929-1931 (Delacour 1933, Rand 1936), and locally common, 1942-1944 (van Someren 1947). In 1973 it was still described as common except for at least 15 km around Antananarivo, where it was rare (Milon *et al.* 1973), but other evidence suggests that it was probably no longer common anywhere at that stage and is likely to be less so now. Thus it was found to be abundant at Lake Ihotry in the south-west in December 1929 (Rand 1936) but was extremely rare there, 1960-1966 (Appert 1971b), though 100-150 were present on it in August 1983 (O. Langrand *in litt.* 1984); and, although birds were common at Lake Alaotra, 1929-1931 (Delacour 1932a), in a three-month study of grebes in north-central Madagascar ranging from south and west of Antananarivo to north of Lake Alaotra, 1960, only 10 of this species were seen (at Lake Alaotra and around Andilamena 30 km to the north) and it was "definitely the rarest" of the three species seen and had "considerably decreased in numbers" (Voous and Payne 1965). Despite a report that at least 100 were present at Lake Itasy and on nearby crater-lakes around 1970, this species along with the Madagascar Pond-heron *Ardeola idae* was then regarded as in complete collapse around Antananarivo (Salvan 1972a). The factors apparently causing the decline at Lakes Ihotry and Alaotra and around Antananarivo are reportedly widespread in Madagascar (e.g. Salvan 1970,1972b, Appert 1971b), and it seems likely that the species will have declined everywhere and may well now be threatened. That it has generally declined has been confirmed by occasional observations spanning the past 15 or so years (D. A. Turner *in litt.* 1983).

ECOLOGY It inhabits lakes, pools and slow stretches of rivers (Rand 1936), preferably those most richly vegetated with aquatic plants and notably the water-lily *Nymphaea stellata*, occurring much less often on vegetation-free water (Appert 1971b). The species is considered to be less exclusively piscivorous than either of its congeners in Madagascar, the Little Grebe *Tachybaptus ruficollis* (with which it is often seen: O. Langrand *in litt.* 1984) and the Alaotra Grebe *T. rufolavatus* (Voous and Payne 1965, Appert 1971b) (see relevant account); of eight stomachs of birds collected, 1929-1931, all held aquatic insects, four also feathers (Rand 1936); of five stomachs, 1960, feathers were in four, fish in two, insects in two, a crustacean in one (Voous and Payne 1965). Breeding appears to occur chiefly at the end of the rainy season (February to April), when water-levels are highest and aquatic plants most developed; in favourable conditions it evidently also occurs in the austral spring (August to October) (Appert 1971b; also Rand 1936). In BMNH there is a downy chick from Namoroka (north-west) in March and a female ready to lay from Iampasika (south-east) in August (NJC). Clutch-size is three to four (Milon *et al.* 1973); nests may be close to each other (see Appert 1971b). The species is forced to move around because many waterbodies annually dry out while others shrink greatly in size (Appert 1971b).

THREATS Apart from the pollution of waters around Antananarivo (Salvan 1970,1972b), two major and two less immediately certain threats can be identified, the first three of which are interrelated.

Introduced exotic fish The introduction of herbivorous tilapia into many waterbodies throughout Madagascar has apparently resulted in a massive reduction in their vegetation (Appert 1971b), e.g. Lake Ihotry had been rich in water-lilies in 1929, but very few were seen in 1960-1966 (Appert 1971b) although it was only in October 1960 that the lake was successfully stocked with tilapia (Griveaud 1960a). These fish are able to colonise sites away from the release area during the rainy season; only very isolated pools or ones which dry out every year escape (Appert 1971b). All waters found to hold grebes in north-central Madagascar, 1960, had abundant small fish, mainly tilapia (Voous and Payne 1965). The black bass *Micropterus salmoides* is regarded as both a food-competitor and a predator on downy young of this and other waterbird species (Salvan 1972a).

Competition with the Little Grebe The spread through Madagascar of *T. ruficollis* is outlined in Threats under Alaotra Grebe. Its post-1945 increase in abundance appears to be related to the conditions created by the introduction of exotic fish, since *ruficollis* is more piscivorous than *pelzelnii* and occurs widely on vegetation-free waters (Voous and Payne 1965, Appert 1971b). "As the structural characters of the invading *ruficollis* more closely resemble *pelzelnii* than *rufolavatus*, it is not unlikely [see Remarks] that the decline of *pelzelnii* is caused by the recent colonisation of *ruficollis*. The structure and ecology of these species make it not improbable that the decline will continue" (Voous and Payne 1965).

Hybridisation with the Little Grebe A possible hybrid *ruficollis* x *pelzelnii* has been described (Benson 1971a) and an apparent pair-bond between birds of these species has been observed in the wild (Benson *et al.* 1976). This evidence, though at present slight, suggests that as *ruficollis* spreads and multiplies while *pelzelnii* contracts and declines, further interbreeding could lead to genetic swamping by the former of the latter.

Reduction of wetlands Various factors over the past 50 years have resulted, in the Mangoky region at least, in less water in rivers and lakes and a lowering of the water-table, so that overall there is less grebe habitat (Appert 1971b). Marshes throughout the island have been transformed into rice-fields and fish-farms (Salvan 1970,1972b).

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED A modern evaluation of the plight of the Madagascar Little Grebe is required before appropriate measures can be proposed; nevertheless it seems clear that such measures should include the safeguarding of a network of vegetation-rich lakes and pools from the introduction of exotic fish.

REMARKS In the passage (from Voous and Payne 1965) quoted under Threats, the original has "likely" for the obviously correct "unlikely": this misprint has been confirmed (K. H. Voous *in litt.* 1983).

ALAOTRA GREBE **ENDANGERED**

Tachybaptus rufolavatus (Delacour, 1932) Podicipediformes: Podicipedidae

SUMMARY This endemic Madagascar waterbird, known chiefly from Lake Alaotra, is in the irreversible process of disappearing through hybridisation with the Little Grebe *Tachybaptus ruficollis.*

DISTRIBUTION The Alaotra Grebe is known primarily from Lake Alaotra (40 km by 3-5 km) and adjacent marshes, at c. 700 m in north-eastern Madagascar (Delacour 1932a, Lavauden 1937, Voous and Payne 1965). A prediction that it would be reported from Lake Itasy and other marshes in central Madagascar (Lavauden 1937) has been partially fulfilled, with records from Ankazobé (80 km north of Antananarivo) in December 1947 (Salvan 1971), a crater-lake north of Analavory (80 km west of Antananarivo) on an unknown date (but apparently around 1970) (Salvan 1972a), "Mianinarivo" (correctly, Miarinarivo: J. T. Hardyman *in litt.* 1984) (one town of this name is near Analavory and just north of Lake Itasy, another is 100 km north of Lake Alaotra) on an unknown date (Voous and Payne 1965), and Lake Kazanga (just south of Lake Itasy) in July 1971 (when at least 10 were seen) (Salvan 1972a). Moreover, the species has been collected as far south as the Isalo massif, in January 1963, and as far west as Mahajanga in November 1969 (see map in Salvan 1971), and it was seen between the Antsingy massif and Antsalova (near the coast due west of Antananarivo) in July 1970 (Salvan 1971) and in the Antsingy reserve (R.N.I. no. 9 du Tsingy de Bemaraha) itself on an unknown date (but apparently around 1970) (Salvan 1972b) (this and the previous record may perhaps be the same). However, it is to be observed that, since hybridisation with the longer-winged, dispersive Little Grebe *Tachybaptus ruficollis* has been taking place from at least 1929, and had seemingly intensified by 1960 (see under Threats), and since many hybrids can be extremely difficult to distinguish as such (see Voous and Payne 1965), the validity of many - if not all - of these records away from Lake Alaotra (which remains the only known breeding site) must be doubtful.

POPULATION Numbers are unknown, but certainly very small. At Lake Alaotra in May 1929, when 15 specimens were first collected, it was found breeding in fair numbers (Delacour 1932a); in May/July 1960, when 13 more specimens were collected, the estimated total number of birds seen at the lake was 50 (Voous and Payne 1965) (this presumably includes the 13 collected). More recently it has been stated that this species "seems in expansion" (Salvan 1972a), presumably as much in terms of numbers as of range; however, the records that are evidently the basis of this view, apart from the doubt cast on them under Distribution above, can be interpreted in much less encouraging ways, e.g. that they only represent the true but hitherto unrecognised distribution of the species, or even that they reflect an unprecedented dispersal from Lake Alaotra in the face of deteriorating conditions there. However, 12 birds were seen on Lake Alaotra in December 1982 (O. Langrand *in litt.* 1984).

ECOLOGY Lake Alaotra is a large but shallow water-body, in 1929 fringed with dense vegetation (dominated by papyrus and reeds) and dotted with water-lilies (Rand 1936). The Alaotra Grebe is almost exclusively piscivorous (Voous and Payne 1965), breeding April to June in 1929 (Rand 1936), January to March in 1960 (Voous and Payne 1965). Its short wing is considered an indication of highly sedentary behaviour (Voous and Payne 1965), but subsequent records away from Lake Alaotra have been seen to call this assumption in question (Salvan 1972a).

THREATS The species is threatened by hybridisation with the far more widespread and numerous Little Grebe, and by alteration of habitat in its only known breeding area. Although only first noted in any numbers in Madagascar in 1945 (Milon 1946), the Little Grebe was evidently fairly widespread in the island in the nineteenth century (up to 17 skins in museum collections), with the earliest record in 1837 and a breeding record from 1895 (Schlegel and Pollen 1868, Hartlaub 1877, Oberholser 1900, Delacour 1933, Milon 1951, Benson 1971a). Despite reports that *ruficollis* disappeared from near Antananarivo around 1955 (Salvan 1972a, Milon *et al.* 1973), it was "by far the commonest species" of grebe at and around Antananarivo and Lake Alaotra in 1960 (Voous and Payne 1965) and had also become widespread in the Mangoky river region by this time (Appert 1971b). Its post-1945 increase in abundance appears to be related to the conditions created by the introduction of exotic fish, especially tilapia, into many lakes and pools throughout Madagascar (Appert 1971b). Hybridisation by the Little Grebe with the Alaotra Grebe, though first recognised in the 1960s (Voous and Payne 1965), has been recorded at least as far back as the 1920s (the type-specimen and up to four others of the original series of 15 appear hybrid) (Voous and Payne 1965), and even a specimen from 1862 seems suspect (Benson 1971a). Of 39 grebes collected in north-central Madagascar in 1960, 13 were *rufolavatus*, 13 *ruficollis*, and 13 hybrids or suspected hybrids of the two; although there was a bias towards collecting birds that proved to fall into this last category, it seemed likely on this evidence that the pure *rufolavatus* strain was "doomed to vanish" (Voous and Payne 1965). Observations at Lake Alaotra in April 1971 confirmed that hybridisation with *ruficollis* was on a large scale (D. A. Turner *in litt.* 1983). Tilapia were already in Lake Alaotra in 1960 (Voous and Payne 1965), and while this may not have been directly injurious to the population of the piscivorous *rufolavatus* (indeed, if *rufolavatus* is truly "in expansion" this may well be due to tilapia) it may have provided greater attraction to the more mobile *ruficollis* and thus accelerated the rate of genetic swamping, and may equally have reduced cover needed by *rufolavatus* for breeding. By 1972 Lake Alaotra was said to be of limited interest only, owing to developments there for rice-growing and fish-farming (Salvan 1972b), a view confirmed by recent observations (O. Langrand *in litt.* 1984).

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED Nothing can be done to prevent the extermination of the Alaotra Grebe in the wild; however, a survey to assess its present condition would be most valuable for, if sufficient numbers of "pure" birds survive, it might be feasible to devise a programme of captive propagation for them.

MADAGASCAR HERON — INSUFFICIENTLY KNOWN

Ardea humbloti Milne Edwards & Grandidier, 1885 — Ciconiiformes: Ardeidae

SUMMARY Mostly at best uncommon, this large but very little known Malagasy waterbird was reported in 1973 to have declined alarmingly and to face extinction unless completely protected, although it appears still to be safe in parts of the west coast of Madagascar.

DISTRIBUTION The Madagascar Heron occurs thinly throughout western Madagascar, chiefly in coastal and adjacent areas, but apparently rarely in the east. Records of this species are relatively few and many appear to involve wandering individuals. Only three breeding sites appear to have been found, in the extreme north (locality not specified), in the extreme south-west (locality not specified), and on Nosy Manitra off the south-west coast, west of Pointe Fenambosy (Pointe Barrow) (Milon *et al.* 1973), although a specimen in BMNH from Lake Ihotry, collected on 8 December 1929, is labelled "breeding" and another in MNHN from Toliara, 18 May 1948, had well developed testes (NJC). Other localities from which birds have been reported are chiefly in the north-west around Mahajanga, including Mahajanga itself (Muddiman 1983), Ampijoroa in the Ankarafantsika area (Milon *et al.* 1973), Ambato-Boeni (Salvan 1970), along the Betsiboka River between Ambato-Boeni and Mahajanga (O. Langrand *in litt.* 1984), and Lake Kinkony (Rand 1936); birds have also been found further north on the coast opposite Nosy Bé (Rand 1936), and well to the south at Berevo on the Tsiribihina River (Bangs 1918), at Lakes Masama and Bemamba near Antsalova (O. Langrand *in litt.* 1984), at Lake Ihotry (Rand 1936) and on a marsh between Lake Ihotry and Morombe (Muddiman 1983). In the central part of Madagascar there have been three records from Antananarivo (Milon 1949, Milon *et al.* 1973), two from Lake Itasy (Salvan 1970,1972, H. A. W. Payne *per* K. H. Voous *in litt.* 1983), one at the lake near Antsimangana, north of Lake Alaotra towards Andimalena, 20 June 1960 (H. A. W. Payne *per* K. H. Voous *in litt.* 1983), and an unspecified number (but more than three) from Lake Alaotra itself (Milon *et al.* 1973, H. A. W. Payne *per* K. H. Voous *in litt.* 1983). Although the type-specimen was from the "east coast" (Milne Edwards and Grandidier 1885), the only other record from the east is of an immature that stayed near Maroantsetra from December 1982 to April 1983 (O. Langrand *in litt.* 1984). Individuals have thrice been recorded from the Comoro Islands: Moheli in September 1958 (Benson 1960), Mayotte in October 1965 (Forbes-Watson 1969), and again on Mayotte in July and August 1974 (D. A. Turner *in litt.* 1983, A. D. Forbes-Watson pers. comm. 1984).

POPULATION Numbers are evidently rather small, and perhaps localised. The colony on Nosy Manitra consisted of five to eight nests, July 1948 (Milon 1948); the other colony in the south-west consists (or consisted) of "several nests each year" (Milon *et al.* 1973); at the site in the far north it is not clear if more than one nest was found (see Milon *et al.* 1973). Thirteen birds were collected by the Mission Franco-Anglo-Américaine, 1929-1931 (Delacour 1932a), which appears to be all or almost all of the birds seen during that period of study (reported as three to four opposite Nosy Bé, "a few" at Lake Kinkony, four at Lake Ihotry: see Rand 1936). All other records appear to concern single individuals only. In 1973 it was reported that recent observations had indicated an alarming decline (Milon *et al.* 1973), but further details were not and have not subsequently been given. Despite all this, two independent observers in the 1970s and 1980s provide more encouraging information, the species being thought "not uncommon" in some areas of the west coast between Mahajanga and Morondava, though rare elsewhere (D. A. Turner *in litt.* 1983, O. Langrand *in litt.* 1984); it has also been found "very common" in two areas, along the Betsiboka River, where 40 were counted between Ambato-Boeni and Mahajanga, April 1982, and at Lakes Masama and Bemamba, date unspecified (O. Langrand *in litt.* 1984).

ECOLOGY The ecology of this species is probably much as other large herons *Ardea*, although the large bill, sombre colouring and observed adroitness in mandibulating prey are considered evidence of specialisation for feeding on large mobile fish rather than on a wider range of aquatic prey (Hancock and Elliott 1978). Both small and large fish (including a 48 cm eel) are recorded as food (Rand 1936, Benson 1960, Forbes-Watson 1969); it feeds in shallow water in lakes and along river banks and on the seashore (e.g. on reefs, at fish-weirs and in estuaries), and is recorded also from rice-fields (Rand 1936, Benson 1960, Forbes-Watson 1969, O. Langrand *in litt.* 1984). Although apparently solitary, it nests in mixed heronries; at one site (in the far north of Madagascar) it has been found nesting at ground level in a vegetation-swathed coral hollow (Milon *et al.* 1973). Breeding (clutch-size three) has been reported in July (Milon *et al.* 1973) and is considered likely (from gonad condition) in December (Rand 1936). Natural predators may include the Madagascar Fish Eagle *Haliaeetus vociferoides*, since a bird has been seen to be attacked by one of these raptors, escaping by diving under water (Langrand and Meyburg 1984).

THREATS The species is perhaps naturally uncommon and localised, and very possibly in competition with the more numerous Grey Heron *Ardea cinerea* and Purple Heron *A. purpurea*. The species's large size and relative tameness were considered in 1973 to expose it to risk, presumably from native hunters, and it was asserted that, having recently suffered an alarming decline, it would soon become extinct unless completely and carefully protected (Milon *et al.* 1973). In 1961, however, under Decree no. 61-096, both Grey and Purple Herons - although represented by endemic Malagasy subspecies - were classified as harmful animals, a situation which still obtained in 1973 (Forbes-Watson and Turner 1973): to the untrained eye the Madagascar Heron is so like these species that it cannot have escaped any persecution of them that may have been - and perhaps still is - officially encouraged. Ardeid colonies commonly suffer exploitation by locals for eggs (O. Langrand *in litt.* 1984). Rice-growing is reportedly beginning to alter Lake Bemamba (O. Langrand *in litt.* 1984).

CONSERVATION MEASURES TAKEN None is known; however, in 1948 the wood which held the colony on Nosy Manitra was protected through a local taboo (Milon 1948, Milon *et al.* 1973).

CONSERVATION MEASURES PROPOSED Studies are needed to determine the number and distribution of colonies of this species, its ecological requirements and long-term trends: such work might be linked with similar work on the Madagascar Pond-heron *Ardeola idae*, and on the endangered Madagascar Fish Eagle. Complete and active protection for it (including the banning of further collection of specimens) and for its breeding sites is essential (Milon *et al.* 1973, Hancock and Elliott 1978). The prohibition of the taking by locals of colonial waterbirds' and seabirds' eggs would be a great step forward for conservation in Madagascar (O. Langrand *in litt.* 1984). For the need for a general ornithological survey of both west and east coast wetlands in Madagascar, and for the possible importance of wetlands around Cap St.André and of a proposed faunal reserve in the Antsalova region, see Conservation Measures Proposed under Madagascar Teal *Anas bernieri.*

REMARKS "This and perhaps Swinhoe's Egret [*Egretta eulophotes*, treated in King 1978-1979] may claim to be the two heron species which are most in need of every care and protection if they are to survive" (Hancock and Elliott 1978).

MADAGASCAR TEAL **VULNERABLE**

Anas bernieri (Hartlaub, 1860) Anseriformes: Anatidae

SUMMARY This little known and evidently much persecuted duck, endemic to Madagascar, has been recorded from a few sites along the west coast and its total numbers must be very low.

DISTRIBUTION Apart from an apparently unsubstantiated assertion that it occurs on the east coast (Milne Edwards and Grandidier 1885) and a specimen in Grenoble collected by L. Lavauden at Lake Alaotra on 5 September 1932 (O. Langrand *in litt.* 1984), the Madagascar Teal is known only from localities close to the western coast of Madagascar, from the far north as far south as Lake Ihotry. There are four specimens, dated 1934, from Montagne d'Ambre (far north) in MNHN, Paris (SNS). The species was collected in June 1969 at Ambilobe (far north-west) (Salvan 1970) and in the last century from the "north-western coast" (Schlegel 1866), this presumably referring to the undated specimen in RMNH from "Bonbetak Baai", i.e. the Baie de Bombetoka at Mahajanga (NJC). A pair was seen in September 1983 on Lake Kinkony (O. Langrand *in litt.* 1984). Two birds were collected in July/August 1930 in the western savannas near Maintirano (Delacour 1932a, Rand 1936); one was seen at Bekopaka around this time (Delacour 1956), and a possible sight-record of a pair in July 1929 at Ankavandra (Rand 1936) would constitute the most inland record for the species (up the Manambolo river east of Antsalova), although subsequently the Antsalova region (especially Lake Bemamba) was shown to be a major area for it in the 1970s (Salvan 1970,1972b, Scott and Lubbock 1974): Lake Bemamba is a shallow saline lake drying up in September/October, when the species is thought to disperse either to the Soahanina estuary or to the remaining small freshwater pools and lakes in the forests and rice-fields (Scott and Lubbock 1974). The species has also been recorded in the last century from around Morondava (Grandidier 1868; two specimens in RMNH: NJC) and in 1957 (but apparently not subsequently: see Threats) from Lake Ihotry (south-east of Morombe) (Griveaud 1960a). These data confirm (but slightly extend) the species's range, anticipated and mapped as from Ambilobe to north of Morombe on the basis of apparent habitat requirements within the 500 to 1,500 mm isohyets (see Salvan 1970 and under Ecology).

POPULATION Although not considered rare on the west coast in the last century (Milne Edwards and Grandidier 1885) it was described as very rare and localised by around 1930 (Delacour 1932a,b); and although it has more recently been judged probably less rare than records suggest (Milon *et al.* 1973) the only evidence of this is from the Lake Bemamba region, where 13 birds were shot in 1970 (Salvan 1970,1972b) and, on Lake Bemamba itself, 81 birds were seen (10 pairs on the eastern shore, 61 individuals maximum on the western) and no more than 120 estimated for the whole lake, August 1973 (Scott and Lubbock 1974); this concentration was considered probably "the largest for hundreds of miles" (Scott and Lubbock 1974).

ECOLOGY In the nineteenth century the Madagascar Teal was reported as occurring in small flocks on estuaries, marshes or pools (Milne Edwards and Grandidier 1885), but at least in July and August the species appears to occur in rather isolated pairs (Salvan 1970, Scott and Lubbock 1974; see also records from 1929 and 1930 above). It appears to occur on marshes where recent alluvia and pliocene soils mingle, in herbaceous savanna (with *Hyparrhenia* and *Heteropogon*), mangrove, and dense deciduous forest (Salvan 1970). Birds feed in shallow water or on mud at the water's edge, but have not been observed to drink or fly to fresh water (Scott and Lubbock 1974). From courtship activities seen in August, birds were expected to breed from mid-September; natives reported breeding in November and April, with clutch-size variously claimed as 2-4 and 8-10 (Scott and Lubbock 1974).

THREATS The hunting of waterfowl in Madagascar was, at least until recently, very widespread and very intense (Salvan 1970,1972b, Forbes-Watson and Turner 1973). Although hunting pressure at Lake Bemamba did not appear to be great in August 1973, there was some poaching (Scott and Lubbock 1974) and the area had been recently opened up for hunting by the building of an airport at Ambereny (Salvan 1972b), such that by the early 1980s many hunters were coming there by private airplane from (e.g.) Mahajanga and Antananarivo (O. Langrand *in litt.* 1984); moreover, locals have reported that they hunt the Madagascar Teal with dogs and plunder nests for eggs (Scott and Lubbock 1974). The impact of such depredations elsewhere in Madagascar is not known. The importance to the species of habitat free of the influence of tilapia and black bass *Micropterus salmoides* is also unknown, but the absence of records from Lake Ihotry after 1957 may indicate that introduced fish pose a threat to the species (for details see Threats under Madagascar Little Grebe *Tachybaptus pelzelnii*). At least in the southern part of the Teal's range (in the Mangoky region), various factors over the past 50 years have resulted in less water in rivers and lakes and a lowering of the water-table, so that overall there is less habitat for aquatic birds (see Appert 1971b). Marshes throughout the island have been transformed into rice-fields and fish-farms (Salvan 1970,1972b), and rice-growing is now reportedly beginning to alter Lake Bemamba (O. Langrand *in litt.* 1984).

CONSERVATION MEASURES TAKEN Hunting is supposed to be banned on Lakes Bemamba and Masama in the Antsalova region, also on parts of Lakes Kinkony and Ihotry (Andriamampianina 1976). The species is listed on Appendix II of CITES, to which Madagascar is a party.

CONSERVATION MEASURES PROPOSED The area west of the north-south line between Antsalova and Bekopaka is so rich ornithologically - but particularly because of its population of Madagascar Teal - that a faunal reserve there has been urged, if only at least for Lake Bemamba (Salvan 1972b; also Salvan 1970), formally recommended (IUCN 1972) and supported (Milon *et al.* 1973, Scott and Lubbock 1974), but no action appears to have been taken; such a reserve would form a valuable westwards extension of the existing reserve at Antsingy (R.N.I. no. 9 du Tsingy de Bemaraha), and would be likely to provide a major sanctuary for several other threatened bird species, notably the Madagascar Fish Eagle *Haliaeetus vociferoides*, Madagascar Heron *Ardea humbloti* and Sakalava Rail *Amaurornis olivieri* (see relevant accounts), and also perhaps the Madagascar Pond-heron *Ardeola idae*. Reassessment of the Lake Bemamba situation is now urgent, especially given that there were 70% more waterfowl in the 1940s than in 1973 (Scott and Lubbock 1974). In general, this species deserves a detailed study at one site to determine its annual requirements and a survey throughout western Madagascar to determine its remaining populations and strongholds. Some of this work could be coupled with attempts to locate populations of the Sakalava Rail, and with survey work on the Madagascar Fish Eagle, Heron, and Pond-heron. In this respect it is to be noted that the extensive wetlands (as shown in IGNT 1964) that lie between Ankasakasa/Cap St.André and Tambohorano appear to have been wholly unstudied by ornithologists and merit inclusion in any future survey. Moreover, the wetlands and associated shorelines along the east coast, from Sambava northwards and Toamasina southwards, have been similarly neglected at least in this century, and in view of nineteenth century records from the east for no fewer than four threatened "west coast" birds (Madagascar Heron, Teal, Fish Eagle and Plover *Charadrius thoracicus*) and of the likely importance of these wetlands for many other bird species, a general ornithological survey is clearly needed along the coastlines indicated above.

REMARKS Only one specimen of this duck appears ever to have been kept in captivity; it proved hardy (Delacour 1956).

MADAGASCAR POCHARD **ENDANGERED**

Aythya innotata (Salvadori, 1894) Anseriformes: Anatidae

SUMMARY This freshwater diving duck, endemic to Madagascar, is extremely poorly known and since 1930 it has become increasingly rare, but nothing appears to have been done to help it.

DISTRIBUTION The Madagascar Pochard is apparently confined to lakes and pools in the northern central plateau of Madagascar. The main site for the species is Lake Alaotra (Delacour 1932a,b, Rand 1936, Lavauden 1937, Milon *et al.* 1973), although there have been no published records from there since the 1930s. However, two flocks (of five and three birds) were seen in the south-east part of the lake between Andreba and Ambatosoratra, 26 May 1960, a flock of 20 (one shot, now in ZMA) was seen at Ambatosoratra, 9 June 1960, and a flock of five was seen on the north-east side near Imerimandroso, 5 July 1960 (H. A. W. Payne *per* K. H. Voous *in litt.* 1983); but a recent two-week search of Lake Alaotra failed to locate the species (O. Langrand *in litt.* 1984). In the 1930s Lake Itasy (west of Antananarivo) was identified as another locality (Lavauden 1937) but there are no subsequent records despite visits in 1969-1971, when the single record for the Antananarivo area was of a pair on Lake Ambohibao, 18 March 1970 (Salvan 1970,1972a). Around 1930 the species was seen on a small pond near Antsirabe (Rand 1936; see Remarks) and it was recently noted that three were collected in 1915 at Ambatomainty, near Maevatanana (Benson *et al.* 1976). On the 15 June 1960 two were seen at a barrage near Ambadivato, in the Andilamena region 70 km north of Lake Alaotra (H. A. W. Payne *per* K. H. Voous *in litt.* 1983). The type-specimen is from Betsileo country (Warren 1966), i.e. the southernmost named area for the species (Betsileo people mapped in Deschamps 1960, also Locamus 1900).

POPULATION Numbers are probably at best extremely small. Around 1930 the species was common and bred at Lake Alaotra, and 27 were collected (Delacour 1932a,b, Rand 1936). The lake was revisited several times in the 1930s and live birds were captured (Webb 1936,1954). Since then it has become increasingly rare (Milon *et al.* 1973). Indeed, since this time the only published record is of the pair seen in 1970 (see Distribution). Two independent observers in Madagascar during the 1970s and 1980s are united in the belief that this bird is on the brink of extinction (D. A. Turner *in litt.* 1983, O. Langrand *in litt.* 1984).

ECOLOGY The Madagascar Pochard is (or was) found on lakes, pools and freshwater marshes with open water, where it feeds by diving; it is rather solitary, otherwise in pairs, and not easy to observe; it nests in a large tuft of reeds or aquatic vegetation, March/April, clutch-size being two (Milon *et al.* 1973).

THREATS Large-scale duck-shooting has been blamed for the evidently disastrous decline of this species (Forbes-Watson and Turner 1973). The introduction of black bass *Micropterus salmoides* and other exotic fish (e.g. tilapia) into the lakes and pools of the high central plateaus has certainly had a serious impact on native wildlife (see Salvan 1970) and may be responsible for the loss of food and/or destruction of young of this species. Gill-net fishing of exotic fish may also take a heavy toll of adults (A. D. Forbes-Watson pers. comm. 1984). By 1972 Lake Alaotra was said to be of limited interest only, owing to developments there for rice-growing and fish-farming (Salvan 1972b), a view confirmed by recent observations (O. Langrand *in litt.* 1984).

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED Legal protection for this species (and many others endemic to Madagascar) was urged in a letter to the Director, Service des Eaux et

Forêts, Chasse et Pêche, over 10 years ago (see King 1978-1979). It is not known if any measures were adopted. A survey is now urgently needed to determine its distribution and numbers, and to provide information from which its conservation can be planned and implemented. This is one species that ought to be savable through captive breeding (see below).

REMARKS The species was frequently bred in captivity prior to World War II, but it is not known to be currently represented in captive collections (Delacour 1959). The locality Antsirabe is assumed (and almost certain) to be that at 19°51'S 47°01'E, not that at either 17°11'S 45°01'E or 13°59'S 49°59'E (in TAW 1980).

MADAGASCAR FISH EAGLE — ENDANGERED

Haliaeetus vociferoides Desmurs, 1845 — Falconiformes: Accipitridae

SUMMARY This little known Madagascar raptor, now confined to rivers and shorelines of the west coast north of Morondava, has declined to a point where it may be close to extinction, yet a project first proposed in early 1979 to survey the species and determine its needs has consistently failed to receive funding.

DISTRIBUTION The Madagascar Fish (or Sea) Eagle is confined to the west coast of central to northern Madagascar, from Morondava north to Diego Suarez. It was formerly reported from the east coast (Grandidier 1867, Hartlaub 1877, Milne Edwards and Grandidier 1879), but these records all appear to be repetitions of each other and based on a single somewhat insubstantial reference to its occurrence near Toamasina in 1862 (Vinson 1865). However, a male was collected on 25 December 1879 at Ampahana (specimen in RMNH: NJC), the only locality of this name (in Office of Geography 1955) being at 14°45'S 50°13'E, with an adjacent coastal lake of the same name, i.e on the north-east coast between Antalaha and Sambava; moreover, five days later the same collector (J. Audebert) obtained another male at "Andrimpona" (specimen in RMNH: NJC), this presumably being the "Andempona" that is marked as the next village (a few kilometres) north of Ampahana, rather than the "Andempona" marked as just north of Sambava (in Locamus 1900). In 1891 it was reported as "all along the western coast and on the numerous small islands off the north-west of the mainland" (Sibree 1891) and this is probably close to the true situation at that time, although evidence of its occurrence in the southern half of the west coast is extremely feeble. Four main general regions have been identified (although these may merely reflect ornithological activity): Nosy Bé and the coastline opposite, the Lake Kinkony region, the Antsalova region, and the coastline between the Mangoky and Fiherenana Rivers, the species apparently being extinct now in this last region. In the first of these regions, eight specimens were collected in two weeks around 1930 on the mainland opposite Nosy Bé (Rand 1936) and there are recent reports of the species from Nosy Bé itself (Thiollay and Meyburg 1981, D. A. Turner *in litt.* 1983). In the second region, there are records from Mahajanga (Kaudern 1922), Lake Kinkony itself, Ambararatabe and Soalala (Rand 1936); in August 1969 the area in the Soalala - Namakia - Lake Kinkony triangle was identified as a major stronghold, at least 11 birds being seen in three days between Mahajanga and Lake Kinkony (D. A. Turner *in litt.* 1983), and a pair was seen there in 1980, east of Mitsinjo along the Mahavavy River (Thiollay and Meyburg 1981). In the third region, eight birds were seen over Lake Masama and the Manambolo River in July 1970 (Salvan 1971, Milon *et al.* 1973, Langrand and Meyburg 1984) and there have been more recent records (Thiollay and Meyburg 1981), including four adults and two juveniles over Lake Masama in June 1982 (Langrand and Meyburg 1984), so that the rectangle of the lakes and marshes between Antsalova, Bekopaka and the sea is now regarded as the last likely area offering hope for the species's survival (Meyburg 1979a, Langrand and Meyburg 1984). In the fourth region, the species was reported from near Morombe around 1930 (Rand 1936) and as frequent in one area around 1960, but not to be found a decade later (Milon *et al.* 1973); there were in fact seven sightings of single birds in the Morombe region, 1959-1975 (Langrand and Meyburg 1984). It is probable that the species was recorded at several unnamed sites along the north-west coast around 1930, given that 27 specimens were collected there "from west of Montagne d'Ambre" (specimen in BMNH: NJC) "to Lake Kinkony" (Delacour 1932a); it was reported near Antsohihy in the 1940s (van Someren 1947), and there are specimens in BMNH and MNHN from Anorontsangana, north of Maromandia (NJC,SNS). Breeding was reported in the early 1970s from Lake Ampijoroa (Ankarafantsika), well inland from Mahajanga (Salvan 1971, Milon *et al.* 1973), but the pair involved was reported not to have produced young for several years prior to 1978 (Meyburg 1979a, B.-U. Meyburg pers. comm. 1983; see Remarks under Van Dam's Vanga *Xenopirostris damii*). Nesting has also recently been recorded on a small island c. 30 km west of Diego Suarez, and there is a recent record from north of Maintirano, five birds being reported shot in this region (Langrand and Meyburg 1984). There appear to be two or three old records from Mauritius (Benson 1970).

POPULATION In the last century the species was not rare and was often seen in the north-west (Schlegel and Pollen 1868), was still fairly common there around 1930 (Delacour 1932a, Rand 1936) but was considered scarce in the 1940s (van Someren 1947). Despite the fairly recent records from Lakes Kinkony and Masama (see above), at the end of the 1970s it was estimated that only 10 pairs survived (Meyburg 1979a, Thiollay and Meyburg 1981). More recently, this estimate has been raised to 30 pairs (O. Langrand *in litt.* 1984). Nevertheless, the species is still to be considered one of the rarest birds of prey in the world (Langrand and Meyburg 1984).

ECOLOGY It is largely a coastal species, inhabiting estuaries and mangrove-bordered bays where shallow waters facilitate fishing, but also lakes and rivers (Grandidier 1867, Schlegel and Pollen 1868, Rand 1936). It takes fish from water in a plunge-dive (Grandidier 1867, Milne Edwards and Grandidier 1879, Rand 1936), though attacks on large waterbirds (Spoonbill *Platalea alba* and Madagascar Heron *Ardea humbloti*) have been witnessed (Langrand and Meyburg 1984). It is commonly found in pairs at traditional sites (Grandidier 1867, Rand 1936), and builds a large nest in the highest tree of forest along the coast or up a river (Schlegel and Pollen 1868), though the nest near Diego Suarez (see Distribution) was on a cliff 6-8 m high (Langrand and Meyburg 1984). It breeds in the dry season (Milon *et al.* 1973), towards the start of the rains (Milne Edwards and Grandidier 1879), but not in November/December (Rand 1936). Only one young is raised (Milne Edwards and Grandidier 1879, Milon *et al.* 1973) though two eggs are laid (Milon *et al.* 1973, Langrand and Meyburg 1984). Age of first breeding is put at four or five years (Milon *et al.* 1973). The records from Mauritius (and also perhaps from the east coast) suggest a powerful dispersive ability.

THREATS The reasons for the decline of this species are unclear (Langrand and Meyburg 1984). Shooting by amateur hunters was suspected to have caused its disappearance between the Mangoky and Fiherenana Rivers (Milon *et al.* 1973), and five birds have been reported shot in recent years in the Maintirano area (Langrand and Meyburg 1984); deliberate destruction of nests is also stated to occur (Thiollay and Meyburg 1981). Rice-growing is reportedly beginning to alter Lake Bemamba (O. Langrand *in litt.* 1984).

CONSERVATION MEASURES TAKEN A leaflet has been produced to increase public awareness of the species's plight (*Fonds d'Intervention pour les Rapaces* no. 9 [1983]: 44, Langrand and Meyburg 1984). Along with all Falconiformes, it is included on Appendix II of CITES, to which Madagascar is a party.

CONSERVATION MEASURES PROPOSED Full protection for this bird is merited (Milon *et al.* 1973). A faunal reserve has been urged for the Antsalova region, identified above (under Distribution) as perhaps this species's last stronghold (see Conservation Measures Proposed under Madagascar Teal *Anas bernieri*). Since early 1979, a proposal to survey and census it from the air, as a first step to determining further conservation action, has languished for lack of financial support, despite repeated inclusion in the annual ICBP programme. It is to be noted that a similar problem exists for the Madagascar Serpent Eagle *Eutriorchis astur* and that these two raptors, among the world's rarest and yet without any conservation action on their behalf, remain the highest priorities for such action at present (Langrand and Meyburg 1984). For the need for a general ornithological survey of east coast wetlands in Madagascar, and for the possible importance of wetlands around Cap St.André, see Conservation Measures Proposed under Madagascar Teal.

REMARKS It is to be hoped that in the course of the proposed survey and resulting research and action for this species it will be possible to accommodate the study and conservation of three other birds of considerable importance, the Madagascar Teal, the Madagascar Heron *Ardea humbloti* (see relevant accounts) and the Madagascar Pond-heron *Ardeola idae*.

MADAGASCAR SERPENT EAGLE — ENDANGERED

Eutriorchis astur Sharpe, 1875 — Falconiformes: Accipitridae

SUMMARY This very poorly known Madagascar rainforest raptor was last seen by an ornithologist over 50 years ago, and hopes for its survival are largely pinned on the conservation of adequate areas of primary forest in the central-east and north-east of the island.

DISTRIBUTION The Madagascar Serpent Eagle is confined to the eastern rainforests of Madagascar, and known from only eight specimens, all collected more than 50 years ago (four in MNHN, two in AMNH, one in BMNH and one in Grenoble) (A. Fayaud *in litt.* 1983, G. S. Keith *in litt.* 1983, NJC); a further specimen reportedly in Berlin (Lavauden 1937) cannot be traced (B.-U. Meyburg *in litt.* 1984). The species was first described from a single specimen collected (presumably around 1874) "in the southern portion of Madagascar" (Sharpe 1875) though the locality was later identified as "Ampasimanavy", a hamlet in the forest a day's march from Andakana village, in the Mangoro valley between Antananarivo and Mahanoro (Milne Edwards and Grandidier 1879; see Remarks). A second bird, dated 1883 and labelled simply "Madagascar", was collected by L. Humblot (specimen in MNHN: NJC). In April 1924 a male was obtained in forest at Fito, i.e. Sihanaka forest (specimen in AMNH: G. S. Keith *in litt.* 1983). The Expédition Citroenen en Afrique obtained a bird at an unknown date and from an unknown locality (specimen in MNHN: NJC), although it is known that the Citroen team arrived in Antananarivo in June 1925 (R. D. Etchécopar *in litt.* 1984). Four specimens were collected in the period 1928-1930, one from Rogez at 900 m in eastern central Madagascar (18°50'S 48°35'E), December 1928 (Lavauden 1932, Benson *et al.* 1976), one from Analamazaotra near Périnet (i.e. also near Rogez), 11 June 1930 (specimen in Grenoble: A. Fayaud *in litt.* 1983), and two from around Maroantsetra (one at sea level at Bevato, 40 km north-west of Maroantsetra up the Vohémar River, 8 May 1930, the other at 600 m at "Ambohimarahavary" [see Remarks under Short-legged Ground-roller *Brachypteracias leptosomus*], two days' march north-east of Maroantsetra, 6 July 1930) in the north-east of the island (Rand 1932,1936). The species has been reported to occur as far south as Farafangana (Lavauden 1937), although there appears to be no evidence for this other than that a bird, either this species or Henst's Goshawk *Accipiter henstii* (see Remarks), was seen at Vondrozo (inland from Farafangana), June or July 1929 (Rand 1932). A forestry official reported making four or five sightings of a raptor closely answering this species's description over the period 1964-1977 in the Marojejy Reserve, north-west of Andapa in north-eastern Madagascar (Meyburg and Meyburg 1978, Meyburg 1979b, Thiollay and Meyburg 1981). There have been no other reports since 1930 though it is hoped the species may also survive on the Masoala peninsula in the north-east (Meyburg and Meyburg 1978, Meyburg 1979b).

POPULATION Numbers are unknown, but the species was repeatedly described as very rare fifty years ago (Delacour 1932a, Lavauden 1932, Rand 1936), so presumably it is very much more so at present: indeed it is authoritatively considered one of the six rarest birds of prey in the world (Langrand and Meyburg 1984). However, since it has also been said to be very shy (Lavauden 1932) it has conceivably avoided detection in several areas, although the forestry official who claimed to have seen it in the Marojejy Reserve (see above) considered it relatively fearless (B.-U. Meyburg *in litt.* 1983). At any rate, to treat the species as extinct (Day 1981) is on present information irresponsibly pessimistic.

ECOLOGY This bird inhabits primary rainforest, although it has also been recorded in secondary growth at the edge of dense forest (Lavauden 1932, Rand 1936). Its short wings and long tail are considered adaptations for flight below the canopy (Lavauden 1932,1937), although it is also considered a bird of the tree-tops (Lavauden 1937). One of the birds collected near Maroantsetra contained part of a very large chameleon (Rand 1936), but the species is also reported to attack lemurs and even poultry belonging to forest guards (Lavauden 1932) and to feed chiefly on mammals (Lavauden 1937). There appears to be no direct evidence that it eats snakes (see Remarks). There are no breeding data (Lavauden 1937).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar. "The present wholesale destruction of the forest" (i.e. rainforest) was being lamented almost 100 years ago (Baron 1890) but has continued unabated throughout the present century (Humbert 1927, Heim 1935, Rand 1936, Swingle 1937, Louvel 1950, Chauvet 1972, McNulty 1975, Guillaumet 1981) and is now proceeding so "incredibly fast" that "good places four or five years ago are already destroyed" and "within the next five years ... all the good [i.e. rich, lowland] forests will vanish" (B.-U. Meyburg *in litt.* 1983). It is estimated that in the years 1981-1985 loss of primary forest in Madagascar will be 35,000 ha per year, most of this in the eastern rainforests and most of it as a result of slash-and-burn ("tavy") cultivation. The de-gazetting of the Masoala Forest Nature Reserve (R.N.I. no. 2) is highly regrettable (see Conservation Measures Proposed).

CONSERVATION MEASURES TAKEN The species's reported presence in the Marojejy Reserve (R.N.I. no. 12), which covers 60,150 ha (Andriamampianina 1981), reinforces the importance of this protected area; however, it has been pointed out that only the lower parts of the reserve provide suitable habitat, the higher-lying areas lacking sufficient vegetation (Meyburg 1979b). A "Special Reserve" also exists at Périnet-Analamazaotra, where the Madagascar Serpent Eagle was once recorded (see Distribution), but only covers 810 ha (Andriamampianina 1981) and the species evidently does not now occur there. Along with all Falconiformes it is included on Appendix II of CITES, to which Madagascar is a party.

CONSERVATION MEASURES PROPOSED Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar: this was formally recommended in 1970 (IUCN 1972). Complete protection of the intact parts of "Sihanaka forest" is of extreme importance, being the single most important tract of unprotected bird habitat at present known in Madagascar: with the reasonable exception of the Snail-eating Coua *Coua delalandei* and the Red-tailed Newtonia *Newtonia fanovanae* (see relevant accounts), all Madagascar rainforest birds here treated as threatened have been recorded there, namely the Brown Mesite *Mesitornis unicolor*, Madagascar Red Owl *Tyto soumagnei*, Short-legged Ground-roller, Scaly Ground-roller *Brachypteracias squamiger*, Rufous-headed Ground-roller *Atelornis crossleyi*, Yellow-bellied Sunbird-asity *Neodrepanis hypoxantha*, Dusky Greenbul *Phyllastrephus tenebrosus*, Grey-crowned Greenbul *P. cinereiceps*, Pollen's Vanga *Xenopirostris polleni* and Madagascar Yellowbrow *Crossleyia xanthophrys* (see relevant accounts). "Sihanaka forest" is technically a misnomer, since the Sihanaka people are to the west of the central rainforest belt, which is inhabited by the Betsimisaraka people (J. T. Hardyman *in litt.* 1984); the name appears to have been imposed by explorers to stand crudely for the broad belt of humid forest from the coast to the Mangoro valley, east and south of Lake Alaotra and in particular in the Toamasina hinterland, notably between the towns of Didy and Fito (see, e.g., the map in Delacour 1932a). Proposals for a comprehensive ornithological survey of Madagascar's rainforests, to feature studies of the Sihanaka forest, the adjacent Zahamena Nature Reserve (R.N.I. no. 3), and other protected areas of rainforest, with particular emphasis on the Serpent Eagle, are to be drawn up as part of an overall plan for bird conservation and research on the island. A proposal in 1979 to search for this species in the Marojejy Nature Reserve and later on the Masoala peninsula (Meyburg 1979b) was adopted as WWF Project 1368, and the required sums were raised; however these sums were not released and the project did not proceed (Langrand and Meyburg 1984). It is to be noted that a similar problem has existed for the Madagascar Fish Eagle *Haliaeetus vociferoides* and that these two raptors, among the world's six rarest and yet without any conservation action on their behalf, remain the highest priorities for such action at present (Langrand and Meyburg 1984). The re-gazetting of the Masoala Forest Nature Reserve (R.N.I. no. 2) was formally recommended in 1970 (IUCN 1972).

REMARKS This species is the only one in its genus (see Sharpe 1875). Concerning the type-locality, Andakana is at 19°22'S 48°05'E on the Mangoro River (Office of Geography 1955, IGNT 1964); neither "Ampasimanavy" nor "Ampasmonhavo" (the name given apropos other species in Sharpe 1875) can be traced (Office of Geography 1955, IGNT 1964), but there is an "Ampasimaneva" a few kilometres to the south of Andakana (see IGNT 1964) which must surely be the site (19°24'S 48°04'E). This is also the type-locality of the Rufous-headed Ground-roller (Sharpe 1875) and it is therefore of considerable importance to establish whether good forest still stands in that part of the Mangoro valley. Concerning the name "serpent eagle", confusion may arise in field studies since one French name for the Madagascar Harrier-hawk *Polyboroides radiatus* is "serpentaire" (A. D. Forbes-Watson pers. comm. 1984): possibly "crested eagle" or "forest eagle" would be a more appropriate name for *E. astur*. It has been remarked that there is great similarity between specimens of the Madagascar Serpent Eagle and those of Henst's Goshawk (A. Fayard *in litt.* 1983), and the AMNH specimen from Fito was originally labelled as the latter species (G. S. Keith *in litt.* 1983): given the importance of museum material in clarifying the range of the former, a check needs to be made of skins of Henst's Goshawk to confirm their identity, and details of any Serpent Eagles thus (or otherwise) discovered are requested to be forwarded to ICBP. Not having been seen with certainty in the wild for over 50 years, by CITES criteria this species would now be considered extinct.

WHITE-BREASTED MESITE **RARE**

Mesitornis variegata (I. Geoffroy Sainte-Hilaire, 1838) Gruiformes: Mesitornithidae

SUMMARY This rail-like terrestrial forest bird is currently known from only two sites in Madagascar, one of which is, however, a protected area.

DISTRIBUTION Although the White-breasted Mesite was first found in 1834 at an unspecified locality in Madagascar, almost a century passed (during which all records of this species are attributable to the Brown Mesite *Mesitornis unicolor*: see Lavauden 1931) before it was rediscovered: an adult female was collected on 12 July 1929 in Ankarafantsika forest (110 km south-east of Mahajanga), north-west Madagascar, and a nest with two eggs was found there in October that year (Lavauden 1931,1932). A year later, on 10-11 November 1930, two males and a gravid female were collected at Ankarana cliffs, 25 km south-west of Tsarakibany, in the far north of the island (Rand 1936). A few were seen in 1971 at Ankarafantsika (Forbes-Watson *et al.* 1973) and further visits there through the 1970s consistently resulted in sightings (D. A. Turner pers. comm. 1983), but there appear to be no other records for this species. Nevertheless it has been speculated that birds may occur in the region between the two known localities, "notably in the Analalava and in the Haut-Sombirano [*sic*]" (Lavauden 1932), and that the Betsiboka River may mark the southern boundary of its distribution (Lavauden 1937). The statement that it occurs "in all western Madagascar" (Milon *et al.* 1973) is patently unsubstantiated. However, recently published information records the species from north-east of Morondava (specifically: 10 km south-west of Marofandilia, 15 km north-north-west and 9 km south of Beroboka and 3 km south of Ampamanmrika lake), several hundred kilometres south of the only other site (Appert 1985).

POPULATION Observations through the 1970s suggest that the species is common at Ankarafantsika (D. A. Turner pers. comm. 1983).

ECOLOGY At Ankarafantsika the species is a ground-dweller in dry forest (Lavauden 1932), likewise at Ankarana cliffs, where a pair was found "running about together in rather low dry forest, somewhat clear of underbrush" (Rand 1936). Food probably consists of insects and fruit (Rand 1951); birds live in pairs on the ground, walking or running with frequent stops and changes of direction, but flying poorly (only if threatened by a predator) (Lavauden 1931, Rand 1936); the nest is placed low in a bush (60-80 cm above ground), evidently October/November (Lavauden 1932, Rand 1936). An association appears to exist between this species and the Rufous Vanga *Schetba rufa*, exactly as for the Subdesert Mesite *Monias benschi* (see relevant account) and Lafresnaye's Vanga *Xenopirostris xenopirostris* (A. D. Forbes-Watson pers. comm. 1984).

THREATS The highly restricted range of this species must be a source of permanent concern and vigilance for its welfare. Deforestation is likely to have affected many areas where it might have been searched for in north-west Madagascar. Introduced rats, widespread in the eastern forests in the 1930s and presumably therefore present in the west, may affect the bird adversely (see under Brown Mesite).

CONSERVATION MEASURES TAKEN The only area where it is currently known to occur falls within the Ankarafantsika Nature Reserve (R.N.I. no. 7) (see Andriamampianina 1981).

CONSERVATION MEASURES PROPOSED A study of the status and ecology of this bird at Ankarafantsika would help determine where else it might be searched for and what management it might require. Ankarana cliffs merit revisiting and careful survey. All such work should be undertaken in conjunction with studies recommended under Conservation Measures Proposed for Van Dam's Vanga *Xenopirostris damii*.

REMARKS The importance of the Ankarafantsika Nature Reserve as the only locality currently known for this species and Van Dam's Vanga cannot be overstated.

BROWN MESITE **INSUFFICIENTLY KNOWN**

Mesitornis unicolor (Desmurs, 1845) Gruiformes: Mesitornithidae

SUMMARY This cryptic and retiring terrestrial rail-like bird of Madagascar rainforest apparently possesses a much wider distribution than has previously been appreciated, but may be at risk from both forest destruction and introduced mammalian predators.

DISTRIBUTION The Brown Mesite evidently occurs throughout much of eastern Madagascar, although most records are from the circle whose diameter lies between Antananarivo and Toamasina. One usually reliable authority gave its range as from Vohimarina (high north-east) to Farafangana (south-east) (Lavauden 1932) but there appear to be no records to support the choice of these extremes and indeed the same authority later speculated whether the species reached even as far south as Mananjary (Lavauden 1937). Reports of the bird from the "north-east" (Humblot 1882), the Masoala peninsula (Lavauden 1937) and south of Maroantsetra (Lavauden 1932,1937), though in themselves too vague to be regarded with confidence, are supported by specimens collected by J. Audebert at Mananara (Antongil Bay), 17 August 1876, "Savary" in February and April 1878 and "Maintinbato" in May 1878 (specimens in RMNH: NJC; also Fisher 1981): "Savary" cannot be traced (e.g. in Office of Geography 1955, IGNT 1964) but a letter from the collector to H. Schlegel, dated 4 March 1878, is headed "Savary, Antongil Bay, west of Mananara, Ancay border, seven days' journey into the interior" (G. F. Mees *in litt.* 1983), which clearly suggests that the "Maintinbato" (i.e. Maintimbato) in question is that just south of Rantabe on the shore of Antongil Bay. The type-specimen was described as from the "north-east" (Delacour 1932a) but this was later refined to "around Tamatave" (Lavauden 1937). There is a specimen in MRAC labelled as from "Brickaville district", February 1928 (NJC). The species occurs in the Sihanaka forest, where four birds were taken in 1925, three in April, one in November (specimens in SMF: NJC), where an adult female was collected in May 1930 (Lavauden 1932) and whence six further specimens were obtained by purchase around this time (Delacour 1932a, Rand 1936). The species is known from the forest between Rogez and Fito (Lavauden 1937), was seen at Périnet in 1939 or 1940 (Webb 1954), and collected in "Lakato forest" in 1924 (two specimens in MRAC: NJC). Four further specimens (in MRAC, SMF and RMNH) are from "Vohibazaha forest, Anivorana district", October 1923 (two) and "Marovato", November 1922 and March 1923 (NJC): Vohibazaha, at 18°48'S 48°33'E, is close to Périnet and Rogez, while of at least 34 localities named "Marovato" in Madagascar (see Office of Geography 1955) three, at 18°57'S 48°49'E, 18°41'S 48°36'E, and 18°27'S 48°41'E, all lie within the general area of forest between Antananarivo and

Toamasina. The species was collected on the "south-east coast" around 1876 (Bartlett 1877,1879), and this otherwise anomalous record was vindicated when nesting birds were found at "Bemangidy" north of Taolanaro (Rand 1951; see Remarks). It is to be observed that the taboo on this species (see Conservation Measures Taken) extended even to speaking its name (Lavauden 1931), so that its existence may often have remained unreported to explorers in certain areas; elsewhere, where no taboo applied, its existence had gone undetected even by natives (Rand 1951). For these reasons, the assertion that the species did not occur at Fanovana (Rand 1936), which may have compounded the judgement that it is highly localised in distribution (e.g. Rand 1951, King 1978-1979), is open to doubt (although the forest at Fanovana is now all cleared - see under Red-tailed Newtonia *Newtonia fanovanae*); and on present evidence it would seem very possible that the bird may be found at many other localities to the north of Toamasina or to the south of Lakato.

POPULATION The species was not considered rare in the last century (Milne Edwards and Grandidier 1885) and in Sihanaka forest it is apparently not very rare (Lavauden 1932). Its wariness and keen senses have been likened to those of pittas (Pittidae) so that it "may be common without being seen" (Webb 1954); nevertheless, it is recently reported as very scarce throughout its range (D. A. Turner pers. comm. 1983).

ECOLOGY The Brown Mesite inhabits the floor of the thickest and remotest parts of rainforest, slipping swiftly on foot through thick vegetation (Lavauden 1931,1932). A bird observed by a seated observer "alternately ran rapidly and then remained motionless, its colours so harmonizing with the background that it was exceedingly difficult to see when stationary" (Webb 1954). Food is probably insects and fruit (Rand 1951); in another account "insects, ants" are mentioned (Milne Edwards and Grandidier 1885). The species flies poorly (only if threatened by a predator) (Lavauden 1931). Both nests found in the south-east in 1948 (on 24 November and 25 December) were in rainforest where a thin cover of shrubs and a few herbs grew below the trees; both were low (1 and 2 m above ground) in the fork of a sloping tree which had lower branches possibly used by the bird to hop up from below; both held one egg, and in both cases the incubating female was caught by hand (Rand 1951).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*). The hilly country in the south-east where nesting was proven in 1948 was evidently in the process of being cleared of forest (see Rand 1951). The brown rat *Rattus norvegicus* and black rat *R. rattus* may affect mesites adversely (Forbes-Watson and Turner 1973), and attention has been drawn to the observation, dating from around 1940, that "the eastern forests are now swarming with them, even in the most isolated regions where the precipitous nature of the country is unfavourable to human habitation" (Webb 1954). It is also speculated whether competition from the Madagascar Wood-rail *Canirallus kioloides* affects the species (D. A. Turner pers. comm. 1983).

CONSERVATION MEASURES TAKEN The species has been recorded from the area now established as the Périnet-Analamazaotra Special Reserve, which covers 810 ha (Andriamampianina 1981). The strong taboo amongst the Malagasy people in the central part of the eastern forests was based on the fact or belief that when the young are captured the adult follows the hunter right back into the village, exhibiting parental concern so like that of a human being as to render the species sacred (Milne Edwards and Grandidier 1885); it is considered that such a taboo must have helped conserve the bird, at least in the past (Forbes-Watson and Turner 1973), and indeed at Périnet the taboo still persists (O. Langrand *per* A. D. Forbes-Watson pers. comm. 1984).

CONSERVATION MEASURES PROPOSED Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sihanaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it.

REMARKS The locality of the two nests found to date was given as "Bemangidy, Poste Mananteina, Fort Dauphin (=Taolanaro) district" with the addition that "Bemangidy is 72 kilometres north of Fort Dauphin and is about five miles west of the Indian Ocean" (Rand 1951). However, the correct names appear to be "Bemangily" and "Manantenina" and the correct distances 55 km and 5 km respectively (see IGNT 1964). It should also be noted that the view, first aired in the original description (Desmurs 1845), that the Brown Mesite might be or was only the female of the White-breasted Mesite *Mesitornis variegata* has resulted in considerable confusion; virtually everything written about the latter in Milne Edwards and Grandidier (1885) does in fact refer to the Brown Mesite; the view that two species were involved was accepted by Hartlaub (1877) and entertained by Lowe (1924) before being confirmed by Lavauden (1931,1932,1937).

SUBDESERT MESITE **RARE**

Monias benschi Oustalet and G. Grandidier, 1903 Gruiformes: Mesitornithidae

SUMMARY This rail-like terrestrial bird of restricted range within the subdesert region of south-west Madagascar, although numerically safe at present, appears to enjoy no protection whatever. It is of exceptional biological interest.

DISTRIBUTION The Subdesert Mesite is restricted to a coastal strip roughly 70 km wide between the Mangoky and Fierenana Rivers, south-west Madagascar, ranging from sea-level to 130 m (Lavauden 1937, Appert 1968, Milon *et al.* 1973). Within this area its distribution was thought "extremely local" (Rand 1936) but other evidence suggests it is widespread (Appert 1968, Turner 1981). Nevertheless it has not been found north of the Mangoky, despite apparently suitable habitat (Appert 1968), and there is no evidence of its occurrence south of the Fierenana, despite records at and near Toliara (Hartert 1912, Bangs 1918): the type-specimen is from Vorondreo, "25 km east of Tuléar (=Toliara)" (Oustalet and Grandidier 1903), but this locality proves to be on the north bank of the Fierenana (i.e. north-east of Toliara) at 23°17'S 43°51'E (Office of Geography 1955). The limit of its range inland up the Fierenana has been given as Fativolo (Lavauden and Poisson 1929), at 23°02'S 44°10'E (in Office of Geography 1955).

POPULATION The species has been reported as common and at times abundant over much of its range (Turner 1981), but the experience of a very recent observer was much less encouraging, though birds were "rather common" at Ihotry village in September 1983 (O. Langrand *in litt.* 1984).

ECOLOGY The Subdesert Mesite is a ground-dwelling bird, reasonably catholic in choice of habitat, primarily requiring areas with dense leaf-litter, at least in patches: thus it is found in both sparse and dense brush woodland with or without *Didierea*, and in open sandy scrub with isolated trees and bushes, etc., but it avoids shadeless areas and those where vegetation is so close to the ground that passage is obstructed (Rand 1936, Appert 1968). It feeds with occasional pecks as it walks along, but mainly by digging in leaf-covered soil (Appert 1968). Stomachs have been found to contain caterpillars, beetles, millipedes, cockroaches, grasshoppers, seeds, and pieces of shell and sand (Lavauden and Poisson 1929, Rand 1936, Appert 1968; also specimen-labels in MNHN: NJC). Parts of certain orchids are reported by natives to be favoured, and damage to orchids has been noted (Appert 1968). Birds are gregarious, generally in groups of four to six, occasionally up to ten, rarely alone; two together always represents a pair, at whatever season (Appert 1968). A report of groups up to 30-40 (Lavauden 1931) has apparently not been corroborated. "Territorial fighting" has been witnessed (Steinbacher 1977), but it is unclear if birds are group-territorial. Females are bolder than males (Rand 1936, Appert 1968). Although in one set of observations males were found to predominate numerically, and this was cited in support of the species possibly being polyandrous (Rand 1936), lengthier field study established no rule in the sexual composition of groups (Appert 1968). On the basis of a male and two females with a nest with two eggs, an instance of polygyny was assumed (Appert 1968), but this conclusion - though perhaps correct

- does not take consideration of other possibilities. Nests (one or two eggs) are placed 1-2 m up in trees or on broken-off tree-trunks, accessible without need of flight (Lavauden 1931, Rand 1936, Appert 1968). Males were reported by natives to incubate and care for the young (Rand 1936) and observations have partially supported this (Rand 1936, Appert 1968), but a female has been found incubating and a pair seen feeding young, though with the female playing more the role of lookout (Appert 1968). Nesting seems mainly to occur within the period of spring rains, October to December, but it may occur earlier or later and two young were even obtained in June, in the middle of the extended dry period (Lavauden 1932, Rand 1936, Appert 1968). The species has been stated not to fly (Delacour 1932a) but it was reported to do so at the sound of a dog barking (Lavauden 1931) and there are two recent and very similar eye-witness accounts (Appert 1968, Turner 1981); moreover, in structure this bird is more adapted for flight and life in trees than the other two mesites (Lowe 1924). An association appears to exist between this species and Lafresnaye's Vanga *Xenopirostris xenopirostris*, since birds of the latter species are often found above parties of the former: the Mesites possibly flush insect prey for the Vangas and benefit in turn from the Vangas' greater vigilance (A. D. Forbes-Watson pers. comm. 1984); for a similar association between a vanga and a mesite, see Ecology under White-breasted Mesite *Mesitornis variegata.*

THREATS The restricted range of this species must be a source of permanent concern and vigilance for its welfare. The Subdesert Mesite shares an identical range with the Long-tailed Ground-roller *Uratelornis chimaera* and occupies the latter's more restricted habitat (Appert 1968); this habitat has been reported as being destroyed (see Threats under Long-tailed Ground-roller). The birds are eaten by dogs and trapped by local villagers (O. Langrand *in litt.* 1984).

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED A study to determine the extent and type of habitat destruction reported in this species's range (see under Threats) is urgently needed. A detailed biological study of the bird would appear likely to yield important new information in the realm of behavioural ecology, given its existence in groups and at least partial sex-role reversal. Both this and the equally remarkable Long-tailed Ground-roller, whose ranges are exactly coincident, merit conservation by means of a protected area.

REMARKS This extraordinary bird occupies a monotypic genus in an endemic Madagascar family of little obvious affinity, both of whose other members are under threat (see relevant accounts).

SLENDER-BILLED FLUFFTAIL — INDETERMINATE

Sarothrura watersi (Bartlett, 1879) — Gruiformes: Rallidae

SUMMARY This small marsh rail is known only from four well separated areas in central and east Madagascar, but is likely to be more widespread, and possibly more at risk from natural causes than from man.

DISTRIBUTION The Slender-billed Flufftail was first described from "south-east Betsileo", i.e. south-central Madagascar, from which four specimens (one undated, three in December 1875) are known (Keith *et al.* 1970). One of these specimens, in BMNH, is labelled "Fangalathova" (NJC) but this is not a locality but evidently a local name for the bird (since such a name is also given for the Madagascar Flufftail *Sarothrura insularis* in Milne Edwards and Grandidier 1885; see Remarks). An early map marks the south-east of "Betsileo province" as the region north-east and south-west of Ikongo (Locamus 1900; see also map in Deschamps 1960). In April 1928 an immature male was collected by L. Lavauden at Analamazoatra near Périnet in eastern Madagascar (specimen in Grenoble: O. Langrand *in litt.* 1984). The species was subsequently found at 1,800 m near Andapa, north-east Madagascar, where 10 specimens were brought in by native hunters between 23 August and 7 September 1930 (Delacour 1932a, Rand 1936, Keith *et al.* 1970). Another two specimens are known, labelled simply "Madagascar" without date or name of collector (Keith *et al.* 1970). In 1970-1971 it was found in the 1,200 km^2 area around the capital, Antananarivo, central Madagascar, at three sites at least, and was suspected of breeding in all *Cyperus* marshes in this area, which is all above 1,250 m (Salvan 1972a); however, a search around Antananarivo in the mid-1970s by three ornithologists (A. D. Forbes-Watson, G. S. Keith and D. A. Turner) wholly failed to rediscover this species, raising doubts about the validity of the records from this area (D. A. Turner *in litt.* 1983). It has been speculated that this species may replace the common Madagascar Flufftail at higher altitudes and that it could occur on the Itremo massif (Benson *et al.* 1976); also that temperature may control its montane distribution (Rand 1936). However, Ikongo and its surrounding area appears to be or have been on the upper edge of the eastern rainforest belt and if the species was indeed collected there, and if the records from Antananarivo are in fact mistaken, there is a strong possibility that its distribution is determined by the distribution of rainforest in Madagascar.

POPULATION Numbers are unknown. On the basis of uncorroborated observations (see above), density has been estimated at one pair per 2 ha of marsh, and the species perhaps breeds in small numbers around Antananarivo (Salvan 1972a). If these records are invalid, however, it is to be noted that the species has not been seen in the wild for over 50 years.

ECOLOGY This rail inhabits small swamps (an association with *Cyperus* is indicated) and adjacent grassy areas, keeping to dense vegetation though occasionally flying short distances (Delacour 1932a, Rand 1936, Salvan 1972a). Food is unrecorded (Keith *et al.* 1970). A male and female in breeding condition, Andapa, September, suggest the species may be a rainy season breeder at that locality (Rand 1936, Keith *et al.* 1970). An adult with a juvenile was reported near Antananarivo, May (Salvan 1972a). There is no evidence of migration (Keith *et al.* 1970).

THREATS Prior to its (uncorroborated) discovery around Antananarivo, this species was considered rare (Delacour 1932a) and possibly "a relict on its way to early extinction" (Keith *et al.* 1970). Antananarivo being in the most densely populated and disturbed part of Madagascar (Salvan 1972a), the bird may prove to be more resilient than suspected. The Laniera marshes, where the species has apparently bred (record of adult with juvenile, above), have been turned into rice-fields, and this is implied to be an ornithological disaster (Salvan 1972a); but it is not clear if the breeding record was made before or after this development.

CONSERVATION MEASURES TAKEN The species has been recorded from the area now established as the Périnet-Analamazaotra Special Reserve, which covers 810 ha (Andriamampianina 1981); birds might occur in the 60,150 ha Marojejy Reserve (R.N.I. no. 12) (see Andriamampianina 1981), since it lies immediately north of Andapa.

CONSERVATION MEASURES PROPOSED A detailed survey of marshes near Antananarivo is needed to establish whether this species is present, and at what densities; protection of selected sites might then be given. Searches also need to be made in the three other areas where birds have been found.

REMARKS This is the least typical member of the genus *Sarothrura*, evidently owing to long isolation in Madagascar, and a genus of its own, *Lemurolimnas*, has been proposed, though regarded as unnecessary (Keith *et al.* 1970). Failure to confirm its presence around Antananarivo need not totally invalidate records from this area, since the species possibly shows a volatility of site-usage akin to that shown by the White-winged Flufftail *S. ayresi* (see relevant account). Although given as quoted under Distribution, the native name of this species is correctly "fangalatrovy" (= "stealer of yams") (J. T. Hardyman *in litt.* 1984).

SAKALAVA RAIL **INSUFFICIENTLY KNOWN**

Amaurornis olivieri (G. Grandidier and Berlioz, 1929) Gruiformes: Rallidae

SUMMARY This marsh-dwelling rail is known from only three widely separated areas in the Sakalava country of western Madagascar, and is generally regarded as rare and localised.

DISTRIBUTION The Sakalava Rail was first described from a single specimen (apparently undated) from Antsalova, west Madagascar (Grandidier and Berlioz 1929), i.e. at about 18°40'S 44°37'E, (*contra* "18°28'S 44°45'E" in Benson and Wagstaffe 1972). In recent years the species has been seen again in the region of Lakes Masama and Bemamba by G. Randrianasolo but a later search of these lakes was unsuccessful (O. Langrand *in litt.* 1984). Soon after its first discovery in this region the species was found c. 300 km to the north-east at Ambararatabe near Soalala, roughly 16°19'S 46°04'E, where seven specimens were collected in March 1931, six of them along the Tsiribahina (Tsiribehino) River (Rand 1936, Benson and Wagstaffe 1972). The only subsequent record is of a female taken from a nest at Nosy-Ambositra on the Mangoky River, 21°55'S 44°00'E, some 360 km to the south of the type-locality, on 9 March 1962 (Benson and Wagstaffe 1972). This record has done nothing to modify the description of the species, over 50 years ago, as strictly localised (Delacour 1932a), which clearly implied that it had been looked for in other areas and found absent. From its behaviour (see Ecology below), it would seem less easy to overlook than, e.g., the Slender-billed Flufftail *Sarothrura watersi* (see relevant account), and new localities for it may prove to be few. However, large areas of apparently suitable but inaccessible habitat do exist (D. A. Turner pers. comm. 1983).

POPULATION Numbers are unknown.

ECOLOGY Birds along the Tsiribahina River at Ambararatabe were found standing on or running over floating vegetation on a narrow, deep stream bordered with tall coarse grass locally called "bararata" (apparently the reed *Phragmites communis*: see Benson and Wagstaffe 1972); though not very shy or active, the birds kept close to the "bararata" and retreated there for shelter (Rand 1936). A bird was also seen on a floating log in a flooded valley clearing; on 26 March a male and female were seen with two well-grown young (Rand 1936). The nest at Nosy-Ambositra was some 50 cm above ground level in bulrushes *Typha angustifolia* near water, in a marshy area with stretches of open water, with bulrushes, water-lilies *Nymphaea stellata* and *Phragmites communis* dominant (Benson and Wagstaffe 1972). The nest held two eggs, probably a complete clutch (Benson and Wagstaffe 1972).

THREATS The species's very restricted distribution, as currently known, exposes it to a variety of potential threats. The eggs of the only recorded nest were eaten by local people (Benson and Wagstaffe 1972) and it is possible that populations could suffer locally from systematic exploitation for food. Rice-growing is reportedly beginning to alter Lake Bemamba (O. Langrand *in litt.* 1984).

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED A faunal reserve has been urged for the Antsalova region, this species's type-locality; for information on this proposal and on the possible importance of wetlands around Cap St.André, see Conservation Measures Proposed under Madagascar Teal *Anas bernieri*. Research on the Teal's distribution could incorporate fieldwork to locate populations of this rail and to determine the threats it may face.

REMARKS Although commonly placed in the genus *Porzana*, the Sakalava Rail has been found to show close affinity to the African Black Crake *Amaurornis (Limnocorax) flavirostris* (Benson and Wagstaffe 1972).

MADAGASCAR PLOVER RARE

Charadrius thoracicus (Richmond, 1896) Charadriiformes: Charadriidae

SUMMARY This shorebird is apparently restricted to coastal grassy areas of south-west Madagascar where it is greatly outnumbered (and possibly outcompeted) by Kittlitz's Plover *Charadrius pecuarius*.

DISTRIBUTION The Madagascar Plover is now (largely or exclusively) confined to coastal south-west Madagascar. It was, however, first described from Loholoka (21°44'S 48°12'E) and the Fanantara estuary (20°51'S 48°28'E) on the east coast of Madagascar (i.e. between Mahanoro and Manakara), when other specimens from the south-east coast were also mentioned (Richmond 1896,1897; coordinates in Office of Geography 1955); there is also a specimen collected by A. Lantz and received by MNHN in 1882 labelled as from the south-east coast (NJC). In the present century it has only been reported with certainty - other than an anomalous inland record of four 60 km from Antananarivo in January 1971 (Salvan 1971) - from the south-west coast between Morondava and Androka. The species has recently been reported without comment from Morondava (O. Langrand *in litt.* 1984), though this is much the most northerly coastal record, birds not otherwise being known to extend beyond the Maintapaka estuary (north of the Mangoky River) (Appert 1971a). Thirteen sites were mapped for the species in the Morombe/Mangoky delta area in the 1960s (Appert 1971a) and several more were found between Morombe and Lake Tsimanampetsotsa, July/August 1972 (Dhondt 1975). Previous records are from Toliara airstrip (Milon 1950), Lake Tsimanampetsotsa (Bangs 1918, Milon 1950), "Nosy Asatra to Beheloka" (Bangs 1918; see Remarks), Androka (Ilinta estuary) (Delacour 1932a, Rand 1936) and Nosy Mborono (Nosimborona), off Androka (Milon 1948). The species is not found at Lake Ihotry or near Antsalova (Dhondt 1975).

POPULATION There are no estimates, but on published evidence the total number must be low, possibly under a thousand. The largest flocks reported are of 33 (Appert 1971a) and 16 (Dhondt 1975); the relatively few other records are all in (usually low) single figures, e.g. only three were found by the Mission Franco-Anglo-Américaine, 1929-1931, after which the species was judged very rare (Delacour 1932a). A two-day survey of the area between Morombe and Befandefa, July 1972, recorded a total of seven birds at four sites; 76 Kittlitz's Plover *Charadrius pecuarius* were found in the same places (Dhondt 1975). A two-day survey at Lake Tsimanampetsotsa, August 1972, recorded a total of 39 Madagascar Plovers at eight sites; at one of these, where several hundred plovers were probably present, 37 were *pecuarius* and only seven *thoracicus* (Dhondt 1975). The species is, however, reported to be "rather common" in the Morombe region (O. Langrand *in litt.* 1984).

ECOLOGY It inhabits short-grass areas near the coast, also flat margins of saltwater expanses and pools, occurring less often on sand- or mudflats (Appert 1971a). At least in July and August, it appears to prefer drier areas than Kittlitz's Plover and even to avoid flooded grassland (Dhondt 1975). The stomach of a specimen in MNHN held large and small insects ("not grasshoppers") (NJC). Eggs have been recorded in November (Appert 1971a) and January (Milon 1950), young in December (Appert 1971a) and August (Bangs 1918, Milon 1950). Breeding and general biology is evidently close to Kittlitz's Plover (see Appert 1971a, Keith 1980; for Kittlitz's, see Cramp and Simmons 1983).

THREATS The reasons for this species's rarity are unclear. What is certain is that Kittlitz's Plover is more recent in Madagascar (Keith 1980), and its relative numerical superiority and much wider distribution suggest that it may compete successfully with *thoracicus*. Hybridisation has not been recorded.

CONSERVATION MEASURES TAKEN The species occurs in the Lake Tsimanampetsotsa Nature Reserve (R.N.I. no. 10) (Andriamampianina 1981).

CONSERVATION MEASURES PROPOSED A study of the status, distribution and year-round ecological requirements of this species is clearly essential in order to determine the measures needed for its survival. Any such study should include a survey of the east coast of Madagascar from Toamasina southwards. For the need for a general ornithological survey of this coast and its wetlands, see under Conservation Measures Proposed for Madagascar Teal *Anas bernieri*.

REMARKS Birds with black breast-bands were not recognised as a species distinct from Kittlitz's Plover until 1896 (see Richmond 1896), and it is possible that museum collections hold specimens of *thoracicus* from before that date whose locality data would be of value in determining the extent of its (at least former) distribution. Neither "Nosy Asatra" nor "Beheloka" are gazetteered (in Office of Geography 1955), but it is clear (from Agassiz 1918 and Bangs 1918) that they must lie between Toliara and Lake Tsimanampetsotsa, along the coast, and indeed a Nosy Satrana and Pointe de Beheloka are marked in this stretch of coastline (in IGNT 1964), at 23°43'S 43°38'E and 23°55'S 43°40'E respectively.

SNAIL-EATING COUA **EXTINCT**

Coua delalandei (Temminck, 1827) Cuculiformes: Cuculidae

SUMMARY This large terrestrial cuckoo is the only bird (other than the elephantbirds Aepyornithidae) in Madagascar generally believed to have become extinct. There is a very remote possibility that it survives.

DISTRIBUTION The Snail-eating Coua is known chiefly from Nosy Borah (Ile de Sainte-Marie) off the northern east coast of Madagascar (Sganzin 1840, Ackerman 1841). The species is also repeatedly stated to have occurred on the mainland opposite Nosy Borah, especially on the immediately adjacent Pointe-à-Larrée (Milne Edwards and Grandidier 1879, Milon *et al.* 1973; also Hartlaub 1877, Delacour 1932a, Rand 1936) and, perhaps owing to its reported survival in the deepest forests of the region between Fito and Maroantsetra (Lavauden 1932), its mainland range has been guessed as "from the head of Antongil Bay southward to Tamatave (=Toamasina)" (Peters 1940). However, it has been pointed out that "there are no exact records of the provenance of mainland specimens" (Greenway 1967), and indeed it is nowhere clear that any specimen is known to have come from anywhere other than Nosy Borah. At least 13 specimens (two each in BMNH and MNHN, one each in MCZ, AMNH, ANSP, RMNH, SMNS, NHMW, Liverpool, Antananarivo and IRSNB: see Remarks) are known to exist (Hartlaub 1860, Delacour 1932a, Rand 1936, Greenway 1967, Benson and Schüz 1971, Schifter 1973, Morgan 1975, NJC), the origin of many of which seems likely to have been Nosy Borah, as it is recorded that specimens from there were dispersed to various museums (Sganzin 1840). Nevertheless, plate 65 in Milne-Edwards and Grandidier (1876) maps the distribution of this species as the eastern rainforest from the latitude of Toamasina north to that of Nosy Borah (but not Nosy Borah itself); the authority for such a distribution is not given. A record of the species as a "waterbird" at Lake Alaotra (Baron 1882) is presumably in error.

POPULATION The extinction of this species is probable (as judged in Delacour 1932a, Rand 1936, Milon 1952, Greenway 1967) but not certain (*contra* Day 1981). None has been reported with certainty since 1834 (Greenway 1967), although the dates of Ackerman's three-year stay (see Ackerman 1841) are not clear and there are three specimens which could have been collected after this date, though not later than 1837, 1840 or 1850 respectively (Benson and Schüz 1971, Schifter 1973, Morgan 1975). The species was "not very rare" on Ile de Sainte-Marie in 1831-1832 (Sganzin 1840), which may perhaps be the source of the statement in 1860 that it was "not rare on the east coast" (Hartlaub 1860); however, no trace of it could be found during six month's exploration in 1865 and it was therefore judged very rare (Milne Edwards and Grandidier 1879; also Jouanin 1962). Following the failure of the Mission Franco-Anglo-Américaine to find it in 1929-1931, and the failure of the offer of a large reward to the procurer of a specimen in 1932 (see Greenway 1967), it was pronounced probably extinct (Delacour 1932a, Rand 1936). Nevertheless, at just this time a "very reliable native who knew exactly what bird was being referred to" reported that the species still survived on the mainland but was very rare and very shy (Lavauden 1932). Much of the area in question was not visited by the Mission Franco-Anglo-Américaine, and has not apparently been searched subsequently, and it is accepted that the species might conceivably survive in a few remote undisturbed patches (Greenway 1967, Milon *et al.* 1973). Survival on Nosy Borah is ruled out as all the original forest has long since been cleared (Lavauden 1932, Daumet 1937, Petter 1963, Keith *et al.* 1974).

ECOLOGY This bird is or was a ground-haunting rainforest-dweller, subsisting on molluscs (Sganzin 1840). An account of its method of breaking snail shells, based on observations in an aviary and apparently also in the wild, has been provided along with brief details of its behaviour and voice (Ackerman 1841).

THREATS Habitat destruction was clearly the chief cause of its disappearance from Nosy Borah (Lavauden 1932, Petter 1963, Keith *et al.* 1974), and was identified as the chief threat to its existence on the mainland as long ago as 1932 (Lavauden 1932): most of the lowlands between Toamasina and Maroantsetra were devoid of forest at the end of the 1960s (Keith *et al.* 1974). Occasional snaring by natives was reported (Lavauden 1932) and this was presumably quite easy at a time when the species was more numerous, and may have played a part in its decline; it was reportedly hunted as much for feathers as for food (Keith *et al.* 1974). Shell remains at certain localities within the forest may have betrayed the presence of birds to hunters (A. D. Forbes-Watson pers. comm. 1984). A recent account gives a cause of extinction as "introduced rodents" (Day 1981): while there appears to be no direct evidence for this, it is conceivable that rats critically reduced the mollusc fauna in key areas and this indirectly contributed to the species's disappearance. For evidence of rats in eastern forests, see Threats under Brown Mesite *Mesitornis unicolor*.

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED It needs to be properly established, through a reexamination of museum material and records, whether the species occurred on mainland Madagascar. Even if this cannot be done, the ornithological surveys that are needed for other reasons in the Sihanaka and other remaining forests between Fito and Maroantsetra (see Conservation Measures Proposed under Madagascar Serpent Eagle *Eutriorchis astur*) should certainly be weighted towards tracking down evidence of this bird's survival.

REMARKS It is to be observed that if the White-breasted Mesite *Mesitornis variegata* went unknown from 1834 to 1929 (see relevant account) and the Yellow-bellied Sunbird-asity *Neodrepanis hypoxantha* from 1929 almost to the present day (but is not extinct: see relevant account), it is certainly conceivable - if less likely - that the Snail-eating Coua could have survived undetected over the same 150-year period. The specimen in IRSNB, whose existence has not previously been announced, was acquired by the museum in 1839 and according to the catalogue it was captured or collected in "Madagascar" in 1832 (P. Devillers pers. comm. 1983), this date perhaps rendering it likely to have come from Sganzin on Nosy Borah (see Distribution).

MADAGASCAR RED OWL — INDETERMINATE

Tyto soumagnei (Milne Edwards, 1878) — Strigiformes: Tytonidae

SUMMARY This owl is known with certainty from rainforest only in eastern central Madagascar, and has been seen only once in the past 50 years.

DISTRIBUTION The Madagascar Red Owl inhabits the eastern region of Madagascar in the circle whose diameter runs between Toamasina and Antananarivo. It does not occur "throughout Madagascar" (*contra* Burton 1973). The type-specimen was collected in 1876 on the east coast near Toamasina (Milne Edwards and Grandidier 1879) and a specimen from around Antananarivo (no date) came to the British Museum in 1879 (Sharpe 1879); as this specimen is catalogued as being collected by "Lorimer" (NJC) it presumably cannot be the bird sent back, also in 1879, by Humblot but which is not listed as going to MNHN (Humblot 1882) and indeed cannot be found there (NJC,SNS). There are two other nineteenth century specimens (in BMHN), one from "the upper forest of Eastern Imerina" in March 1893, one from "Merimitatra" (the label also states "between the two forests"), east Madagascar, January 1895 (Wills 1893, NJC); the former area has been cleared of forest (D. A. Turner pers. comm. 1983), but a place bearing the latter name is marked (in Locamus 1900) as a comparatively large settlement (now abandoned or re-named: not in Office of Geography 1955 or on recent maps) east of Anjozorobe, at roughly 18°25'S 48°05'E, on the upper western slopes of the Mangoro valley and thus between the two belts of forest bordering the valley (Sihanaka forest in the east, Angavo escarpment forest in the west). One collector obtained only three birds of this species in 40 years on Madagascar (two of these specimens were destroyed in 1927) (Lavauden 1932); all three were found in Sihanaka forest (Delacour 1932a). Two specimens (a pair) were shot in March 1930 at Analamazoatra, near Périnet (Lavauden 1932), and another was taken near Fito, Sihanaka forest, on 15 February 1934 (Allen and Greenway 1935). The only subsequent record has been of a bird in deep mountainous rainforest (1,200-1,800 m) a day's walk from the nearest motorable road, Fierenana district (c. 65 km north of Périnet), in 1973 (King 1978-1979, J. I. Pollock *in litt.* 1983). The species is also reported as occurring on the Masoala peninsula (Milon *et al.* 1973) but evidence for this - although it seems likely - has not been traced.

POPULATION Numbers are unknown, but the species has always appeared to be extremely rare (e.g. Delacour 1932a, Lavauden 1932, Milon *et al.* 1973).

ECOLOGY This owl inhabits humid rainforest and is strictly nocturnal, reportedly living in isolated pairs and feeding on frogs caught in clearings (Lavauden 1932). There are no other data, but it is to be observed that at least three specimens have come from localities (Toamasina, Antananarivo and Merimitatra) apparently outside heavily forested areas; however, it is not known to occur in grassland (*contra* Burton 1973).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*).

CONSERVATION MEASURES TAKEN The species has been recorded from the area now established as the Périnet-Analamazoatra Special Reserve, which covers 810 ha (Andriamampianina 1981). The Madagascar Red Owl is listed on Appendix I of CITES, to which Madagascar is a party.

CONSERVATION MEASURES PROPOSED Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sihanaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it.

REMARKS Although originally placed in its own genus (*Heliodius*), this species is clearly a small, dark reddish-orange barn owl *Tyto* (Lavauden 1932, Allen and Greenway 1935; also Sharpe 1879).

SHORT-LEGGED GROUND-ROLLER RARE

Brachypteracias leptosomus (Lesson, 1833) Coraciiformes: Brachypteraciidae

SUMMARY This roller is confined to deep rainforest in the centre and north-east of Madagascar, and is widely considered rare. It is threatened by forest destruction.

DISTRIBUTION On current limited knowledge, the Short-legged Ground-roller occurs in two discrete general areas of Madagascar, in the north-east (Marojejy to around Maroantsetra) and central-east (chiefly Sihanaka forest). Records from the north-east are from the Marojejy Nature Reserve, September 1972 (Benson *et al.* 1976), around Antanombo Manandriana, one day's march west of Andapa, 1930 (Delacour 1932a, Rand 1932,1936), around "Ambolumarahavany" (see Remarks), two days' march north-east of Maroantsetra, 1930 (Delacour 1932a, Rand 1932,1936), and around Bevato, 40 km north-west of Maroantsetra, 1930 (Delacour 1932a, Rand 1932,1936), Maroantsetra (specimen in SMF: NJC), Mananara, November 1876, and Savary (for location of which see Distribution under Brown Mesite *Mesitornis unicolor*), November 1877 to April 1878 (specimens in RMNH: NJC), and from the Masoala peninsula (Turner 1984). In the central-east, the species is known from Sihanaka forest (Delacour 1932a), Périnet, August 1982, at 950 m (O. Langrand *in litt.* 1984), the Toamasina region, September 1913 (specimen in SMF: NJC), Fanovana (Delacour 1932a) and the east Imerina forest (Wills 1893, Oberholser 1900), these last two areas having now been cleared (D. A. Turner pers. comm. 1983) as presumably has that around Toamasina. There is also a record from near Ampasimbe (Newton 1863; see Remarks), and a skin in BMNH, undated and labelled "Sambririna": no such locality can be traced (in Office of Geography 1955), but the possibility that "Sambirano" is intended - i.e. the area of humid forest in the far north-west - cannot be ignored. Two other localities, "Ambore" and "Ankoraka Sahambendrana" (specimens in ZFMK and MNHN respectively: NJC) cannot be traced.

POPULATION This species has been considered commoner than the largely sympatric Scaly Ground-roller *Brachypteracias squamiger* (see relevant account), and over two years 42 specimens were collected or acquired as against 20 of the latter (Delacour 1932a,b). Nevertheless the Short-legged Ground-roller has a somewhat more restricted range and within this has consistently been regarded as rare in some degree (Hartlaub 1877, Milne Edwards and Grandidier 1881, Rand 1936, Lavauden 1937, Milon *et al.* 1973). A recent study has suggested that all ground-rollers have been thought rarer than they are, since their silence and secretive behaviour lead them to be "completely overlooked"; this species is considered "shy though not uncommon" (Turner 1984).

ECOLOGY It inhabits heavy rainforest, "frequenting low, wet places where the trees cast a continual shade and the ground-cover of spindly saplings leaves the damp forest floor nearly bare" (Rand 1936). Although it is considered terrestrial, one observation was of a bird that perched on horizontal strands of vines and in small trees, remaining immobile for minutes on end, with short fast flights between perches (Benson *et al.* 1976), another was of a bird which, when flushed from the ground, flew up to a tree and hid behind branches (Dresser 1893), while a recent study suggests it is in fact much the most arboreal of the ground-rollers (Turner 1984). It has been reported to scratch at moss and dead leaves with its feet like a gallinaceous bird, to uncover beetles, ants, larvae, millipedes, pill-millipedes, ant-lions, worms and small reptiles (Milne Edwards and Grandidier 1881; hence Milon *et al.* 1973). Of eight stomachs, one held a snake; two, chameleons; one, beetles; two, caterpillars; four, other insects; one, a snail (Rand 1936). Two other stomachs held large ants plus beetle remains (Milon *et al.* 1973) and tenebrionid beetles (Benson *et al.* 1976) respectively. Natives reported it to be a night-feeding bird (Sharpe 1871) and it is said to be at least partly nocturnal (Hildebrandt 1881) and locatable in the early morning and evening (Milne Edwards and Grandidier 1881). It is solitary except in breeding season, when it occurs in pairs (Milne Edwards and Grandidier 1881). Birds breed in December, excavating the nest in a tunnel (c. 1 m) in a bank (Milon *et al.* 1973); they are also reported to nest in holes in trees (Dresser 1893).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*).

CONSERVATION MEASURES TAKEN The species occurs in the Marojejy Nature Reserve (R.N.I. no. 12), which covers 60,150 ha, and in the Périnet-Analamazaotra Special Reserve, which covers 810 ha (Andriamampianina 1981).

CONSERVATION MEASURES PROPOSED Full protection for all ground-rollers has been called for (Salvan 1970). Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sihanaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it. This species requires study to determine the basic aspects of its ecology and whether or not it is migratory: in view of native reports that it hibernates (Dresser 1893), it seems likely that some movement takes place, and an understanding of this may be crucial to its long-term conservation.

REMARKS From context, Ampasimbe is evidently the locality on the main road from Antananarivo to Andevoranto, at 18°58'S 48°40'E, well outside the main rainforest block (see Office of Geography 1955, IGNT 1964); however, an earlier map indicates that a small belt of forest, named Madilo, crossed the road near Ampasimbe (see Locamus 1900), though this is presumably now all cleared. "Ambolumarahavary" is presumably identical to "Ambohimarahavary" (see Distribution under Madagascar Serpent Eagle) and is probably, correctly, "Ambolomirahavavy" (J. T. Hardyman *in litt.* 1984), though in fact none of these names can be traced.

SCALY GROUND-ROLLER RARE

Brachypteracias squamiger Lafresnaye, 1838 Coraciiformes: Brachypteraciidae

SUMMARY This roller is confined to deep rainforest in the centre and north-east of Madagascar, and is widely considered rare. It is threatened by forest destruction, by village dogs and by human exploitation for food.

DISTRIBUTION The Scaly Ground-roller occurs throughout the eastern rainforests of Madagascar. Records are from (north to south) Marojejy (Benson *et al.* 1976), Andapa (Rand 1936), around Maroantsetra (Rand 1936, O. Langrand *in litt.* 1984; see Remarks), "Mointenbato" (Fisher 1981), i.e. Maintimbato, and Savary (for location of both see Distribution under Brown Mesite *Mesitornis unicolor*), December 1877 to April 1878 (specimens in RMNH and MNHN: NJC), the Masoala peninsula (B.-U. Meyburg pers. comm. 1983, Turner 1984), the Soamianina (= "Semiang", "Tsimianona") River (type-locality, opposite Nosy Borah) (Hartlaub 1877, Milne Edwards and Grandidier 1881), Sihanaka forest (Delacour 1932a, Rand 1936), Périnet (Webb 1954), Analamazoatra (specimen in Grenoble: O. Langrand *in litt.* 1984), Rogez (Benson *et al.* 1976), the Toamasina region, July 1912 and October 1913 (specimens in MNHN and SMF: NJC) and south-east Madagascar (Dresser 1893). Its occurrence in the south-east has been entirely overlooked this century, but was substantiated by four specimens (see Dresser 1893). One specimen in BMNH is labelled "Voolaly, S. E. Madagascar" (untraceable) and dated February 1872 (NJC); another in SMF was collected on 8 October 1931 at Eminiminy, south-east Madagascar (NJC), gazetteered as at 24°41'S 46°48'E (Office of Geography 1955) and mapped as on the eastern boundary of the Andohahela Nature Reserve (in IGNT 1964). Of two specimens in BMNH collected by J. Audebert and dated February 1879, one has an illegible label (see Remarks), while the other is from "Antsondririna" (NJC): the only gazetteered locality of this name is in the far north-east, at 13°00'S 49°41'E (Office of Geography 1955), and thus much the most northerly record (if correct) for the species.

POPULATION This species has been widely considered rare in some degree: "very rare" (Sganzin 1840), "quite rare" (Milne Edwards and Grandidier 1881), "everywhere rare" (Rand 1936; also Delacour 1932a). Nonetheless, a recent study has suggested that all ground-rollers have been thought rarer than they are, since their silence and secretive behaviour leads them to be "completely overlooked" (Turner 1984). The species was seen almost daily on the Masoala peninsula in October 1980 (B.-U. Meyburg pers. comm. 1983).

ECOLOGY The Scaly Ground-roller is a ground-adapted bird of heavy, deep-shaded rainforest with sparse undergrowth (Rand 1936; also Hartlaub 1877, Benson *et al.* 1976), considered the terrestrial counterpart of the somewhat arboreal Short-legged Ground-roller *Brachypteracias leptosomus* (see relevant account); when disturbed, it either flies a few yards or runs a few steps, then stands quietly watching the intruder (Turner 1984). Native reports that it is nocturnal (Sharpe 1871) have not been proven; and though several ground-rollers appear to be most active at dusk (Turner 1984), recent observations on this species suggested it to be active throughout the day (O. Langrand *in litt.* 1984). Of five stomachs, four contained large terrestrial insects, one a spider (Rand 1936); another held ants and scarabaeid beetles (Benson *et al.* 1976). Prey seen taken includes ground-beetles, ants, caterpillars, centipedes, earthworms, snails, small frogs; Lepidoptera and Diptera are also hawked in flight; whether or not the Short-legged Ground-roller scrapes at the leaf-litter with its feet to uncover its prey, as reported (see relevant account), the Scaly Ground-roller only ever uses its bill for such purposes (O. Langrand *in litt.* 1984). Breeding evidently occurs in September (see Benson *et al.* 1976); a nest-hole probably of this species consisted of a tunnel less than a metre long, with a chamber lined with dead leaves and earthy pellets, built into a bare, sloping bank in deep forest (Benson *et al.* 1976). A nest with young was found on 4 November 1982, 50 km north-west of Maroantsetra at 350 m (O. Langrand *in litt.* 1984).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*). The species is also threatened by young villagers, who trap birds and catch them in the nest, and by village dogs which also catch birds (O. Langrand *in litt.* 1984).

CONSERVATION MEASURES TAKEN The species occurs in the Marojejy Nature Reserve (R.N.I. no. 12), which covers 60,150 ha, and presumably in the Périnet-Analamazaotra Special Reserve, which covers 810 ha, and the Andohahela Nature Reserve (R.N.I. no. 11), which covers 76,020 ha (Andriamampianina 1981).

CONSERVATION MEASURES PROPOSED Full protection for all ground-rollers has been called for (Salvan 1970). Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sihanaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it.

REMARKS For exact localities where the species has been found around Maroantsetra, see Rand (1932). The illegible locality on the Audebert label (see Distribution) is possibly "Ampirina", but no such name has been traced (on Locamus 1900 or in Office of Geography 1955), although it must be fairly close to Antsondririna to have been visited in the same month in 1879.

RUFOUS-HEADED GROUND-ROLLER RARE

Atelornis crossleyi Sharpe, 1875 Coraciiformes: Brachypteraciidae

SUMMARY This roller is confined to deep rainforest in the centre and north-east of Madagascar, and is widely considered rare. It is threatened by forest destruction.

DISTRIBUTION On current limited knowledge, the Rufous-headed Ground-roller occurs in two discrete general areas of Madagascar, in the north-east (Tsaratanana massif, Marojejy Reserve, and Andapa) and central-east (in a circle whose diameter runs from Antananarivo to Toamasina); it has also been recorded in two more southerly general forest areas in south-central Madagascar. Records from the north-east appear to be based on only three specimens, one from Tsaratanana massif at 1,500 m in 1966 (Albignac 1970), one from Ambodifiakarana, in the Marojejy Nature Reserve, at 1,600 m in 1958 (Griveaud 1960b, Benson *et al.* 1976), and one from Antanombo Manandriana, one day's march west of Andapa, at around 1,800 m in 1930 (Delacour 1932a, Rand 1932,1936). The bird is next recorded some 400 km to the south from the Sihanaka forest (Delacour 1932a, Rand 1936), including Didy (Milon *et al.* 1973) and Fito (Benson *et al.* 1976; specimens in MNHN: NJC). Birds have also been seen, collected or acquired from natives in "Forêt Ruanaka" (untraceable: possibly a mistake for "Sianaka") in the Brickaville district, Vohibazaha forest and Lakato forest (specimens in MRAC: NJC), Analamazaotra, and near Périnet (Lavauden 1932, O. Langrand *in litt.* 1984, A. D. Forbes-Watson pers. comm. 1984; see Conservation Measures Taken), Fanovana (Delacour 1932a) and the east Imerina forest (Dresser 1893, Rothschild 1895, Oberholser 1900), though this and the forest at Fanovana are now cleared (D. A. Turner pers. comm. 1983). The type-locality, first reported as "Ampasmonhavo" (Sharpe 1875), then "Ampasimanavy" (Milne Edwards and Grandidier 1881), is almost certainly therefore Ampasimaneva, on the Mangoro River, at 19°24'S 48'04'E (see Remarks under Madagascar Serpent Eagle *Eutriorchis astur*). The most southerly records are from south-central Madagascar in "the forest land that lies between the Betsileo and Tanala...[which] covers the eastern side of the mountains along the edge of the central plateau...[and] is thick and dense, about fifteen or twenty miles in width" (Deans Cowan 1882) and, in 1984, from the Vondrozo region (O. Langrand pers. comm. 1984).

POPULATION The species is widely considered rare in some degree (Richmond 1897, Lavauden 1932, Rand 1936, Griveaud 1960b) but, from the number of skins in one local collection around 1930, it was evidently then "not uncommon" in Sihanaka forest (Rand 1936; also Delacour 1932a) and indeed "not rare" at Didy, presumably around 1970 (Milon *et al.* 1973). It was listed as common in the Betsileo/Tanala border forest a century ago (Deans Cowan 1882). A recent study has suggested that all ground-rollers have been thought rarer than they are, since their silence and secretive behaviour lead them to be "completely overlooked"; however this is considered the rarest and least known species (Turner 1984), a view endorsed by recent observations (O. Langrand *in litt.* 1984).

ECOLOGY "This bird probably frequents the ground in the heavy forest; one stomach examined contained insect remains" (Rand 1936). It is reported to nest in holes in the ground (Dresser 1893). A not fully grown bird collected in late March (specimen in MNHN: NJC) suggests a December/January breeding season. In central-east Madagascar, the species seemingly disappears during the winter months (May/August) (Dresser 1893), though there are in fact specimens (in BMNH, MNHN and SMNS) from Sihanaka taken in May and August (NJC). There appears to be no other information specifically on this bird, although it has been listed as characteristic of secondary forest dominated by *Ravenala madagascariensis*, such forest mostly occurring from sea-level to 500 m (Lavauden 1937); the basis and validity of this assertion are unknown.

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle). Two areas of forest where it was known to occur have been felled (see Distribution).

CONSERVATION MEASURES TAKEN The species evidently occurs in both the Marojejy Nature Reserve (R.N.I. no. 12), which covers 60,150 ha, and the Tsaratanana Nature Reserve (R.N.I. no. 4), which covers 48,622 ha (Andriamampianina 1981), although its status in both (one record each) appears precarious. Observation of this ground-roller several kilometres from and c. 100 m higher than the Périnet-Analamazaotra Special Reserve has been taken to suggest that the reserve may be too low to be of great value in helping to preserve this species (A. D. Forbes-Watson pers. comm. 1984).

CONSERVATION MEASURES PROPOSED Full protection for all ground-rollers has been called for (Salvan 1970). Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sihanaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it. This species requires study to determine the basic aspects of its ecology, particularly in relation to its apparent migrations (see Ecology above), an understanding of which is probably crucial to its long-term survival.

LONG-TAILED GROUND-ROLLER **RARE**

Uratelornis chimaera Rothschild, 1895 Coraciiformes: Brachypteraciidae

SUMMARY This remarkable terrestrial bird of restricted range within the subdesert region of south-west Madagascar, although numerically safe at present, appears to enjoy no protection whatever.

DISTRIBUTION The Long-tailed Ground-roller is restricted to a coastal strip between the Mangoky and Fiherenana rivers, south-west Madagascar, ranging up to 80 m altitude (Appert 1968, Milon *et al.* 1973). Most sites known for the species within this area up to 1966 have been listed (see Appert 1968, but also Oustalet 1899, Ménégaux 1907, Bangs 1918), with the conclusion that its distribution coincides with that of *Didierea* woodland (Appert 1968). It therefore has stricter habitat requirements and a lower altitudinal tolerance than the closely sympatric Subdesert Mesite *Monias benschi* (see relevant account). If the altitudinal limit quoted above is accurate, even only roughly, it cannot occur much more than 30 km inland in the southern half of its range (see 100 m contour in Army Map Service 1968), while in the northern half it has not been recorded east of Lake Ihotry (Appert 1968) other than at Mamono village near Ankida (O. Langrand *in litt.* 1984). Moreover, the revelation that some seasonal movement may occur (see Ecology below) suggests that birds range beyond the currently known limits or that they occupy only parts of their known range at any given season. Evidence of its presence beyond the confines of the Mangoky and Fiherenana, e.g. on Montagne de la Table south of Toliara (Rand 1932; see Remarks), is lacking, and the report that it occurs south to Cap Sainte-Marie (Lavauden 1937) is in error.

POPULATION In the south between Toliara and Manombo, at the turn of the century, it was found in good numbers mainly at Ambolisatra (Ménégaux 1907), and this area is obviously still important (see Appert 1968). It was found to be fairly common around Lake Ihotry in 1929 (Rand 1932,1936) but was apparently becoming rare there in the 1950s (Griveaud 1960a) and was judged to be "extremely rare" from second-hand information in the early 1960s (Petter 1963). In 1968 it was described as "one of the rarest birds in the world" (Appert 1968). A survey (presumably around 1970) concluded that "the total population between Tuléar (=Toliara) and Lake Ihotry is not more than 500 pairs, and nearer 250 pairs with an 80% probability" (Milon *et al.* 1973). More recently, a repeated visitor to its area of distribution has suggested that "in areas of undisturbed habitat it is common, and may even be termed locally abundant, particularly in the area of dense *Didierea* woodland some 30 km north of Tuléar" (Turner 1984), a judgement supported by another recent observer (O. Langrand *in litt.* 1984).

ECOLOGY The Long-tailed Ground-roller inhabits very arid areas in low, generally fairly dense deciduous woodland, always with (mostly herb- and grass-free) sandy soil (a prerequisite for nesting); it is commonly found in association with the cactus-like *Didierea madagascariensis* and the sporadic *Euphorbia stenoclada*, although absent from *Didierea*covered dunes, which are probably too loose and too little shaded (Appert 1968). It feeds almost exclusively on terrestrial invertebrates (e.g. beetles, grasshoppers, cockroaches, woodlice, caterpillars, ants), typically by rummaging in leaf-litter beneath a bush or tree (Appert 1968; also Oustalet 1899, Rand 1936, Milon *et al.* 1973, and specimen-labels in MNHN: NJC); a low-flying butterfly was also once seen taken (Appert 1968). Birds are active (singing and feeding) at night, at least at times (Appert 1968; also Turner 1984); singing occurs commonly in late winter (August/September) (O. Langrand *in litt.* 1984). The species keeps largely to the ground, running powerfully and flying rarely, but typically calls from a low (up to 3 m high) horizontal perch (Appert 1968). Although it is stated to occur in small family groups (Lavauden 1937; hence Petter 1963, Milon *et al.* 1973), this can only happen for a short period in the year, as the species is otherwise reported to occur singly over the southern winter, and always in pairs from the start of the breeding season (October or earlier through to January) (Appert 1968; also Rand 1936). In one area where it was studied (30 km north of Toliara), birds appeared to be seasonal in occurrence, being present from September to April but generally absent from May to August (Turner 1984). The nest-hole is excavated by both birds in flat or slightly sloping ground, with a tunnel extending to up to 120 cm (Appert 1968); a report of nesting in steep river-banks (Lavauden 1937) has been doubted (Appert 1968; also O. Langrand *in litt.* 1984). Clutches reputedly consist of three or four eggs (Lavauden 1937), this being supported by a record of three juveniles evidently from one brood (Rand 1936).

THREATS The restricted range of this species must be a source of permanent concern and vigilance for its welfare; such concern is compounded by its apparently migratory behaviour (see Ecology above), which doubles the risk it faces from any habitat destruction. This species was hunted by herdsmen with blowpipes at the turn of the century (Ménégaux 1907) and natives were trapping birds and digging out nests in the 1950s and 1960s (Griveaud 1960a, Appert 1968); trapping by local villagers is still being practised (O. Langrand *in litt.* 1984). Some 20 years ago, the species's habitat was reported to be in a "critical situation ... being more and more broken up and ... in process of rapid extinction" (Petter 1963). Subsequent observers (Appert 1968, Turner 1984) have made no reference to such habitat loss, although it is noted that none of this habitat is protected and that at one favoured site (30 km north of Toliara) some encroachment by villagers is occurring (Turner 1984).

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED Full protection for all ground-rollers has been called for (Salvan 1970). Immediate protection of its habitat and protected area status for a representative tract of *Didierea* were formally recommended in 1970 (IUCN 1972). A study to determine the extent and type of habitat destruction reported in the Long-tailed Ground-roller's range (see under Threats) is urgently needed, together with a detailed ecological study of the bird to provide data essential to any strategy for its long-term conservation, particularly in relation to its apparent seasonal movements. Both this and the equally remarkable Subdesert Mesite, whose ranges are almost exactly coincident, merit conservation by means of a protected area.

REMARKS This extraordinary bird occupies a monotypic genus. Concerning its occurence south of Toliara, a peak named "Mahinia ou Table" and some low hills named "Châine de la Table" are indicated as lying behind the coast between the Fiherenana and Onilahy estuaries (in Locamus 1900).

YELLOW-BELLIED SUNBIRD-ASITY — INDETERMINATE

Neodrepanis hypoxantha Salomonsen, 1933 — Passeriformes: Philepittidae

SUMMARY This Madagascar endemic species, difficult to distinguish from its only congener, is known from 12 specimens collected before 1930, although it was recognised as a species only in 1933. The generally held view that it is unlikely to be extinct, despite extensive forest destruction within its known range, is supported by the discovery of a nesting pair in 1976, but it must be rare at best.

DISTRIBUTION The Yellow-bellied Sunbird-asity was recognised as a species distinct from the Wattled Sunbird-asity *Neodrepanis coruscans* only in 1933, and no specimens of it have been collected since; it is known only from eastern-central Madagascar, in forests east and perhaps south of Antananarivo, and the Sihanaka forest. Data from the 12 (or 13: see Remarks) currently known specimens, in order of their collection, are as follows:

one male, no locality or date but prior to October 1879 (Benson 1971b);
one male, central Madagascar, June 1880 (Eck 1968, Benson 1976a);
three males, one female, Andrangoloaka, November 1880 (Stresemann 1937, Salomonsen 1965; also Eck 1968, Benson 1976a);
two males, one female, east of Antananarivo, July 1881 (Salomonsen 1933, Benson 1974);
one male, "E. Imerina" (near Antananarivo), October/November 1895 (Wetmore 1953);
one male, Sihanaka forest, 25 February, probably 1925 (Greenway 1967);
one male, Fito (i.e. Sihanaka forest), August 1929 (Salomonsen 1965).

Andrangoloaka was reported, at second-hand, to be situated high (1,000-1,300 m in one account, 1,400 m in another) on the eastern slopes of the plateau east of Antsirabe, c. 150 km south of Antananarivo, but this settlement and the great majority of surrounding forest no longer exist (Stresemann 1937, Greenway 1967). This information appears without doubt to be wrong, however, since there is or was an "Andrangolaoka" (*sic*) at 19°02'S 47°55'E on the upper slopes of the forested escarpment immediately east of the Mantasoa reservoir east of Antananarivo (Office of Geography 1955; not marked in IGNT 1964): in terms of the other records, this appears no less likely a locality than at Antsirabe, which is well outside the main rainforest belt, and indeed it appears as both "Andrangaloaka" and "Andrangoloaka" on separate nineteenth century maps which show no similar name anywhere near Antsirabe (see Laillet and Superbie 1889, Locamus 1900; also Remarks). The forests around Antananarivo, from the eastern parts of which the type-material came (Salomonsen 1933), no longer exist (Salomonsen 1934; also Wetmore 1953), nor do those at "East Imerina" (D. A. Turner pers. comm. 1983), but the species is expected to survive in Sihanaka forest, to the north-east of the Imerina plateau (Salomonsen 1965, Greenway 1967, Benson 1974). A stand of original forest at Tsinjoarivo, near Antsirabe, was twice identified as a likely site for the species (Lavauden 1937, Greenway 1967; see Remarks), the remaining tiny patches of forest at the former locality of Andrangoloaka could perhaps still have held some birds (Stresemann 1937), and forest east of Anjozorobe (not Ankazobe as reported in King 1978-1979), north-east of Antananarivo, was also considered worth investigating (Lavauden 1937), but whether and in what condition these forests still survive is unknown. The Fierenana district north of Périnet has also been suggested as a possible site for the species (King 1978-1979). In December 1973 and November 1976 birds were seen and photographed (originals and copies with VIREO at ANSP) in forest several miles from and c. 100 m higher than the Périnet-Analamazaotra Special Reserve (A. D. Forbes-Watson pers. comm. 1984).

POPULATION Numbers are unknown. While only nineteenth century records, all from the now largely deforested central parts of Madagascar, were known, the species was considered at best very rare and probably extinct, a judgement reinforced by the failure of the Mission Franco-Anglo-Américaine of 1929-1931 to find any (Salomonsen 1933,1934, Lavauden 1937, Stresemann 1937, Wetmore 1953). However, the discovery that birds had been collected in Sihanaka forest in the 1920s has resulted in confident predictions of its survival, albeit in low densities (Salomonsen 1965, Greenway 1967, Benson 1974), and these have been borne out by the 1976 sighting even though this was not itself in Sihanaka (see Distribution). The species was noted for being inexplicably uncommon in the last century around Andrangoloaka (Hildebrandt 1881; see Remarks).

ECOLOGY This species inhabits rainforest; it is regarded as possibly a highland counterpart of the very similar Wattled Sunbird-asity (Wetmore 1953; also Lavauden 1937, A. D. Forbes-Watson pers. comm. 1984), although records from Sihanaka forest indicate possible sympatry between the two species (Benson 1974). It is a nectar-feeder like the Wattled Sunbird-asity; both species assume breeding plumage in September/November (Salomonsen 1965). A pair observed near Périnet in December 1973 were feeding young in a (sunbird-like) nest placed 4-5 m up in thick forest (A. D. Forbes-Watson pers. comm. 1984). The species may inhabit canopy and thus have escaped notice (Benson 1980). However, observations a century ago refer to it feeding at flowering bushes in primary forest clearings, also to its call being a barely audible soft whistle (Hildebrandt 1881; see Remarks). In November 1976 near Périnet a male was observed feeding at *Loranthus* blossom; in December 1973 at the same locality a male was watched fly-catching alate termites and feeding them to nestlings (A. D. Forbes-Watson pers. comm. 1984).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*).

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sihanaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it.

REMARKS Concerning the number of museum specimens of this species, there is apparently a thirteenth in Sydney, Australia, labelled merely "Antananarivo" (A. D. Forbes-Watson pers. comm. 1984). Along with two other eastern Madagascar forest birds, the Dusky Greenbul *Phyllastrephus tenebrosus* and the Red-tailed Newtonia *Newtonia fanovanae*, the Yellow-bellied Sunbird-asity is thought likely to have been overlooked owing to its sparseness, elusiveness and difficult habitat (Benson 1974). Its validity as a full species has recently been reaffirmed (Benson 1974). The Tsinjoarivo intended as a probable site for the species is most likely that at 19°37'S 47°40'E, i.e. on the edge of the main rainforest belt, and not that at 19°54'S 46°39'E (in Office of Geography 1955). Observations in the last century (Hildebrandt 1881), given under the name of the Wattled Sunbird-asity, appear to refer exclusively to the Yellow-bellied species, reference being made to "brilliant yellow" undersides, only a few specimens being collected (J. M. Hildebrandt was the collector of all four specimens from Andrangoloaka listed under Distribution), and (elsewhere in the paper) Andrangoloaka as the locality in which much fieldwork had been done (and where indeed the paper was written).

APPERT'S GREENBUL **RARE**

Phyllastrephus apperti Colston, 1972 Passeriformes: Pycnonotidae

SUMMARY This ground-haunting, dry forest bulbul is known with certainty from only two remote unprotected localities in south-west Madagascar, where it is exceptionally rare and faces the danger of destruction of its habitat by fire.

DISTRIBUTION Appert's Greenbul was first found in a forest 40 km south-east of Ankazoabo, south-west Madagascar, where it was twice seen, on 7 June and 4 September 1962; on the latter date two specimens were collected, from which the species was described ten years later (Colston 1972). Throughout this intervening period the collector never found the bird again during studies over an area of 40,000 km^2 around the Mangoky River (Colston 1972). On 20 August 1974 it was rediscovered in the same patch of forest as in 1962 and a specimen was collected and sent to Antananarivo (O. Appert *in litt.* 1983; for numbers then seen, see Population). A single bird was seen in the nearby Zombitsy forest, east of Sakaraha, in July 1974 (Benson and Irwin 1975), two or three were present the following month (O. Appert *in litt.* 1983), and birds have been consistently seen there subsequently (see below). Two specimens, probably of this species, were collected east of Toliara ("probably near Sakaraha") and were deposited for a time in Antananarivo, but are now lost (Colston 1972; but see under Distribution and Remarks for Grey-crowned Greenbul *Phyllastrephus cinereiceps*). The sites south-east of Ankazoabo and east of Sakaraha belong to (what was at least in 1963) a fairly unfragmented (but variously named) block of forest (Vohibasia forest, Jarindrano forest, Mangona forest, Zombitsy forest), extending to the north and south of Andranolava and very roughly covering 1,000 km^2 (see IGNT 1964). Nevertheless, despite fieldwork throughout the Zombitsy forest, 1976-1981, the species was always only ever found in the same single area in one corner, only 0.5 km^2 in size (D. A. Turner pers. comm. 1983). A recent (but undated) record of one (seen on the ground) "15 km east of Sakaraha" (O. Langrand *in litt.* 1984) perhaps involves a new (third) site for the species.

POPULATION Numbers are probably very small. Soon after its first description it was considered possibly quite common (Forbes-Watson *et al.* 1973), but subsequent evidence is against this: apart from what is said above under Distribution, it could not be relocated by one observer in the Zombitsy forest in August 1974 (Benson and Irwin 1975) nor was it found at another nearby site east of Sakaraha during five days' fieldwork, 1972-1973 (Benson 1976b). From this it would appear that the species is very local and sparse within its small known range. At the corner of the Zombitsy forest where it could always be found, 1976-1981, seven to eight birds were usually to be seen, though once 15; probably 20-30 birds is the maximum for this area (D. A. Turner pers. comm. 1983). In the forest south-east of Ankazoabo on the last occasion the species was seen there (20 August 1974), two groups were encountered, one of two to three and the other of about eight birds (O. Appert *in litt.* 1983).

ECOLOGY The species inhabits dense dry forest, searching for food in the leaf-litter (Colston 1972). Although it is reported to be highly terrestrial, behaving rather like an akalat *Sheppardia*, rarely moving more than 1 m above ground, and always occurring in groups of five to eight (Colston 1972, D. A. Turner pers. comm. 1983), the bird seen in Zombitsy forest in July 1974 was single (though in the company of c. 20 Long-billed Greenbuls *Phyllastrephus madagascariensis*) and kept 1-5 m above ground (Benson and Irwin 1975): indeed, observations in Zombitsy forest in November 1976 were commonly of birds clinging to liana tangles up to 2 m from the ground, in the manner of reed warblers *Acrocephalus* (A. D. Forbes-Watson pers. comm. 1984). Birds have once been seen to go higher in the trees when disturbed, and they may do so habitually at times when the forest is more humid (O. Appert *in litt.* 1983). The Zombitsy forest is much greener in the dry season than that south-east of Ankazoabo, retaining some of its leaves (O. Appert *in litt.* 1983).

THREATS The highly restricted range of this species must be a source of permanent concern and vigilance for its welfare, and in late 1978 or early 1979 a cyclone destroyed forest as close as 2 km to the single known area in Zombitsy (D. A. Turner pers. comm. 1983); moreover, forest burning in this region has apparently been very serious in recent years (O. Appert *in litt.* 1983).

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED Further fieldwork to determine the range and status of this species is desirable, but protection of the forests from which it is known is perhaps more immediately important. Control of the present forest cutting and burning is essential for ecological stability in the region (O. Appert *in litt.* 1983).

REMARKS Study of the Antananarivo specimen, alongside the type, is desirable for absolute confirmation of the validity of the species (Colston 1972).

DUSKY GREENBUL RARE

Phyllastrephus tenebrosus (Stresemann, 1925) Passeriformes: Pycnonotidae

SUMMARY This mysterious bulbul of rainforest undergrowth is known from only eight skins and two adjacent localities (Sihanaka forest and Périnet-Analamazoatra), eastern central Madagascar.

DISTRIBUTION The Dusky Greenbul was first described from four specimens collected in the Sihanaka forest, eastern Madagascar, of which one was collected in December 1924 (type), one in June 1925 and one in December 1925 (Stresemann 1925, Benson *et al.* 1976, D. K. Read *in litt.* 1983). Two further specimens from Sihanaka forest (undated) were acquired by the Mission Franco-Anglo-Américaine from Herschell-Chauvin around 1930

(Delacour 1932a, Rand 1936), and another was obtained there on 7 April 1929 (Lavauden 1932). A bird was also shot north of Analamazaotra (near Périnet) on 8 May 1929 (Lavauden 1932). A single bird was seen at Périnet on 25 June 1974, one on 23 November 1976 and one on 14 November 1977 (D. A. Turner *in litt.* 1983; also Benson and Irwin 1975). That the species occurs thoughout "forests in the east of Madagascar" (Lavauden 1937) appears an unacceptably sweeping assumption; that it may occur at other sites in the central section of these forests (Milon *et al.* 1973) seems a reasonable hope.

POPULATION Numbers are unknown. This species probably goes unrecorded by combining extreme elusiveness and difficult habitat with general sparseness (Benson 1974). Its rarity has been remarked (Delacour 1932b, Lavauden 1932).

ECOLOGY From existing records (see Distribution) it is confined to humid rainforest. It was judged probably a bird of ground-cover (Rand 1936) and the first observation in life was of a single bird with a pair of White-throated Oxylabes *Oxylabes madagascariensis*, moving through branches c. 2 m above the ground, presumably gleaning insects though it was not actually seen to feed (Benson and Irwin 1975). Subsequent observations confirm it to be an undergrowth species (D. A. Turner pers. comm. 1983). The bird seen in November 1976 was clinging to vertical stems 1-2 m from the ground (A. D. Forbes-Watson pers. comm. 1984).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*).

CONSERVATION MEASURES TAKEN The species occurs in the Périnet-Analamazaotra Special Reserve, which covers 810 ha (Andriamampianina 1981).

CONSERVATION MEASURES PROPOSED Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sihanaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it.

REMARKS The Dusky Greenbul has been treated as a race of the Madagascar Greenbul *Phyllastrephus madagascariensis* (Milon *et al.* 1973) but its validity as a full species has since been reaffirmed (Benson 1974, Benson *et al.* 1976; also Benson and Irwin 1975).

GREY-CROWNED GREENBUL — RARE

Phyllastrephus cinereiceps (Sharpe, 1881) — Passeriformes: Pycnonotidae

SUMMARY This Madagascar bulbul, probably confined to rainforest, remains almost totally unknown, and apparently has been found only twice in the past 50 years.

DISTRIBUTION The Grey-crowned Greenbul possibly occurs throughout the rainforests of eastern Madagascar, but is known from only a few scattered sites. It was first described from Fianarantsoa, in the southern half of the eastern rainforest belt (Sharpe 1881), and subsequently found in the nearby Ankafana (= Tsarafidy) forest (seven specimens in BMNH, all March 1881: NJC; see Remarks), Sihanaka forest and at Fanovana (Delacour 1932a, Rand 1936), though this last area is now cleared (D. A. Turner pers. comm. 1983), and in the Tsaratanana massif (Milon 1957). An observation of the species is reported from "Lambomakandro forest" to the east of Sakaraha in south-west Madagascar (Milon *et al.* 1973), but for a bird previously known only from the humid forest area of the island this record appears somewhat anomalous (see Remarks); if this is discounted, the species has only been recorded twice in the past 50 years, in the Tsaratanana massif (see above) and near Didy, on the western edge of the Sihanaka forest, in May 1971 (A. D. Forbes-Watson pers. comm. 1984).

POPULATION The species was considered uncommon in Sihanaka forest 50 years ago (Delacour 1932a) and is known from apparently only a single specimen from Tsaratanana (Milon 1957).

ECOLOGY It inhabits the ground-cover of deep rainforest, gleaning for insects through the low bushes, and associating with the Short-billed Greenbul *Phyllastrephus zosterops* (Rand 1936).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*).

CONSERVATION MEASURES TAKEN The species presumably occurs in the Tsaratanana Nature Reserve (R.N.I. no. 4), which covers 48,622 ha (Andriamampianina 1981).

CONSERVATION MEASURES PROPOSED Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sihanaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it. The forest at Tsarafidy where this species occurs was identified in 1961 as a place of exceptional interest for its wildlife which certainly deserved complete protection (Griveaud 1961); the species may be expected in the nearby "Nandehizana" forest, if this still survives (for both localities see Conservation Measures Proposed and Remarks under Madagascar Yellowbrow *Crossleyia xanthophrys*).

REMARKS It is possible that "Fianarantsoa" was a generalised locality and that the type-material actually came from (the fairly nearby) Tsarafidy forest. The anomalous record of this species from east of Sakaraha, south-west Madagascar, given (in Milon *et al.* 1973) without any further information, may possibly be connected with the two lost specimens thought to be of Appert's Greenbul *Phyllastrephus apperti*, which came from "east of Tuléar, probably near Sakaraha" (Colston 1972; see relevant sheet): two villages named Lambomakandro are situated in the northern parts of the Zombitsy forest (in IGNT 1964), which is one of only two only certain localities for Appert's Greenbul.

VAN DAM'S VANGA — RARE

Xenopirostris damii Schlegel, 1866 — Passeriformes: Vangidae

SUMMARY This insectivorous bird of deciduous forest is known this century from a single site (Ankarafantsika) in north-west Madagascar which is, however, a protected area.

DISTRIBUTION Van Dam's Vanga was originally described from two specimens collected on 9 October 1864 in the forests near Ambassuana (Ambasohana) in the far north-west of Madagascar (Schlegel 1866, Schlegel and Pollen 1868). At least six further specimens were collected at around this time and probably at this locality (given as Pasandava Bay) (Milne Edwards and Grandidier 1885). The generalisation of the type-locality as Pasandava (Ampasindava) Bay (south of Nosy Bé) (e.g. Milne Edwards and Grandidier 1885, Lavauden 1932,1937, Milon *et al.* 1973) or else as "the Sambirano" (Benson *et al.* 1977), i.e. the general region of the river of that name which runs into this bay, is misleading: according to the contemporary map (in Pollen 1868) Ambassuana lay on the river of the same name, some 20 km east of the easternmost part of Pasandava Bay and much closer to Ambara (Ambaro) Bay: it would appear to have been situated at about 13°35'S 48°40'E and a few kilometres east or south of the locality now called Maherivaratra (past which the Ambazoana River flows), and indeed there is an "Ambazoana Bala" marked at roughly this spot in a 1900 map (see Locamus 1900). There have been no further records of the species from the far north-west, but it appears that the Ambazoana valley has never been revisited. The species was rediscovered on 9 October 1928 when a male was collected on the Ankarafantsika plateau, south-east of Mahajanga, and a juvenile was collected there on 5 July 1930 (Lavauden 1932); the species was found and collected there again in 1969-1971 (Salvan 1970, Forbes-Watson *et al.* 1973) and has been regularly seen subsequently (D. A. Turner pers. comm. 1983, O. Langrand *in litt.* 1984); the area involved in the post-1969 observations is near Lake Ampijoroa (Milon *et al.* 1973, A. D. Forbes-Watson pers. comm. 1984; see Remarks).

POPULATION Although this species was unanimously described as "very rare" (Schlegel and Pollen 1868, Delacour 1932a, Lavauden 1932) and even treated as Endangered in King (1978-1979), the most recent observations at Ankarafantsika indicate that it is in fact present in fairly good numbers there, with certainly 50 or more pairs in one relatively small area where the forest is untouched (D. A. Turner pers. comm. 1983).

ECOLOGY It inhabits primary deciduous forest (Delacour 1932a, D. A. Turner pers. comm. 1983); it is seen along the edges of woods foraging for insects (Schlegel and Pollen 1868). The stomachs of the first two known specimens contained beetle remains (Schlegel and Pollen 1868). Although described as solitary (Schlegel and Pollen 1868) it was also reported to occur in small groups of six to eight birds (Milne Edwards and Grandidier 1885).

THREATS The highly restricted range of this species must be a source of permanent concern and vigilance for its welfare. Deforestation is likely to have affected many areas where it might have been searched for in north-west Madagascar.

CONSERVATION MEASURES TAKEN The area where it has been recorded this century partly falls within the Ankarafantsika Nature Reserve (R.N.I. no. 7) (see Andriamampianina 1981).

CONSERVATION MEASURES PROPOSED A study of the status and ecology of this bird at Ankarafantsika would help determine where else it might be searched for and what management it might require (besides confirming, for example, that it is resident throughout the year). An investigation of the type-locality (see Distribution) is warranted to establish whether any original tracts of forest remain and whether they still hold populations of this species. All such work should be undertaken in conjunction with studies recommended under Conservation Measures Proposed for the White-breasted Mesite *Mesitornis variegata*.

REMARKS Although this species has been considered doubtfully distinct from Lafresnaye's Vanga *Xenopirostris xenopirostris* (see, e.g., Delacour 1932a, Appert 1970) and confused with it (see, e.g., Bartlett 1875, Ménégaux 1907), it has been affirmed as a good species (in Lavauden 1932) and this judgement is accepted here. The importance of the Ankarafantsika Nature Reserve as the only locality currently known for the species and the White-breasted Mesite cannot be overstated. However, it is to be noted that (according to IGNT 1964) Ampijoroa is well outside the boundaries of the nature reserve, and right next to the main road from Antananarivo to Mahajanga.

POLLEN'S VANGA — RARE

Xenopirostris polleni (Schlegel, 1868) — Passeriformes: Vangidae

SUMMARY This insectivorous rainforest bird is known from a wide variety of localities in eastern Madagascar but is everywhere rare.

DISTRIBUTION The scatter of records for Pollen's Vanga indicates that it is confined to the rainforests of eastern Madagascar. However, the type-locality is the "north-west coast"

(Schlegel and Pollen 1868) (attempts to trace anything more precise have been fruitless). If the bird is confined to humid forest, and if the map of the area explored by the original collectors (in Pollen 1868) represents the total area they prospected, then (according to the vegetation map in Rand 1936) the only suitable localities in the north-west are the Montagne d'Ambre or the western parts of the Tsaratanana massif, particularly the Manongarivo massif (west of the Sambirano) (see IGNT 1964). The original three specimens were later described as coming from "north-east" Madagascar (Hartlaub 1877) but this is evidently in error (see Remarks). However, there is a suspected sight record from Marojejy (north-east) in September 1972 (Benson *et al.* 1977) and one was seen at 500 m near Maroantsetra in November 1982 (O. Langrand *in litt.* 1984). All other records except one are from the central parts of eastern Madagascar, listed here from north to south. There are two specimens in BMNH from Fenoarivo Atsinanana, dated May 1895 (Benson *et al.* 1977, NJC), and twelve in MNHN and MRAC from Sihanaka forest (NJC; also Lavauden 1932), one of these latter actually being taken between Fanovana and Beforona (see Remarks). Specimens are known from both Fanovana (c. 800 m), April 1931 (Delacour 1932a, Rand 1932,1936) and August 1932, and Beforona, September 1932 (specimens in Stockholm: C. Edelstam *in litt.* 1983), but forest at least at the former locality no longer exists (D. A. Turner pers. comm. 1983). Individuals have been seen in November 1976, July 1980 and December 1982 at Périnet (D. A. Turner *in litt.* 1983, O. Langrand *in litt.* 1984). Several specimens were reported to have been collected in the forests on the eastern slopes of the great central massif (Milne Edwards and Grandidier 1885), although the only traceable reference to any of these is to one from south-east of Antananarivo, February 1872 (Sharpe 1872; see Remarks); however in UMZC there are three specimens labelled "Imerina, 1891" (Imerina is the whole area around Antananarivo: see Deschamps 1960) and another taken within 60 km of Antananarivo, 1881 (NJC), and presumably all four were from "the forests of the eastern slopes" in central Madagascar. Single adult males were collected at Mahanoro on 1 May and the "Sakales" River (see Remarks) on 15 May 1895 (Richmond 1897). In 1959 a specimen was collected in Tsarafidy forest between Ambohimahasoa and Fianarantsoa (Griveaud 1961), two specimens were collected there ("Forêt d'Amboasary") in January 1961 (Benson *et al.* 1977), two birds were seen (one mist-netted) there in April 1971 (Forbes-Watson *et al.* 1973, D. A. Turner *in litt.* 1983), and a specimen in SMF labelled as Lafresnaye's Vanga *Xenopirostris xenopirostris* and taken at "Amboasary" on 27 October 1931 (NJC) presumably also originates from Tsarafidy. In MNHN there is also a specimen from 30 km north-north-west of Taolanaro in the far south-east of Madagascar, collected on the 26 May 1948 (NJC).

POPULATION Although unanimously regarded as rare (Delacour 1932a, Rand 1936, Milon *et al.* 1973) and even as Endangered (in King 1978-1979), it is clear from the evidence above that this species has a much wider range than has often been stated. However, the nineteenth century report of its occurrence in groups (see Ecology) has not been confirmed, which might (conceivably) indicate a greater decline in numbers than that resulting simply from the decline in total forest area. It is evidently only ever present in small numbers wherever it survives.

ECOLOGY Pollen's Vanga is apparently a bird of primary rainforest. It was reported (presumably by a collector in a personal communication) to live in groups of 8-10, to feed on insects, small reptiles and frogs, to fly low and to be tame (Milne Edwards and Grandidier 1885). The MNHN specimen from Taolanaro contained a very large spider, a caterpillar and insect remains; it was not in breeding condition (NJC). All sight records given under Distribution (from Maroantsetra, Périnet and Tsarafidy as well as the possible one from Marojejy) were of birds in mixed bird-parties (Benson *et al.* 1977, D. A. Turner *in litt.* 1983, O. Langrand *in litt.* 1984), so it is possible that the groups of 8-10 referred to in the last century were not intended to imply monospecific flocks.

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*). It is not known whether primary forest still occurs in the coastal areas where the species was collected in the last century (Fenoarivo Atsinanana, Mahanoro, "Sakales" River), but this seems unlikely.

CONSERVATION MEASURES TAKEN The species occurs in the Périnet-Analamazaotra Special Reserve, which covers 810 ha, and possibly in the Marojejy Nature Reserve (R.N.I.

no. 12), which covers 60,150 ha (Andriamampianina 1981).

CONSERVATION MEASURES PROPOSED Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sihanaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it. The forest at Tsarafidy where this species occurs was identified in 1961 as a place of exceptional interest for its wildlife which certainly deserved complete protection (Griveaud 1961); the species may be expected in the nearby "Nandehizana" forest, if this still survives (for both localities see Conservation Measures Proposed and Remarks under Madagascar Yellowbrow *Crossleyia xanthophrys*).

REMARKS The error concerning the type-material originating from north-east Madagascar arises from the fact that the specimen-labels say "N. O. Madagascar": in both Dutch and German this would signify north-east, and was taken as such by Hartlaub (1877), but the language used on the labels is French ("voyage de Van Dam"), hence "N. O." signifies north-west (specimens in RMNH: NJC). That one of the specimens in MNHN labelled as from Sihanaka should also say "route de Fanovana à Beforona" (i.e. part of the road between Antananarivo and Toamasina) greatly stretches the limits accepted here of the "Sihanaka forest" (see Conservation Measures Proposed under Madagascar Serpent Eagle). "Kinkimauro" was given as the precise locality of the specimen from south-east of Antananarivo (Sharpe 1872), and later repeated as "Kinkimanro" (Hartlaub 1877), but "kinkimavo" was in fact a widespread native name for certain grey birds (Milne Edwards and Grandidier 1885) and it is obvious that the word was written on the specimen's label by the collector and misinterpreted as a site by its recipient. The "Sakales" river cannot be traced but it is evident that the collector was very close to the Sakaleona River (south of Mahanoro) at the time and these are doubtless identical ("Sakales" is obviously a misreading of Sakaleo, a village which in the last century stood at the estuary of the river: see Locamus 1900); both this and the site at Mahanoro have been included in a map of the species's distribution (see Benson *et al.* 1977) although there is no reference to Richmond (1897) as the source. There is a striking similarity between the plumages of the Tylas Vanga *Tylas eduardi* and immature Pollen's Vanga (Sharpe 1870, Benson 1971b, Benson *et al.* 1977, O. Langrand *in litt.* 1984) and, as it appears that the two species are sympatric and possibly without differences in habitat, a field study of their relationship has been urged (Benson *et al.* 1977).

BENSON'S ROCKTHRUSH — **INSUFFICIENTLY KNOWN**

Monticola bensoni Farkas, 1971 — Passeriformes: Muscicapidae

SUMMARY This recently described rock-haunting thrush is possibly quite widespread but as yet is known only from a few dry rocky areas in south-west Madagascar.

DISTRIBUTION Benson's Rockthrush was recently described from two old specimens collected by "Zaast" at an unknown time in an intraceable locality ("Ankarefu, Antinosy Cy") in "south-west" Madagascar (Farkas 1971). In 1962 birds were discovered and recognised as a new species at several localities in the Mangoky River region and the northern Isalo massif, and found again in 1969 and 1970 in the latter locality and at a single site between Ihosy and Zazafotsy (east of the northern Isalo massif) (Farkas 1971). In August 1969 and June 1971 the species was found 150 km south of the northern Isalo massif (D. A. Turner *in litt.* 1983). On 10 July 1977 two birds were observed on telephone wires along the main road running through the Zombitsy Forest Reserve near Sakaraha (D. A. Turner *in litt.* 1983). Excluding the records from Antinosy County (southern Madagascar; but see Remarks), all sightings are from between the Mangoky and Onilahy Rivers, south-west Madagascar, but the distribution of the species has been anticipated as covering one-fifth of the island, from "at least" the eastern fringes of the Bemaraha plateau in the central-west to "Antinosy County" in the south (see map in Farkas

1971, also under Remarks); it should however be noted that localised distribution, despite more extensive and apparently similar habitat, is a characteristic of several threatened Madagascar birds (e.g. Subdesert Mesite *Monias benschi*, Appert's Greenbul *Phyllastrephus apperti*) and a wider range for this species cannot be assumed with confidence. In the Mangoky region birds were only seen in winter (June/July) and in different habitat (see Ecology), and it seems likely that some local migration occurs at this season (Farkas 1971).

POPULATION Numbers are unknown. At least six males (some paired) were found along a 2 km stretch of road in one locality (Farkas 1971), so the population density is probably fairly high and stable in suitable habitat. Nevertheless, on present information it remains possible that total numbers are very small (Forbes-Watson *et al.* 1973).

ECOLOGY This is the only rock-inhabiting *Monticola* in Madagascar, apparently preferring huge rocks and extended cliff faces rising steeply out of open rolling hillsides, birds keeping mostly to rocks, occasionally visiting thin bushes, small trees, etc., but retreating to high rocks in alarm; food is insects sometimes caught in flight (Farkas 1971). Display-flights are performed from the highest available rock-peaks, the song being loud, clear, attractive; territories may be as close as 200 m and the species is probably double-brooded or else a late summer breeder (Farkas 1971). In winter, some birds are found in dry riverbeds, rocky canyons, hill slopes with huge boulders, all with scattered bushes and trees (Farkas 1971); the birds on wires by the roadside in dry forest at Zombitsy were also presumably wintering (D. A. Turner *in litt.* 1983).

THREATS None is known, but the population could prove to be extremely low and restricted.

CONSERVATION MEASURES TAKEN The Isalo massif is protected as a national park (Andriamampianina 1981). It is to be noted that the original authority did not collect any new specimens but used one of the two old skins for the type (Farkas 1971).

CONSERVATION MEASURES PROPOSED Studies are needed to determine the extent of this species's breeding and wintering range, undertaken in the course of other fieldwork in the general region of and at increasing distances from the Isalo massif.

REMARKS Although treated as a race of the "Madagascar Rockthrush" *Pseudocossyphus imerinus* (Milon *et al.* 1973), the status of Benson's Rockthrush as a valid species has been reaffirmed (see Benson *et al.* 1977). The map in Farkas (1971) shows "Antinosy [*sic*] County" in the far south of Madagascar; however, maps in Deschamps (1960) show that the Antanosy people occupied and still occupy the extreme south-east part of southern Madagascar, south and east of the area shown by Farkas. While it is still possible that Benson's Rockthrush occurs in the southern area shaded by Farkas (1971), e.g. in the Ivakoany massif, the maps in Deschamps (1960) show an area of south-west Madagascar, across the Onilahy River at the southernmost end of the Isalo massif, colonised by "Antanosy émigrés", and this seems more likely to be the type-locality of the species (the "Cy" on the type's specimen-label probably specifies "country" rather than the assumed "County", hence something less institutionalised and fixed). Moreover, of 11 gazetteered localities under the name "Ankarefo" ("Ankarefu" is not listed) in Office of Geography (1955), only one falls into either area of Antanosy people as marked by Deschamps, this being just north of Betroka at 23°06'S 46°06'E, some 100 km east of the Isalo massif.

MADAGASCAR YELLOWBROW — INDETERMINATE

Crossleyia xanthophrys (Sharpe, 1875) — Passeriformes: Muscicapidae

SUMMARY This distinctive species is confined to Madagascar's rainforests, where it has been seen only twice in the past 50 years.

DISTRIBUTION The Madagascar Yellowbrow is known from rainforest in central eastern Madagascar, with one record from the north. It was first described from a single bird collected on the "east coast" of Madagascar (Milne Edwards and Grandidier 1881). Subsequently it was widely collected but very poorly documented in the literature. Published records before 1930 are of three specimens from Fianarantsoa received in BMNH in 1880 (Sharpe 1881; NJC), the species as common in Ankafana (= Tsarafidy) and "Nandehizana" forests, also around 1880 (Deans Cowan 1882; see Remarks), a specimen presumably from the eastern Imerina forests in the 1890s (Oberholser 1900), and a "considerable number of skins" (at least eighteen) procured by one collector from Sihanaka forest (Delacour 1932b, Rand 1932). In BMNH there are in fact six specimens from Ankafana (which may well be the locality intended by "Fianarantsoa", which is fairly nearby) and six also from Sihanaka, in MNHN there are 12 from Sihanaka, and in BMNH and MRAC together there are also two from Brickaville district, 1925, six from Andevoranto forest, 1925, four from Lakato forest, 1924-1925, and one from "Betsileo", undated (NJC,SNS), "Betsileo" indicating south-central Madagascar (see map in Deschamps 1960, also Locamus 1900). Despite this relative wealth of records, since 1930 there have been only two: one in the Tsaratanana massif in the north in 1966 (Albignac 1970) and one at Périnet east of Antananarivo in July 1968 (Benson and Irwin 1975).

POPULATION Along with the Yellow-bellied Sunbird-asity *Neodrepanis hypoxantha*, Dusky Greenbul *Phyllastrephus tenebrosus* and Red-tailed Newtonia *Newtonia fanovanae*, this species is considered difficult to observe because of its elusiveness, sparseness, and difficult habitat (Benson 1974, Benson and Irwin 1975). That one particular collector should have obtained a "considerable number" of specimens probably only reflects the time-period over which his collections were made (40 years in one account: see Distribution under Madagascar Red Owl *Tyto soumagnei*) and, perhaps, the hunting techniques of the natives from whom most of his ornithological material was acquired (see Rand 1932).

ECOLOGY General "habits" were considered likely to prove similar to the Grey-crowned Oxylabes *Oxylabes cinereiceps*, which is a bird of ground-cover in heavy forest and gleans for insects through low bushes (Rand 1932). The bird seen in 1968 was in undergrowth on the edge of evergreen forest (Benson and Irwin 1975).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*). The forest in eastern Imerina is now all cleared (D. A. Turner pers. comm. 1983), and it seems unlikely that forest near the coast at Brickaville or Andevoranto would now be extant.

CONSERVATION MEASURES TAKEN The species has been recorded from the Tsaratanana Nature Reserve (R.N.I. no. 4), which covers 48,622 ha, and the Périnet-Analamazaotra Special Reserve, which covers 810 ha (Andriamampianina 1981).

CONSERVATION MEASURES PROPOSED Immediate and effective protection of as much remaining rainforest as possible would almost certainly guarantee the survival of this and all other rainforest-dependent species in Madagascar; and at least, on current knowledge, complete protection of the intact parts of Sianaka forest is of extreme importance (see Conservation Measures Proposed under Madagascar Serpent Eagle). Any ornithological work in the other areas from which the species is known, or where it might be expected, should where possible be extended to include searches to locate it. The forest at Tsarafidy where this species occurs was identified in 1961 as a place of exceptional interest for its wildlife which certainly deserved complete protection (Griveaud 1961); protection for "Nandehizana" forest, if it survives, is also merited, and a survey to relocate and evaluate this forest is warranted (see Remarks).

REMARKS Tsarafidy (i.e. Ankafana) forest, north of Fianarantsoa, is important not only for this species but also for Pollen's Vanga *Xenopirostris polleni* and the Grey-crowned Greenbul *Phyllastrephus cinereiceps* (see relevant accounts), Pitta-like Ground-roller *Atelornis pittoides* and Brown Emu-tail *Dromaeocercus brunneus*, as well as many rare lemurs, invertebrates and plants (Deans Cowan 1882, Griveaud 1961). The location of "Nandehizana" forest, also of substantial importance (see Deans Cowan 1882), has not hitherto been traced, but there is a Nandihizina marked on an old map (see Locamus 1900) somewhat to the north of what is now called Tsarafidy, and which on a modern map would be located at 20°47'S 47°10'E, i.e. the block of forest straddling the road between Ambositra and Ambohimahasoa (in IGNT 1964). A taxonomic reassessment of this bird has judged it to be a babbler (Timaliinae) not a bulbul (Pycnonotidae) (Benson and Irwin 1975), and it now reoccupies the monotypic genus created for it in 1877 (Hartlaub 1877), being aberrant enough possibly to require placing in a separate tribe, the Crossleyini (Irwin 1983).

RED-TAILED NEWTONIA **INDETERMINATE**

Newtonia fanovanae Gyldenstolpe, 1933 Passeriformes: Muscicapidae

SUMMARY This flycatcher is known only from a single specimen from a forest, now cleared, in eastern central Madagascar. If it is not an invalid taxon based on an aberrant bird, it is either greatly overlooked, genuinely rare, or extinct.

DISTRIBUTION The type and only specimen (adult, sex unknown) of the Red-tailed Newtonia was collected in the Fanovana forest, eastern central Madagascar, in December 1931 (Gyldenstolpe 1933). Although its late discovery may reflect a very limited area of distribution (Gyldenstolpe 1933) it probably inhabits "the forest of the central part of the Humid East" (Rand 1936) and may occur in the Sihanaka forest (Salomomsen 1965) and at Périnet (Benson *et al.* 1977), although observations at Périnet in recent years have failed to find it (D. A. Turner pers. comm. 1983).

POPULATION Numbers are unknown, but the species is regarded as probably sparse (Benson 1974).

ECOLOGY The ecology of this species is wholly unknown, other than that it must, as a flycatcher, be insectivorous. It has been speculated, on the basis of the plumage and ecological characters of its congeners, that the species may frequent the canopy of evergreen forest, in which it could be easily overlooked, especially if in any case uncommon (Benson 1974, Benson *et al.* 1977). Such speculation matches the contention that the species is a mimic of the female Red-tailed Vanga *Calicalicus madagascariensis* (see Remarks), since the latter is a bird of forest canopy (Milon *et al.* 1973, Benson *et al.* 1977).

THREATS Destruction and disturbance of primary rainforest is the single most serious threat to this and all other rainforest-dependent species in Madagascar (see Threats under Madagascar Serpent Eagle *Eutriorchis astur*). The forest at Fanovana is now completely cleared (D. A. Turner pers. comm. 1983).

CONSERVATION MEASURES TAKEN None is known.

CONSERVATION MEASURES PROPOSED Protection of as much remaining rainforest as possible is the primary need; further study at certain sites, especially Périnet, to establish the continued existence and likely requirements of this species, is desirable.

REMARKS Not having been seen for over 50 years, by CITES criteria the Red-tailed Newtonia could be treated as extinct. However, along with two other eastern Madagascar forest birds, the Yellow-bellied Sunbird-asity *Neodrepanis hypoxantha* and the Dusky Greenbul *Phyllastrephus tenebrosus*, it is thought likely to have been overlooked owing to its sparseness, elusiveness and difficult habitat (Benson 1974, Benson *et al.* 1977). Its validity as a full species has recently been reaffirmed (Benson *et al.* 1977), the possibility that it is an aberrant female Red-tailed Vanga (Forbes-Watson *et al.* 1973) being rejected on the grounds of its slender *Newtonia* bill, the Vanga having a short, stout bill and also differing in its larger, heavier size, black lower mandible, pale lores, and conspicuous broad (not narrow) white eye-ring (G. S. Keith *in litt.* 1983); nevertheless, the similarity in the plumage between the two is so "incredibly close...that this must be a case of mimicry" (C. Edelstam *in litt.* 1983).

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APPENDIX 3.B. MAMMALS

Accounts for all lemur species and for the subspecies *Lemur macaco macacao* and *L. macaco flavifrons* are included. Tentative IUCN categories for each taxon are listed below; some of these will certainly require revision as more detailed information on the status of lemurs becomes available.

E *Allocebus trichotis*	K *Lemur coronatus*
nt *Cheirogaleus major*	nt *Lemur fulvus*
nt *Cheirogaleus medius*	V *Lemur macaco macaco*
K *Microcebus coquereli*	E *Lemur macaco flavifrons*
nt *Microcebus murinus*	V *Lemur mongoz*
nt *Microcebus rufus*	I *Lemur rubriventer*
K *Phaner furcifer*	K *Lepilemur dorsalis*
K *Avahi laniger*	K *Lepilemur edwardsi*
E *Indri indri*	K *Lepilemur leucopus*
K *Propithecus verreauxi*	K *Lepilemur microdon*
V *Propithecus diadema*	K *Lepilemur mustelinus*
E *Daubentonia madagascariensis*	K *Lepilemur ruficaudatus*
K *Hapalemur griseus*	K *Lepilemur septentrionalis*
E *Hapalemur simus*	I *Varecia variegata*
K *Lemur catta*	

HAIRY-EARED DWARF LEMUR

Allocebus trichotis (Günther, 1875) Primates: Cheirogaleidae

SUMMARY Endemic to Madagascar. Considered the rarest of all the lemurs and known from only four specimens collected from the eastern forests; three were collected last century and the fourth in 1965. Cause of decline unknown. Protected by law but not known to occur in any reserve. Any conservation measures will have to await the discovery of living specimens.

DISTRIBUTION Madagascar. Known only from four specimens. The only 'modern' specimen was caught by A. Peyrieras in 1965 in the Andranomahitsy Forest to the west of Mananara on the east coast (4,9). The four records do suggest, however, that at one time the species occurred quite widely in the eastern humid forests (9). For map see (9).

POPULATION It is possible that this animal is extinct; if not, the number remaining might be very low (4,8). However, Petter has recently commented that the species may be a cryptic canopy dweller and thus could be overlooked (10). An effort to locate the species in the Andranomahitsy Forest in 1975 was unsuccessful (6). The species is considered the rarest of the lemurs (9).

HABITAT AND ECOLOGY Nothing known. The Andranomahitsy Forest is typical high rain forest of eastern Madagascar.

THREATS Unknown. In 1972 Petter reported that habitat alteration had not as yet occurred within its small known range (4).

CONSERVATION MEASURES Protected by law. Not known to occur in any reserve area and has never been studied (8). Surveys are needed to discover whether the species still survives and if so to recommend appropriate conservation measures; these will undoubtedly include protection of its habitat, and the possibilities of captive breeding.

All species of Cheirogaleidae are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING The species has never been kept in captivity.

REMARKS For description of animal see (2,3,5,7,9). The species has been included in the family Lemuridae.

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GREATER DWARF LEMUR

Cheirogaleus major E. Geoffroy, 1812 Primates: Cheirogaleidae

SUMMARY Endemic to Madagascar where it occurs in forested areas in the east. Not considered threatened at the present time although forest loss will undoubtedly decrease its range and numbers. Protected by law and occurs in a number of reserves. Has not been studied in the wild.

DISTRIBUTION Madagascar. Occurs throughout the forested areas of the east from Taolanaro (Fort Dauphin) to Mt d'Ambre, and extending westward to include the Tsaratanana Massif and the Sambirano region (7). Petter *et al.* also indicate that a population of *C. major* exists on the Bongolava Massif, at the far western edge of the Eastern Region; presumably its isolation occurred relatively recently (3,7). Most recent authors have recognized at least two subspecies, of which one (*C. m. crossleyi*) is reported to occur primarily to the north of the Masoala Peninsula, while the other (*C. m. major*) is found to the south (3,7). However Tattersall believes the situation is still unclear and prefers at present to regard the species as variable but monotypic (7). The range of *C. major* once extended well onto the central plateau. For maps see (3,7).

POPULATION Not thought to be threatened at the present time, although in 1975 Richard and Sussman reported it to be declining (along with almost all Malagasy lemurs) (5). More information is required.

HABITAT AND ECOLOGY The humid forests of the east. Nocturnal; rests during the day in constructed nests (7). Aestivates (6). Almost nothing is known of social organization; individuals are invariably sighted singly, although seem to sleep in groups. Has been reported in 'considerable' densities in certain areas of high food concentrations. Dwarf lemurs apparently feed on ripe fruit, nectar and pollen, with insects only occasionally taken; leaves are never eaten (3,7).

THREATS Undoubtedly the loss of forest in the east will adversely affect this species but no specific reports of threats have been located.

CONSERVATION MEASURES Protected by law. Known to occur in the Montagne d'Ambre National Park and in Natural Reserves 1 (Betampona), 3 (Zahamena), 4 (Tsaratanana), 11 (Andohahela) and the Special Reserves of Nosy Mangabe and Périnet (5,8,9). Has not been studied and although this species is not as yet considered threatened, an ethoecology study would certainly be valuable.

All species of Cheirogaleidae are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1986 five individuals were held in captivity, at Duke University Primate Center in the U.S.A. (10). Local people in Taolanaro are known to have specimens as pets (8).

REMARKS For description of animal see (1,2,3,7).

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FAT-TAILED DWARF LEMUR

Cheirogaleus medius E. Geoffroy,1812 Primates: Cheirogaleidae

SUMMARY Endemic to Madagascar. Exhibits marked adaptations to survival in the dry, deciduous forests of the west and south. Local population densities can be very high, but, in common with other species of this region, it is likely to be affected by habitat destruction. Legally protected and occurs in several nature reserves. Its survival will depend on the protection of suitable areas of habitat.

DISTRIBUTION Madagascar, where it is still found in most of the western and southern forests (8,17) from the Bay of Narinda to Taolanaro (17). The species may also have occurred in eastern and northern Madagascar and in the Sambirano region, in sympatry with *Cheirogaleus major*, but the present status of such populations is problematical (17). For map see (17).

POPULATION No census has been undertaken; however the species is still widespread and is unlikely to be threatened at present.

HABITAT AND ECOLOGY Inhabits the dry, deciduous forests of the west and south which have a 7-8 month dry season. The most characteristic feature of the species is its ability to 'aestivate' for at least six consecutive months and, in some instances, up to eight months of the dry season. This appears to be an adaptive feeding strategy which consists of harvesting 'surplus' food when available, and withdrawing into aestivation during the period of minimum production (4). The dormant period is spent inside deep holes of tree trunks where three to five individuals may be piled upon each other (4). In the Marosalaza Forest the species was observed to emerge at the end of November, just before the rainy season, and thus just as the period of intensive food production began (4). Since the existence of hiding places seems to be an essential condition of its survival, it tends to be associated with trees of a certain size (4,8). *C. medius* is chiefly an opportunistic frugivore, although insects are also an important component of the diet. Seasonal variation in diet follows food availability: nectars and fruits in November; fruits and an increasing proportion of insects in the period December - February. After this time, the proportion of fruits in the diet may increase at the time of fattening preceding dormancy (4). Nocturnal. Individuals are invariably sighted singly (17). Petter has noted extremely high population densities of the species in the Marosalaza Forest, i.e. 350 animals per 100 ha (4). Home ranges were about 4 ha. Mating was observed in the wild at the beginning of November and births occurred in January (4). Captive studies show gestation to be 61-64 days and litter size to be usually two offspring (range 1-4); cannibalism of newborn was frequent (2). Infants reach sexual maturity during their first year i.e. they are able to breed in their first breeding season (1). The genus *Cheirogaleus* is the only primate which regularly uses faeces as scent marking material (15).

THREATS In 1972 Petter reported that forest and scrub clearance were causing a rapid contraction of range (8).

CONSERVATION MEASURES Protected by law, although difficult to enforce. Known to occurs in Natural Reserves 7 (Ankarafantsika) and 11 (Andohahela) (9,14), as well as in the private reserves of Analabé and Berenty owned by M. de Heaulme (7,11,14,17). Has been studied to some extent in both the wild and captivity (1,2,3,4,15). This species is reputed to be particularly dependent on trees with holes in which it can hibernate, and this tends to be associated with trees of a certain age; habitat protection and management can thus be expected to be especially important.

All species of Cheirogaleidae are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1986 there were over 100 individuals in captivity, most at the Duke University Primate Center, U.S.A. (16). The majority are evidently captive bred (6).

REMARKS For description of animal see (5,6,7,10,12,17). The species is often divided into two subspecies but according to Tattersall the distinction is unwarranted (17).

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COQUEREL'S MOUSE LEMUR

Mirza coquereli (A. Grandidier, 1867) Primates: Cheirogaleidae

SUMMARY Endemic to the forests of western Madagascar which are fast disappearing. Protected by law, has been the subject of several etho-ecology projects, and occurs in two protected areas. A captive breeding group exists.

DISTRIBUTION Madagascar where it has a restricted range in the forests of the west (5,8,10,13), apparently in a scattered series of disjunct isolates (13), principally between the Onilahy and Fierenana Rivers, i.e. from about the region of Ankazoabo northwards to Belo-sur-Tsiribihina, or a little beyond (13). It also occurs on the Ampasindava Peninsula and in the adjoining region (13). Petter *et al.* have suggested that it occurs in coastal forests in the area intervening between the southern and northern populations (9), but this remains unconfirmed (13). Although the former range is not precisely known it was certainly more extensive than today (8). For maps see (9,13).

POPULATION Mittermeier (1986) commented that it was probably endangered; its range is very small and forest loss is rapid (14). In 1975 Sussman and Richard considered *M. coquereli* to be one of the Malagasy lemurs which was 'extremely rare and probably on the brink of extinction' (12). In 1972 it was reported to be still fairly abundant in some isolated forest patches (8), for example along the streams of the coastal forest north of Morondava, although was considered threatened (8).

HABITAT AND ECOLOGY Inhabits the more humid parts of the dry, deciduous forests of western Madagascar. Adapts to the dry season, when forest productivity is markedly diminished, by feeding mainly on the secretions produced by colonies of homopteran larvae; during the wet season feeds omnivorously: on fruit, flowers, and insects, and probably also on eggs and small vertebrates (1,5,13). Nocturnal; during the day rests in large spherical nests which it constructs of small twigs (5,8), usually located at a height of 2-10 m, often in trees which do not shed their leaves during the dry season (e.g., Euphorbiaceae) and are thickly covered with lianas (5). Pagès reports that contact between individuals during the night's activity is rare, although she suggests that a 'loose pair bonding' between males and females may exist. Male and female ranges overlap partially, that of the female averages about 10 ha, that of the male about 8 ha. Most time is, however, spent in much smaller core areas, averaging 3 ha for females and 2 ha for males. Pagès believes that the core area is defended, at least by males (4,5,6,13). The species exhibits only a brief period of sexual activity, gestation lasts about three months. It is reported to have 2-3 young a year (8), though animals at Duke University have a litter size of 1 or 2 (11).

THREATS The species's range is contracting through forest degradation and destruction, and by cultivation of the remaining areas of land that can be irrigated (8).

CONSERVATION MEASURES Legally protected but enforcement is difficult. It is known to occur in Natural Reserve 9 (Tsingy de Bemaraha) and in Analabé private reserve north of Morondava owned by M. de Heaulme (12). The species has been the subject of a number of studies (4,5,6,10).

All species of Cheirogaleidae are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING One breeding colony exists, at Duke University Primate Center; in September 1986 it comprised 23 animals (2). In the early 1970s a pair were also kept for breeding purposes at the Brunoy Laboratory of the French Museum of Natural History (8).

REMARKS For description of animal see (3,7,9,13). Often included in the genus *Microcebus* (e.g. 4,5).

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GREY MOUSE LEMUR

Microcebus murinus (J.F. Miller, 1777) Primates: Cheirogaleidae

SUMMARY Endemic to Madagascar. This and its sister taxon *Microcebus rufus* are the most abundant of the lemurs and are not considered threatened at the present time. Protected by law, has been the subject of studies, and occurs in a number of reserves.

DISTRIBUTION Madagascar. Occurs throughout the forested areas of western, southern and south-eastern Madagascar, from Taolanaro to the Sambirano region (15). Martin (1972) notes that in the Taolanaro area the Grey Mouse Lemur's area of distribution includes the littoral forest to the north and east of the town, while the Brown Mouse Lemur *Microcebus rufus*, occurs in the rain forest which extends southward, to the west of Taolanaro, almost to the coast. There is thus in this region a sharp environmental demarcation between the two species, since although the two areas receive similar rainfall, the littoral is much better drained, and supports a vegetation of distinctly less humid aspect that does the interior (6,15). The northern boundary of the Grey Mouse Lemur is not precisely known, but the species appears not to occur north of the Sambirano River (15). Grey Mouse Lemurs are also found on Nosy Bé Island off the north-west coast (3). For maps see (12,15).

POPULATION Not threatened; the species remains widespread and abundant. In 1975 *M. murinus* and *M. rufus* were considered (together) to be the most abundant lemurs and perhaps the only ones not declining in number (14). However, even for *M. murinus* Martin (1973) gives data indicating that heavy tree-felling had been affecting population densities (7,8). A study in the south also suggested that population densities were not as high as previously estimated and that extensive grazing by both cattle and goats was destroying the low bush habitat of the species even in areas where no actual tree felling occurred (8).

HABITAT AND ECOLOGY Forests of western Madagascar, where it seems to be adapted to forest-edge habitats. Martin has noted that *Microcebus* are usually sighted within a few metres of paths and tracks and rarely deep in the forest (6,7,15). In arid *Didierea* forest near Bemarivo, not far from Mandena, the species occurred at a density of 3.6 individuals per ha (2,15). Nocturnal; they sleep in nests during the day. Seemingly solitary when active but sleep in groups. Martin has suggested that the species forms relatively stable 'population nuclei', i.e. localized concentrations, with sizeable gaps between them. Ranges are very limited. An omnivore; fruit comprises the main part of the diet, though flowers are consumed often, and leaves and insects occasionally (5,6,7,15). *M. murinus* exhibits a period of lethargy during the dry season, at this time the animals may stay in their nests for several consecutive days, and overall activity is considerably reduced (5). Gestation is 61-64 days (4).

THREATS Tree felling and grazing by cattle and goats have been noted to decrease densities (7,8).

CONSERVATION MEASURES Protected by law and known to occur in Natural Reserves 6 (Lokobé), 7 (Ankarafantsika), 8 (Tsingy de Namoroka), 9 (Tsingy de Bemaraha) and 11 (Andohahela) (15), in the Beza Mahafaly Special Reserve and the private reserves of Analabé and Berenty owned by M. de Heaulme (3,14,15). The species has been the subject of a number of studies (1,5,6,7,13).

All species of Cheirogaleidae are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING The species breeds well in captivity, although social stress can cause premature deaths (10). The total captive number is unknown, but is certainly in the hundreds (18); in September 1986 there were 73 at the Duke University Primate Center, U.S.A. (9).

REMARKS For description of animal see (8,11,12,15). The Rufous or Brown Mouse Lemur is now usually considered a distinct species, *Microcebus rufus* (15).

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BROWN MOUSE LEMUR or RUFOUS MOUSE LEMUR

Microcebus rufus (Lesson, 1840) Primates: Cheirogaleidae

SUMMARY Endemic to eastern Madagascar. Not threatened. Protected by law and occurs in a number of reserves.

DISTRIBUTION Madagascar where it occurs throughout the humid forests of the eastern region, from Taolanaro to Mt d'Ambre, including the offshore island of Nosy Borah, and extending in the north-west to include the Sambirano region, at least to the north of the Sambirano River (7,8). For map see (7).

POPULATION Unknown although certainly abundant; not threatened (9).

HABITAT AND ECOLOGY The humid forests of the east, in secondary as well as primary forest (7).

THREATS Unknown.

CONSERVATION MEASURES Protected by law. Known to occur in Montagne d'Ambre National Park, in Natural Reserves 1 (Betampona), 3 (Zahamena), 5 (Andringitra), 11 (Andohahela) and 12 (Marojejy) (7), and in the Special Reserves of Nosy Mangabe and Périnet (6).

All species of Cheirogaleidae are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1981 one male was held in captivity at Duke University Primate Center in the U.S.A. (2); it has subsequently died.

REMARKS For description of animal see (1,3,5,7). Previously *rufus* was considered a subspecies of *Microcebus murinus*. However Martin has been able to demonstrate that consistent differences exist between *M. rufus* and *M. murinus* in cranial morphology, in addition to the more traditional distinctions in pelage colouration and ear length. Furthermore it is now known that Mouse Lemurs with rufous pelage do occur sympatrically with the Gray western form, if only sparsely (7).

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FORK-MARKED LEMUR

Phaner furcifer (Blainville, 1839) Primates: Cheirogaleidae

SUMMARY Endemic to Madagascar. This specialized gum eater occurs principally in the west, although small populations do occur in the north, east and south. Numbers are unknown; it is believed to be declining because of habitat loss, and habitat changes due to progressive climatic aridification since the 1920s. Protected by law, has been the subject of some studies, and occurs in several protected areas. Additional information on distribution and status is required before an adequate conservation plan can be formulated.

DISTRIBUTION Madagacar, where it has a rather patchy distribution. Occurs principally in the west where it has a wide, but now discontinuous, range, extending from about the latitude of Toliara, northward to the region of Antsalova. Another population occurs further to the north - south of Soalala, and another in the Ampasindava Peninsula, due south of Nosy Bé, and adjoining region (16). In the far north an isolate exists on Mt d'Ambre (13,16), while in the east *Phaner* occurs on the Masoala Peninsula (13,16). A population has also been discovered in the extreme south in Natural Reserve 11 (Andohahela) on the Mananara River (15). For maps see (11,16).

POPULATION No estimate of numbers exist; the species was described in 1975 as declining (14), although has been described as relatively abundant at some sites in western Madagascar (13,16). The population in Natural Reserve 11 was estimated to number about 20 animals in 1974 (15), Durrell visited the area again in 1981; she confirmed the presence of *Phaner* but not the numbers (3). Presumably the species was once far more abundant than it is today.

HABITAT AND ECOLOGY Inhabits different types of forest: the dry deciduous forest of the west, the transitional zone between coastal lagoons and forest, rain forest on the east coast, dry *Didierea*bush forest in the far south, and may be found in areas of secondary forest although appears to require a continuous forest canopy (1,13,15,16). Has been observed at altitudes of 500 m near Maroantsetra at Hiaraka Station (9), and at 1000 m in Sambirano in the Montagne d'Ambre area (13). Density has been estimated at 1-2 animals per ha (16). Nocturnal; the time when it leaves its sleeping place is closely controlled by light level (6,7). During the day it sleeps in tree holes, the abandoned nests of *Mirza coquereli*, or amongst the broken branches of baobabs (1,12,13,16). It is a specialized gum eater, exhibiting extensive adaptations of the teeth, the digestive tract, the nails and the tongue, though will feed on flowers, fruit, insect larval secretions, insects (1,10,12,13), and nectar (2). Largely solitary but social; heterosexual pairs are reported to occupy the same range, the female being dominant and having priority at favoured feeding sites. Members of a pair remain in constant vocal contact, and the male regularly marks the female with his throat gland (1,5,13,16). *P. furcifer* is said to bear a single young, born around the time of the first rains, i.e. about November/December (1,13).

THREATS Its range is contracting owing to forest destruction and clearance for cattle pasturing and agriculture (9).

CONSERVATION MEASURES Legally protected but this is difficult to enforce. Occurs in the Montagne d'Ambre National Park which requires better protection, and in the Analabe private reserve owned by M. de Heaulme situated north of Morondava. Also occurs in Natural Reserve No. 11 (Andohahela) near the village of Hazofotsy (24°49'S, 46°37'E) (15). Additional information is needed about distribution and status as a prerequisite to conservation recommendations. The species has been the subject of some studies (1,5,6,7,10,12,13).

All species of Cheirogaleidae are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora; trade in them between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING A few pairs are held in captivity in France (9).

REMARKS For description of animal see (4,8,11,16). Although there seems to be some minor size and pelage differences between individuals from different areas (specimens from the east coast, for instance, are larger and darker than those from the west, while Russell and McGeorge have reported a reddish population from the far south (13,15,16)), Tattersall suggests that at present there are not sufficient data to distinguish subspecies (16).

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WOOLLY LEMUR

Avahi laniger (Gmelin, 1788) Primates: Indriidae

SUMMARY Endemic to Madagascar. Two subspecies are usually recognised: one in the eastern and one in the north-western forests. A nocturnal folivore which can be locally common, overall status is unknown although the species is presumed to be declining through habitat destruction. It does occur, however, in logged secondary forest. Legally protected and both subspecies occur in protected areas. The species has been studied at Périnet-Anamalazaotra in eastern Madagascar. Listed on Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Malagasy Republic. *A. l. laniger*, the Eastern Woolly Lemur is found virtually throughout the eastern strip of humid forest, although infrequently at high density. Precise northern limit is unknown, may possibly extend as far as the Tsaratanana Massif (8,13). Subfossil evidence indicates that *Avahi* formerly occurred in central Madagascar, at least as far west as Analavory (13). *A. l. occidentalis*, the western form, today occurs only in a relatively restricted area in the north-west, to the north and east of the Betsiboka River, from the Ankarafantsika forest to the Bay of Narinda (3,13). It formerly ranged more widely (3,13). For map see (13).

POPULATION Overall status unknown, although the species is considered common at at least two sites - Périnet and Ranomafana in eastern Madagascar - and is likely to be so elsewhere (12). The western race was considered by Petter in 1972 to be 'Vulnerable' (3).

HABITAT AND ECOLOGY The species is found in both the eastern tropical moist forest and in the drier, deciduous forests of western Madagascar. A four month study at Périnet in eastern Madagascar from August to October 1984 found group size of 10 groups censused to range from 1 to 4 with mode 2 (16); the modal size of 8 groups censused by Pollock in 1975 at the same site was also 2. These are almost certainly family groups. Births, of single young, appear to be seasonal, at least at Périnet (16). Group home ranges ranged between 1 and 2 ha in size and did not appear to overlap (16). During the study period the animals were almost exclusively folivorous, feeding on leaves of at least 17 plant species; on three occasions they were seen feeding on flowers of *Erythroxylum* sp. and have been seen eating fruits of *Rheedia* sp. and of an unidentified species of Acanthaceae (16). They were very largely nocturnal, becoming active at dusk, having a 2 to 4 hour rest period around midnight and then resuming feeding; some were found active again at dawn and continued feeding well into daylight (16).

THREATS Habitat destruction poses the principal long-term threat to the species (12). The forest is being lost to agriculture, timber and industry (12). *A. laniger*, like many other lemur species, can almost certainly adapt to some habitat disturbance or modification and indeed O'Connor and Pigeon note that a knowledgeable local source reports that *Avahi* occur at highest densities in logged, secondary forest (14). However the extent of all forest cover is decreasing rapidly on Madagascar.

CONSERVATION MEASURES Legally protected but this is not enforced. *A. v. laniger* occurs in the following Natural Reserves: Betampona (No.1), Zahamena (No.3), and Andohahela (No.11); it also occurs in the Special Reserve at Périnet (12,13,14,15). *A. v. occidentalis* occurs in the Ankarafantsika Natural Reserve (No.7), however better protection is required since the reserve is being increasingly degraded by fire (3).

All species of the family Indriidae are are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora; trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING The Woolly Avahi has been difficult to maintain in captivity because of its specialized leaf diet; animals have frequently died within a week of capture. In 1957 some specimens survived for a few months in Parc Tsimbazaza, Antananarivo, Madagascar (3).

REMARKS For description of animal see (5,6,13). The generic name *Lichanotus* is occasionally used (2).

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INDRI

Indri indri (Gmelin, 1788) Primates: Indriidae

SUMMARY This, the largest living Malagasy lemur is restricted to parts of the north-eastern forests of Madagascar. Apparently dependent on undisturbed forest habitat and thus in acute danger of extinction because widespread forest destruction has susbstantially reduced the available habitat; much of what remains is fragmented into isolated forest islands. Has a slow breeding rate. Protected by law. Occurs in several reserves.

DISTRIBUTION Malagasy Republic. Inhabits parts of the belt of rain forest along the north-eastern escarpment of Madagascar, approximately between the latitudes of Sambava and Mahanoro, but not however on the Masaola peninsula (6,7,8,12,14). Within this region distribution is patchy due to discontinuity of forested areas (9). A century ago the species range undoubtedly stretched further north, south and west (9), and subfossil evidence indicates that within the past millenium or so, populations of *Indri* occupied the interior of Madagascar at least as far west as the Itasy Massif, well to the west of Tananarive (14). For map see (14).

POPULATION Numbers unknown. Populations in the mid-1970s were considered possibly still stable in the least disturbed parts of the range; in many of the more disturbed areas the animal was rare or absent (9).

HABITAT AND ECOLOGY Coastal and montane rain forest from sea level to about 1800 metres (7,9,12). Estimates of population density range from three or fewer individuals per sq. km (5) to a maximum of 9-16 per sq. km (6,8). Diurnal and arboreal, the Indri lives in family groups of 2-5 individuals which defend strict territories of 0.15-0.3 sq. km (4,6,7,8). The female appears to be the dominant member of the group (10). Loud melodious vocalizations mostly during the morning betray its presence (9). Diet consists of leaves, fruit and flowers. A single young is born to each family group about every three years (6,7,8).

THREATS The major threat is habitat destruction. Tree felling by commercial companies, supplying wood for the cities and for export, and extensive clearing of land for cultivation around settlements are steadily reducing the total amount of forest and leaving behind only small isolated patches. The selective extraction for furniture-making of favourite food plants of the Indri, particularly *Ocotea* spp., further impoverishes its environment (9). Its vulnerability to such threats is moreover enhanced by the combination of very limited distribution and a slow breeding rate.

CONSERVATION MEASURES Legally protected, but enforcement is impaired by difficulties of communication, expense, and the fragmented range of the species. However, in Malagasy folklore the Indri is considered to be part of human ancestry and is thus protected in some areas by an apparently still locally effective taboo on killing or capture. Occurs in several reserves: a fairly dense population is reproducing well in the Reserve de Babakotos (Indri) in the Analamazoatra forest, which includes Andasibe (formerly Perinet) (6); in National Reserve No. 1 (Betampona) there are only a few and since this reserve is well managed and other lemurs are abundant and in good physical condition, the low density of Indri may be due to unidentified 'natural' factors; some probably also survive in National Reserve No. 3 (Zahamena) on the west of Lake Alaotra, but their status is unknown (9). Its natural history was the subject of a study by Jon Pollock from June 1972 to August 1973, in which major features of its ranging, feeding and social behaviour were determined (6,7,11).

The principal conservation recommendations are: strict control of felling and selective lumbering. Management of existing and new reserves to contain adequate recognition of local needs for forest produce. Further studies of Indri breeding activities, territoriality and distribution, to include a) inventory of relevant rain forest areas and their Indri populations, if any, coupled with mapping of the distribution of the 70 known food plants of the species; and b) observations of Indri population dynamics and reproductive behaviour in areas of both high and low population density, such information being vital for managing or establishing reserves (9). The feasibility of a captive breeding programme should be investigated.

The Indri is listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in it between acceding nations is subject to strict control and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING There are none in captivity at the present time (2).

REMARKS For description of animal see (1,3,6,14). In some features of its natural history (such as diet, social structure, maturation rate, territoriality) the Indri exhibits a remarkable evolutionary convergence with the Hylobatidae (Gibbons) of South-east Asia (9). This data sheet was compiled from information supplied by J.I. Pollock.

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DIADEMED SIFAKA

Propithecus diadema Bennett, 1832 Primates: Indriidae

SUMMARY Endemic to eastern Madagascar. Five subspecies are recognised. The species appears to occur naturally at low population density and is considered severely threatened, primarily by habitat loss through deforestation. Protected by law, though difficult to enforce, and occurs in a number of reserves. A brief study of the subspecies *P. d. edwardsi* has been undertaken. The feasibility of a captive breeding project should be investigated.

DISTRIBUTION Malagasy Republic, in the forests of the north-east and east (7). Tattersall recognises five subspecies. *P. d. diadema*: throughout the primary forest of the eastern humid zone between the Mangoro River and the approximate latitude of Maroantsetra, although not apparently in the immediate vicinity of the town (7). *P. d. candidus* from the humid forest belt north of Maroantsetra to the Andapa Basin and the Marojejy Massif. Probably once occurring as far north as Sambava and possibly Daraina (7). *P. d. edwardsi*: range uncertain but seems to occupy an area of the eastern humid forest south of the Mangoro River to about the latitude of Manakara; may be distinct from *P. d. holomelas* but may merely represent a clinal variation (7). *P. d. holomelas*: range uncertain and needs investigation; Tattersall reports the only identifiable collecting locality as near Fianarantsoa (7). Petter *et al.* indicate that it occupies a narrow strip of the western part of the eastern rain forest between the latitudes of Fandriana and Vondrozo (3). *P. d. perrieri*: restricted to the forests of the north-east of the Andrafiamena mountain chain, just south and east of Anivorano Nord. The type site, the dry forest of Analamera, abutting on the sea, accounts for about half of this total area (1,7). For map see (7).

POPULATION The species is undoubtedly rare and appears to exist naturally at low population densities (see below) (6). Certainly declining (6). Of the five subspecies *P. d. perrieri* is considered the rarest (7); its population in 1971 was estimated at 500 animals (1). In 1982, *P. d. candidus* was described as extremely rare throughout its range (7). In 1986 Wright noted that *P. d. edwardsi* still appeared relatively widespread in forests around Ranomafana (21°16'S, 47°28'E), although always at low density; it had however apparently disappeared from around Vondrozo, just south of this (22°50'S, 47°20'E) some time in the past 35 years (8).

HABITAT AND ECOLOGY A rain forest species. Only *P. d. edwardsi* has been studied in any detail, in a four month study at Ranomafana in south-eastern Madagascar (8,9). Group size, in nine groups censused, ranged from 4 to 8 (8,9); group sizes elsewhere have been given as ranging from 2 to 5 (4,5,7). In August at Ranomafana there were infants in 5 out of the 9 groups, including one infant known to have been born in mid July; interbirth interval may be 2 years. Home ranges in 2 groups intensively studied were 1 sq. km for a group of four and 2 sq. km for a group of 8, and there was some evidence that these ranges were nearly exclusive to the groups studied, at least at the time of year of the study; this home range size is around 15 times greater than that established for *Propithecus verreauxi* (8,9). A rough population density from these figures, of 4 per sq. km, is the lowest for any lemur so far studied (8); this is corroborated by observation elsewhere in the species's range (5,7). The species is largely folivorous; at Ranomafana 53% of diet consisted of leaves (30% young leaves from trees, 23% leaves from vines, herbs and tree parasites), 25% of flowers and 22% of fruits (8,9). The Sifakas travelled and fed in all habitats at Ranomafana and fed at all heights, including on the ground; they rested at heights of 5-10 m and slept, on ridges, at 8-10 m (8,9).

THREATS Forest loss principally for 'tavy' (slash-and-burn cultivation). Its naturally low population density will make it particularly vulnerable in this regard. The extent to which it is hunted is unclear; some populations (e.g. *P. d. perrieri*, and *P. d. edwardsi* around Ranomafana) are protected by local taboos ('fady'), but it is not known if this extends to the species in other areas. The habitat of *P. d. perrieri* was reported in 1972 to have contracted as a result of savanna fire encroachment (1).

CONSERVATION MEASURES Protected by law, although difficult to enforce. Occurs in several reserves: Betampona (No.1), Zahamena (No.3), Andohahela (No.11), Marojejy (No.12) (6).

All species of Indriidae are listed in Appendix I of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING There are not known to be any in captivity.

REMARKS For description of animal see (2,7); sometimes described as the most strikingly beautiful of all the lemurs (7).

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VERREAUX'S SIFAKA

Propithecus verreauxi A. Grandidier,1867 Primates: Indriidae

SUMMARY Endemic to Madagascar, where it has a wide distribution. Four subspecies are recognised. Abundant, although numbers are declining; the status of *P. v. coronatus* is perhaps cause for concern. Principal threat is loss of forest habitat. Protected by law and all subspecies occur in State or private reserves, however protection of these areas needs improving. Very few in captivity and a captive breeding programme for all subspecies is recommended.

DISTRIBUTION Malagasy Republic where the species is widely distributed, occurring in the forests of the north-west, west, south-west and south (20,24). Four subspecies are recognised. *P. v. verreauxi* inhabits the south and south-west from just west of Taolanaro to Tsiribihina River (9,20,24); in 1972 Petter reported its range to be rapidly decreasing (9);

however in 1982 Tattersall reported it to be flourishing in all types of forest (24). *P. v. coquereli*: in the north-west - north and east of the Betsiboka River (24). Petter in 1972 reported it to be confined to isolated forest patches and unburned areas in the Ankarafantsika Natural Reserve; formerly occurred in all forests north of the Betsiboka River (9). *P. v. deckeni*: west coast from somewhere to the south of Antsalova north to the Betsiboka River. Present range does not apparently extend southward as far as the Tsiribihina River, which marks the northern limit of *P. v. verreauxi*. An inland isolate also on the Bongolava Massif, north-west of Tsiroanomandidy. In the north-west part of the range it is difficult to define the boundary of *P. v. deckeni* with *P. v. coronatus* (24). *P. v. coronatus*: forests of the north-west between the ranges of *deckeni* and *coquereli*, although generally unclear; an isolate also exists (or did) in the Tsiroanomandidy region (24). In 1972 Petter reported that the overall ranges of *deckeni* and *coronatus* had largely been destroyed and animals were confined to small remnant forests (9).

The literature mentions a fifth subspecies *P. v. majori*, however recent opinion is that this is simply a melanistic variant within *P. v. verreauxi* (24). For maps see (18,20,24).

POPULATION Very few data available, probably numbers in the tens of thousands (16). Richard (1983) commented that *P. v. coronatus* had the most limited distribution and was the cause of most concern (16). Described in 1975 as abundant although declining in number (23).

HABITAT AND ECOLOGY Mixed forests; found in rich, mixed deciduous and evergreen forest, tamarind-dominated gallery forest, and the semi-arid Didierea thorny forest of the south (5,13,18,20,24). Diet consists primarily of leaves and fruit with flowers and bark also eaten (15,16,18,20,21,24). Largely diurnal. Group size averages about 6 animals (range 3-13), and social structure seems variable (3,13,18,20,24). Indeed it is now believed that Sifaka troops are loosely bound aggregations of individuals which may have little long-term core of kin (5). Furthermore ranging differs in different forests (3,15). At Berenty, groups have been observed to defend highly exclusive territories of 2-5 ha (3) and Mertl-Millhollen has noted olfactory marking on the edges of ranges (6). In Richard's study area range size was 6.75 to 8.5 ha and ranges of neighbouring groups overlapped (20). Gestation is about 130 days and females give birth to a single young every second year (3) if it survives, or very year if it does not (16). Population density in Berenty which is a very favourable habitat is about 100 per sq. km (4).

THREATS Destruction and degradation of its forest habitat is the major threat (9,23); principally caused by overgrazing by cattle and goats in the south-west and south and clearance for small and large-scale agriculture in the east, west and north (16). Savannah fires are also detrimental to the habitat of the species - they give rise to extensive erosion, increase the rate of water run-off and hence accentuate flood/drought cycles, these cycles in turn disrupt habitats away from the central plateau. In 1972 Petter reported that the habitat of *P. v. coronatus* had been almost completely degraded or destroyed, and that of *P. v. verreauxi* might become seriously endangered as a result of the rapid disappearance of the southern *Didierea* bush, gallery forests and western forests (9). The species was formerly protected over much of its range by a taboo but, as human traditions change, it is increasingly hunted (9,23).

CONSERVATION MEASURES Legally protected although enforcement is difficult. *P. v. verreauxi* occurs in Natural Reserves 10 (Tsimanampetsotsa) and 11 (Andohahela), the Réserve Speciale de Beza Mahafaly, where it is reportedly abundant, and in the private reserves of Analabe and Berenty (9). *P. v. coquereli* occurs in Natural Reserve 7 (Ankarafantsika) (9,18,20). *P. v. deckeni* and *coronatus* both occur in Natural Reserve 8 (Tsingy de Namoroka) and *P. v. deckeni* occurs in Natural Reserve 9 (Tsingy de Bemaraha). In 1972, Petter suggested that a 'réserve ponctuelle' (a very small reserve sufficient to protect a species with a very restricted distribution) should be created in an undisturbed remnant of the habitat of *P. v. coronatus* in the Tsiroanomandidy neighbourhood (9). A survey is needed to determine the status of the area today (4). The species has been the subject of several studies, in particular by Alison Richard (2,3,6,11, 13-15,17-23). *P. v. verreauxi* has been studied in the 200 ha Berenty Reserve intermittently since 1963 (5).

Propithecus spp. are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING As of September 1986 Duke University Primate Center held 11 individuals (25); the subspecies was not given, although in 1983 the Center held 2 male and 3 female *P. v. deckeni* (12). In 1971 an unspecified number were held in the Parc Tsimbazaza in Antananarivo, Madagascar (1,8).

REMARKS For description of animal see (7,20,24). A study of the skulls of *P. v. deckeni* and *coronatus* suggests that they are more closely related to each other than to the other subspecies and in certain anatomical features would appear to be closely related to *Propithecus diadema* from eastern Madagascar.

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AYE-AYE

Daubentonia madagascariensis (Gmelin, 1788) Primates: Daubentoniidae

SUMMARY Endemic to Madagascar. In recent years the Aye-aye has generally been believed to be on the verge of extinction; new records, however, indicate that it is relatively widespread on the Madagascan mainland and may not be as rare as has been assumed. Despite this the species is still not common and has certainly declined, chiefly because of destruction and degradation of its forest habitat, but also because it is believed to be a harbinger of evil and is therefore killed on sight. Protected by law though difficult to enforce, the Aye-aye definitely occurs in two reserves (one, Nosy Mangabe, to which it has been introduced), and probably occurs in several more. The Aye-aye is in a monotypic family and is one of the most remarkable curiosities of Madagascar's fauna, every effort should therefore be made to conserve it.

DISTRIBUTION Madagascar. The present distribution of this little-seen species remains uncertain, but it is now known to be more widely distributed on the Madagascan mainland, at least in the eastern humid forests, than has hitherto generally been assumed. Recent mainland records are from lowland forest in the region of Mananara (16°10'S, 49°46'E) south of Maroantsetra, and from mid-altitude forest around Périnet (18°56'S, 48°24'E); several sightings have been made in each of these areas in 1985-86, in the latter both within the Reserve de Faune de Périnet-Analamazoatra and in adjacent forests (17,18,19). It is also known to survive on Nosy Mangabe in Antongil Bay where it was introduced in 1966 (2,3,4,13,16,17). In the far south the species has been reliably reported by forest guards in Andohahela Natural Reserve (ca 24°40'S, 46°40'E) in the Anosyenne Hills north-west of Taolanaro (19). Wright, however, noted in 1986 that recent careful searches of forests in the region of Fianarantsoa (chiefly around Ranomafana, Vondrozo and Kianjavato) revealed no signs of Aye-ayes (21). Earlier records indicate that the species has also been widespread in northern, and perhaps western Madagascar (14); it is not unlikely that it still occurs in these regions. Tattersall notes that accurate locality records are few, although the presence of Aye-aye has been reported in the north at sites from the Montagne d'Ambre to Ankobakabaka near Befandriana Nord (14). Western records are less definite, with the only collecting record being from Ampasimena at the northern tip of the Ampasindava Peninsula, although it has repeatedly been asserted to occur in the region of Mahajanga and south of this, near Andranomaro south of Soalala where a fresh skin was reported in the 1930s (14); it may possibly also occur in the Tsingy de Bemaraha region (20).

POPULATION Unknown; the species is evidently far from common, although it now seems likely that it is more abundant than has been thought. Ganzhorn and Rabesoa report finding 3 individuals at 3 different sites in a single night near Périnet in 1985/86 (18) and the species has evidently been recorded in some numbers around Maroantsetra and Mananara (19). On Nosy Mangabe a female and her baby were sighted in March 1983 and in August 1984 two were seen in one night, 450 m apart (17).

HABITAT AND ECOLOGY Much of the biology and ecology of the species remains little known. The Aye-aye has been recorded in areas of primary rain forest, deciduous forest, secondary growth, cultivation (particularly coconut groves) and possibly even in mangrove swamps and dry scrub forest (11,13,14). Recent reports indicate that the Aye-Aye is generally recorded 1-3 m above the ground, although Petter reports that the species requires tall trees for nesting in (11,13). The records at Périnet (altitude 900 m) counter earlier suggestions (11,13) that the species is restricted to the coastal zone (18). Ganzhorn and Rabesoa note that at Périnet no individuals were recorded in summer 1984, despite intensive night work, or from September to December 1985; it was not clear from this whether the Aye-aye were transients in the forest areas surveyed, or whether they shifted their home ranges seasonally or were more active, and thus more easily seen, during the warmer time of year (records were in December - February) (19). Diet consists of various fruits, and insect larva for which it probes dead wood with its exceptionally elongated third finger (10,11,12,13). Nocturnal, it rests during the day in a large bowl-shaped nest (11,12,13,14). Social organization is poorly known and although usually regarded as solitary, it may be that the species is social, if not gregarious (11). Probably only one young is born every 2 or 3 years, birth season appears to be October-November (11).

THREATS Principal threat has been, and is, destruction and degradation of its forest habitat. Although apparently an adaptable species it is unlikely that it ever existed in high density (14), and its present rarity seems to be due to a combination of this factor, the rapid disappearance of its habitat, and persecution by villagers who believe it to be a harbinger of evil (3,4,9,11,13,14).

CONSERVATION MEASURES Legally protected but this is difficult to enforce. The Aye-aye has definitely been recorded in the 1980s in the Special Reserve of Périnet-Analamazoatra and has also been reported to occur in the Natural Reserves of Betampona (No.1) and Andohahela (No.11) (18,19). The species also survived at least until 1975 in a small special reserve established on the mainland at Mahambo, near Fenoarivo Atsinanana, following Petter's discovery of a population there in 1957 (9,10,11,13); it is not known if the species still survives there. Because of forest destruction and persecution of the Aye-ayes in this area it was also decided to translocate several specimens to the island of Nosy Mangabe (520 ha), 6 km west of Maroantsetra in Antongil Bay (9,11,13); this was carried out under the auspices of a conservation programme initiated by IUCN in 1964 and supported by the World Wildlife Fund (9,13). The island represents one of the few undisturbed areas on the east coast, is separated by a rough sea from the mainland, and is taboo to most people in the area because it is the site of ancestral tombs (3,9,11,13). Acting on Dr Petter's recommendations, the Malagasy Government in December 1966 declared the island a Special Reserve (Decree No. 65-795) and nine Aye-aye were released onto it (1,9,11,13). The project then ceased but in 1980 a decision was taken by the WWF office in Madagascar (itself established in 1979) to initiate a new project to study and protect the Aye-aye on Nosy Mangabe (1,15).

The species is listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in it or its products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1986 there were 2 females and 1 male in captivity at Vincennes in Paris (22). In the late 1960s a pair of Aye-ayes were kept in captivity for two years at Maroantsetra for breeding studies (no breeding in fact occurred). The animals were transferred to Parc Tsimbazaza in Antananarivo in 1970; one was still alive in 1975, but has since died (2,3).

REMARKS For description of animal see (7,8,11,14). The Aye-aye, due to its peculiar diet and ecology, is an exceptional example of adaptation among mammals, indeed it appears to occupy the niche of a woodpecker (5). Initially it was thought to be a type of squirrel because of its peculiar dentition, and was at first classified with the rodents (11). Only one extant species is recognised within the family, however the skeletal remains of a larger form from the south-west of Madagascar, which apparently disappeared less than 1000 years ago, have been described as a separate species, *Daubentonia robusta* (11,14).

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GREY GENTLE LEMUR

Hapalemur griseus (Link,1795) Primates: Lemuridae

SUMMARY Endemic to Madagascar where it occurs in the east and north-west. Four subspecies are now recognised. Hunted for food and in some areas suffers from habitat destruction. Protected by law and occurs in a number of protected areas. Specific conservation measures need to be determined. Listed in Appendix 1 of CITES, and class A of the African Convention.

DISTRIBUTION Madagascar where it occurs in the north-west and the east. Four subspecies are now recognised. *H. g. griseus* in the humid forests of eastern Madagascar, from the Tsaratanana Massif to Taolanaro, although rarely in great density, and reported to be now extremely sparse in most of the north-western end of its range (13). *H. g. alaotrensis* from the reed beds of Lake Alaotra and the surrounding marshes. *H. g. occidentalis* known from two isolates, both in the west - one in the region of Antsalova/Lake Bemamba, between Maintirano and Belo-su-Tsiribihina, the other in the Sambirano region from Maromandia to Beramanja (13). Collecting records also exist from other localities, notably to the east of the Antsalova/Lake Bemamba isolate, and in the Namoroka region but the species seems absent from these areas today (13). Tattersall also reports that another small isolate may survive in the area of Ankazoaba (13). A new subspecies, *H. g. meriodinalis*, has recently been described from the south-east coast (15). For map see (13).

POPULATION No overall figures are available. The Lake Alaotra form, *H. g. alaotrensis*, is regarded as endangered by two authorities (1,16). However both *H. g. griseus* and *H. g. occidentalis* are considered at least locally abundant (1,13,17,18); the former has densities as high as 40-60 individuals per sq. km at Périnet in central-eastern Madagascar and of 10-20 per sq. km at Ranomafana in the south-east (18). *H. g. griseus* is thought unlikely to be declining throughout its range (18), as has been asserted (11). No information has been located regarding *H. g. meridionalis.*

HABITAT AND ECOLOGY Moderately or very humid forests, reed beds, marsh areas, and bamboo forests, and occurs over a considerable range of altitude (6,7,13). A two month field study of *H. g. griseus* at Périnet, during the austral winter, found group size, of 8 groups studied, ranged from 4 to 6; each group contained at least an adult pair, one juvenile and one infant (17). Home range sizes for each group were small (6-10 ha) (17). Group sizes elsewhere have been reported as around 3 to 5, although groups as large as 30-40 have apparently been recorded (7,8,9,10,13). A single young is produced and the birth season appears to be January and February (7). The Périnet study confirmed that bamboo is the principal item of the diet with ninety percent of total feeding time spent eating new shoots, young leaf bases and stem pith of *Bambusa*; other foods included fig leaves, leaf stems of terrestrial grasses, young leaves from trees and small berries from understorey plants (17). It was thought possible that the proportion of fruit in the diet increased in summer when the quantity available increased, although evidence was lacking (17). The western form is also believed to subsist almost entirely on bamboo while *H. g. alaotrensis* has been observed to eat *Phragmites* leaves and the buds and pith of *Cyperus* (7). At Périnet the lemurs ranged through all habitats where bamboo was present and fed at all heights, from the ground to tree canopy level; they were active throughout the day, apart from a 1-1.5 hour midday rest period, and were inactive at night, when they slept in emergent trees (17). In contrast, at Maroantsetra in the north-east Petter and Peyrieras have observed *H. griseus* to be largely crepuscular, although activity may continue after nightfall (6,7).

THREATS Because this species is well adapted to bamboo forest it is unlikely to suffer from forest destruction as much as other species. Indeed, in areas burned and abandoned long ago, where the bamboo has entirely replaced the original forest, the density of animals appears to be greater than in the undisturbed habitat (13). The lake form, however, suffers greatly from habitat destruction. For example in 1969 Petter and Peyrieras witnessed huge fires set in the reed beds around the lake. The animals fleeing from the flames were killed, or captured for later consumption. In one village visited, seven Gentle Lemurs had been eaten in one night (7). Elsewhere *Hapalemur* is hunted, often by boys with slingshots (17), although it is not known what impact this has on the population.

CONSERVATION MEASURES Legally protected although enforcement is difficult. Occurs in Natural Reserves 1 (Betampona), 3 (Zahamena), 4 (Tsaratanana), 11 (Andohahela) and 12 (Marojejy) (11). Has been studied by Petter and Peyrieras (6,7).

All species of Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them between acceding nations thus being subject to severe restriction, trade for primarily commercial purposes being banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1984 there were 2 males and 3 females at Mulhouse Zoo in France, 1 male and 2 females at Cologne in F.R. Germany and 5 males and 4 females at Duke University Primate Research Center, U.S.A. (4); by September 1986 the number at Duke had increased to 11 (18).

REMARKS For description of animal see (3,5,8,13,15).

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BROAD-NOSED GENTLE LEMUR

Hapalemur simus Gray, 1870 Primates: Lemuridae

SUMMARY Endemic to Madagascar where it is currently known to survive only in a very restricted area in the south-east. Considered critically endangered through clearance of habitat

along rivers leading to loss of the Giant Bamboo on which it apparently depends. Surveys and a four month study were carried out in 1986; these are planned to be extended in 1987 and should serve as a basis for any conservation plans. Listed in Appendix 1 of CITES and Class A of the African Convention.

DISTRIBUTION Madagascar. Modern records are confined to the south-east, where the species was confirmed in 1986 as surviving in forests at Ranomafana (21°16'S, 47°28'E) and east of this at Kianjavato near Mananjary (10). *H. simus* was evidently once widespread in Madagascar; subfossil remains have been discovered in the far north, at Andrafiabe in the Ankarana karst region, in the north-west at Anjohibe near Mahajanga, and at Ampasambazimba in the Lake Itasy basin in central Madagascar (9). It is speculated that the species might once have occurred in all regions except the extreme south and south-west (9). It evidently remained widespread in the eastern forests at least until the 19th century, as post-1870 records range from near Mananara (16°10'S, 49°46'E) in the Antongil Bay region to Vondrozo (22°50'S 47°20'E) near Farafangana in the south (8,9).

POPULATION Unknown, although considered by Wright to be the most endangered of all lemur species, by virtue of its apparently now highly restricted range and specialized diet (see below) (10); the species is generally considered critically endangered (1,3,4,7,8). In 1986 population density at Ranomafana was estimated at less than 10 per sq. km (10).

HABITAT AND ECOLOGY The species appears to be dependent on Giant Bamboo (10). A four month study at Ranomafana in 1986 found that 90% of its diet consisted of the pith of the stems, and the leaf stems of Giant Bamboo, although it was observed to eat fruit 2 or 3 times (10). It was found at Ranomafana in groups of 4-12 individuals and at Kianjavato in groups of 8-12 (10), while Petter *et al.* note that it has been seen in groups of 5-6 individuals in February, and in a group of 10 in April (5,6). Both diurnal and nocturnal activity has been observed at Ranomafana (10).

THREATS Loss of habitat appears to pose a critical threat to the species. Giant bamboo is reportedly only found along large rivers, where human settlements tend to be concentrated, and most habitat along rivers has already been cleared (10). The bamboo itself is used for fencing and to provide water containers and is now generally rare (10).

CONSERVATION MEASURES Legally protected but enforcement is virtually nonexistent. The species is not known to occur in any reserve. Surveys undertaken in 1986 are planned to be extended in 1987 to other forests in the Fianarantsoa - Mananjary region, in an attempt to provide an accurate assessment of the present status of *H. simus*, to serve as a basis for conservation plans (10).

All species of Lemuridae are listed in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them between acceding nations is therefore subject to severe restriction and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING None are in captivity at the present time.

REMARKS For description of animal see (2,3,8).

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RING-TAILED LEMUR

Lemur catta Linnaeus, 1758 Primates: Lemuridae

SUMMARY Endemic to Madagascar, where it occurs in the forests of the south and south-west. Still considered abundant though has declined in numbers, and may now be threatened. Protected by law, occurs in a number of protected areas and has been the subject of studies. Breeds well in captivity. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Madagascar. Restricted to the south and south-west but ranges into the interior highlands farther than any other lemur. Range bounded approximately by a line connecting Belo-sur-Mer with Fianarantsoa (although it does not appear to occur in the area immediately around Manja) and Fianarantsoa with Taolanaro. However distribution is not continuous within this range (16). For maps see (12,16).

POPULATION In 1975 Richard and Sussman reported it to be abundant, although declining (13). Mittermeier, O'Connor and Pidgeon all consider that the species may be threatened (17, 18).

HABITAT AND ECOLOGY The dry forests of the south and south-west, where it lives in three basic habitats: semi-deciduous gallery forest, bush and scrub forests, and mixed forests which occur where the continuous canopy forest merges into bush and scrub habitat (3,17). Evidence is accumulating that the species may be dependent on gallery forest for its survival (18). Diurnal and the most ground dwelling of the lemurs. Social organization is centred around a core group of females and their infants and young juveniles. Females appear to remain in the troop of their birth and are dominant over males. Defence of territory seems to be primarily a female responsibility. Males, in general, are peripheral to the core group and seldom enter into territorial disputes, nor do they necessarily remain with one troop their entire lives (3,8). A high incidence of intra troop aggression in the form of chasing and cuffing has been noted. Ranges of troops studied at Berenty have varied from 5.7 ha to 23 ha (3), and sizes of troops from 5 to 22 animals with an average of 13 animals per group (8). Diet consists of fruit, leaves, flowers, herbs (16), and insects (L. Durrell, pers. obs.). Mating season is in April/May; most conceptions in one forest have been noted to occur within about a two-week interval. Normally one infant (occasionally twins) is born in September (6). Population density at Berenty, which is in very favourable habitat, is about 150 per sq. km (6).

THREATS The species has declined in number because of habitat loss and some consider it likely that this will have an affect on its long term survival (17,18). If the species is indeed dependent on gallery forest, it almost certainly is threatened as this habitat, being close to water, particularly attracts human settlement (18). Hunted for food and because it raids crops; dogs are used to hunt it since it is the only extant lemur which habitually travels on the ground (13).

CONSERVATION MEASURES Protected by law. Occurs in Isalo National Park, Natural Reserves 5 (Andringitra), 10 (Tsimanampetsotsa), 11 (Andohahela) (13), and the private reserve of Berenty owned by M. de Heaulme which harbours about 150 *L. catta* (3,5,7,8,13). Has been the subject of studies (2,3,4,5,7,8,9,14,15). The *Lemur catta* troops in Berenty Reserve have been studied every few years from 1963 until the present, allowing for long-term perspective on changes in troop social behaviour, population, and positioning of territorial core areas and home range boundaries (9). Surveys are needed to determine the present extent of its range.

All species of Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned. However since *Lemur catta* breeds so well in captivity a number of countries have relaxed regulations on trade in animals from captive self-sustaining populations (1).

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING Numerous in zoos where it breeds well.

REMARKS For description of animal see (10,11,12,16).

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CROWNED LEMUR

Lemur coronatus Gray,1842 Primates: Lemuridae

SUMMARY Endemic to Madagascar where it occurs in the dry and moist forests of the extreme north. Information on status not located. The species seems fairly adaptable to habitat changes. It is hunted as a crop pest. Legally protected and occurs in Mt d'Ambre National Park, however its protection in the park needs improving. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Madagascar. Occurs in the arid Cap d'Ambre, the extreme northern tip of Madagascar. Southern limit in the west is the Ankarana Massif, between Ambilobé and Anivorano Nord; in the east its distribution extends south to the Fanambana River, which reaches the sea a few km beyond Vohémar (8). For maps see (6,8).

POPULATION No information on status; may not be threatened. Fairly adaptable to habitat changes (5,8). Mittermeier (1986) believes it to be vulnerable (9).

HABITAT AND ECOLOGY The dry forests of the arid north (5,8), but has apparently adapted to humid forests on the slopes of Mt d'Ambre (possibly being forced there by pressure on its preferred habitat) (8,9). Also found in plantations (5). Lives in relatively large groups containing multiple adult males and females (8). Travels regularly on the ground (8).

THREATS No specific data located concerning the threat of habitat loss; since the species seems capable of adapting to habitat changes this factor may not be adversely affecting it. However, Mittermeier (1986) notes that clear cutting of forests occurs in the north (as elsewhere) and would obviously eliminate lemurs from an area (9). It is also frequently hunted by native farmers because of its depradations on crops; hunting occurs illegaly within the Mt d'Ambre National Park (5).

CONSERVATION MEASURES Legally protected but this is difficult to enforce. Occurs in the Mt d'Ambre National Park, however protection needs to be improved and poaching stopped (5). Information on its status is required.

All species of Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1984 there were 17 at Cologne Zoo, F.R. Germany, 3 at Mulhouse Zoo in France and 9 at Duke University Primate Center, U.S.A. (3); by September 1986 the number at Duke had increased to 13 (10). Most are presumed captive-bred (3).

REMARKS For description of animal see (4,6,8). Sexually dichromatic (8). Previously *L. coronatus* was considered a subspecies of *Lemur mongoz* (2), but is now given specific status (7,8,9).

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BROWN LEMUR

Lemur fulvus E. Geoffroy, 1796 Primates: Lemuridae

SUMMARY Occurs in Madagascar and on Mayotte Island in the Comoro Archipelago. *Fulvus* was previously included in *Lemur macaco* but is now considered a distinct species. Also *fulvus* is now generally considered to include *rufus, albifrons, mayottensis, collaris, sanfordi* and *albocollaris.* As a species it is widespread and abundant although the status of the subspecies *sanfordi, albocollaris* and *collaris* is cause for concern. Protected by law and all subspecies except *sanfordi, mayottensis* and *albocollaris* occur in protected areas. Breeds well in captivity. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Madagascar and the French 'territorial collectivity' of Mayotte in the Comoro Island group. Seven subspecies are recognised (23), although Tattersall points out that it is essential to bear in mind, especially in the case of eastern populations of *fulvus*, that the taxonomy as well as the distribution information is provisional (23). For maps see (15,23).

L. f. fulvus, the Brown Lemur, occurs in at least three distinct areas: in the north-west, to the north and east of the Betsiboka River, from south of Ambato-Boeni to Analalava; in the north, in a small area to the east of the Galoka mountains, south of Beramanja; and in the east, south of Lake Alaotra and around Andasibé. The limits of the last isolate are not known (23). *L. f. rufus*, the Red-fronted Lemur, is found in both western and eastern Madagascar; in the west along the south-western bank of the Betsiboka River, from Katsepy (opposite Majunga) at least as far as Ambato-Boéni, and where suitable forest exists as far south as the Fiherenana River. It has been recorded south of the Fiherenana only at Lambomakandro, north and east of Sakaraha, and close to the river. To the east, in common with other lemurs, *rufus* is limited by the availability of forest, which diminishes progressively toward the interior. In the eastern humid forests the distribution of *rufus* is less well understood. It has been collected as far south and west as Ivohibé, at the southern end of the Andringitra Massif. Along the coast, the most southerly collecting locality is near Manakara. The northern boundary of eastern *rufus* is highly uncertain, the species possibly occurring as far north as the Mangoro River (23). *L. f. albifrons*, the White-fronted Lemur, occurs in the humid eastern forests, but precise limits are poorly known. The southern limit appears to be around Tamatave, at least along the coast and it is possible that, at least toward the coast, the southern boundary of *albifrons* is marked by the Ivondro River, but this needs to be confirmed. In the interior the subspecies occurs at least as far south as the Natural Reserve of Zahamena, east of Andreba. In the north, its distribution extends as far west as the Marojejy Massif, north of Andapa, but not on to the Tsaratanana Massif; along the coast it reaches beyond the northern limit of the rain forest, to the Fanambana River, near Vohémar (23). The taxon also occurs on Nosy Mangabe (7). *L. f. mayottensis*, the Mayotte Lemur, is unique to Mayotte Island (375 sq. km) in the Comoros (23); however there is an increasing belief among researchers that this lemur is a hybrid population deriving from introduced western Madagascan populations of *rufus* and *fulvus*. *L. f. collaris*, the Collared Lemur, occurs in south-western Madagascar, from the southern end of the humid forest strip, near Fort-Dauphin, north to the Mananara River which flows in a south-easterly direction to meet the sea at Vangaindrano. The northern and western limits are not clear (23). *L. f. sanfordi*, Sanford's Lemur, is restricted to the immediate area of the Mt d'Ambre in northern Madagascar (6,23), from the northern flanks of the mountain south at least as far as the Ankarana Massif, between Anivorano Nord and Ambilobé, where specimens have been collected (23). Petter *et al.* (1977) have indicated that toward the east this subspecies occurs widely down to the latitude of Sambava (11), however Tattersall reports that his surveys have not substantiated this (23). *L. f. albocollaris*, the White-collared Lemur, (7,23,28) inhabits the eastern humid forests between the Mananara and Faraony Rivers, however as yet this range has not been adequately surveyed (23).

POPULATION As a species the Brown Lemur is abundant and widespread (12) and although probably declining it is probably not threatened at the present time (15). Tattersall (1982) remarks that most subspecies of *L. fulvus* 'still exist in adequate abundance to ensure their survival (under present conditions, not necessarily if they worsen) for a few decades yet.'

L. f. fulvus: no information has been located about numbers or status. *L. f. rufus*: in 1975 reported to be the most widely distributed of the subspecies, being found in all forests throughout the west coast of the island, although not in the north (15); it is presumably therefore fairly numerous. Petter in 1972 reported *rufus* to be 'Endangered' having become depleted over the greater part of its range (he considered that in the 1940s it was the most abundant lemur in Madagascar) (6). *L. f. mayottensis*: the minimum population is thought to be not less than 50 000 and the actual number may be higher. After his November 1982 visit to Mayotte, Tattersall reported that 'while it would be alarmist at this point to claim that the Mayotte Lemurs are threatened, these primates do face a severe curtailment of their habitat in the longer term' (24). *L. f. collaris*: few data located; reported as abundant in R.N.I. No.11 (Andohahela) in the mid-1980s. *L. f. sanfordi*: in 1972 Petter considered this subspecies to be 'Endangered' (6). *L. f. albifrons*: few data available, Mittermeier in 1984 noted that it seemed abundant on Nosy Mangabe (7). *L. f. albocollaris*: no data located.

HABITAT AND ECOLOGY *Lemur fulvus* occurs in nearly all of the remaining forested areas around the coast of Madagascar except in the extreme south where semi-arid conditions and desert-like vegetation occur (4,15,17). On Mayotte Island it is found wherever there is forest but is rare at altitudes above 300 m (23). The species appears to be highly adaptable, exhibiting different social organization, ranging behaviour, diet etc. in different conditions. For example, *L. f. rufus* and *L. f. fulvus* exist in small groups whereas *L. f. mayottensis* appears to lack clearly defined groups, living instead in 'open' groups (although whether these are truly 'open' or simply subgroups of a larger, more exclusive, local population has not yet been determined) (23). *L. f. rufus* studied by Sussman at Antserananomby and Tongobato had very small home ranges (O.75-1 ha) which overlapped extensively and high population densities (around 9-12 individuals per ha), whereas *L. f. fulvus* at Ampijoroa studied by Harrington had a home range of about 7 ha, although neighbouring groups showed some overlap; territorial defence was exhibited when both groups were in the area of overlap at the same time (4,23). It thus seems likely that *L. fulvus* under conditions of low population density may defend a considerable part of its home range as a territory; while under more crowded conditions it will tolerate much more overlap with neighbouring groups (4). Diet also varies: *L. f. rufus* appears to feed primarily on leaves (14,15,17) whereas *L. f. mayottensis* feeds on fruit, flowers and leaves (23). Diets of both also varied seasonally (23). Regarding activity patterns: *L. f. rufus* does not seem to exhibit a significant amount of activity at night whereas *L. f. mayottensis* is active as much at night as during the day (so-called diel activity) (22,23) and observations on the subspecies *fulvus, sanfordi* and *albifrons* suggest they might exhibit similar diel activity patterns (1,4,23).

Petter (1972) reported that the mating season for *rufus* and *sanfordi* was from April to June and that a single young was born between August and November after a gestation period of 4.5 months (6).

THREATS Undoubtedly forest loss will have adversely affected this species, although no specific details have been located. On Mayotte, Tattersall (1983) reports that the vegetation has suffered considerably since his initial surveys in 1974-5, and inroads into the forest have become particularly marked since 1980. Virtually the entire forest of Mavingoni, in which

Mayotte Lemurs were intensively studied in 1974-5, 1977 and 1980 had disappeared by 1982 and this represented an island-wide trend (24). In 1972 Petter reported that *rufus* had been depleted over the greater part of its range by intensive hunting (mainly with traps by woodcutters) and degradation of its habitat, especially by burning and cattle grazing (6). Similarly for *sanfordi* Petter in 1972 reported that numbers had decreased principally as a consequence of illegal hunting and timber exploitation in and around the Montagne d'Ambre National Park (6).

CONSERVATION MEASURES Protected by law though difficult to enforce. Occurs in the following protected areas:

Natural Reserve	1	Betampona (12)	*L. f. albifrons* (?);
Natural Reserve	3	Zahamena (12)	*L. f. albifrons*(23);
Natural Reserve	4	Tsaratanana (12)	*L. f. rufus* (?);
Natural Reserve	5	Andringitra	
Natural Reserve	7	Ankarafantsika (12)	*L. f. fulvus* (3,4);
Natural Reserve	8	Namoroka (12)	*L. f. rufus*;
Natural Reserve	9	Bemaraha (12)	*L. f. rufus*;
Natural Reserve	11	Andohahela (12)	*L. f. collaris* (23);
Natural Reserve	12	Marojejy (12)	*L. f. albifrons* (23);

Analabé (12);	
Nosy Mangabe (12);	*L. f. albifrons* (7);
Mt d'Ambre National Park (6)	*L. f. sanfordi* (6);

Has been the subject of studies (1-5,9,14-22,24,25).

More precise information is needed on which to base conservation recommendations. Certainly the conservation status of *sanfordi, albocollaris* and *collaris* needs urgent investigation (27).

All species of Lemuridae are included in Appendix I of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, which makes trade in them between acceding nations subject to severe restrictions and trade for primarily commercial purposes banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING The Brown Lemur breeds well in captivity. The most recent information is listed below by subspecies.
L. f. fulvus: in 1984 at least 200 were held in at least 36 collections, most presumed captive bred (8).
L. f. rufus: in 1984 47 males and 50 females were reported held in 19 collections, most were presumed to be captive bred (8).
L. f. albifrons: at least 134 individuals held in 15 collections in 1984, most captive bred (8).
L. f. mayottensis: at least 148 individuals were held in 31 collections in 1984, most captive bred (8).
L. f. collaris : 20 were held at Duke University Primate Center, U.S.A. in September 1986, with an additional one out on loan (30); in 1984 an unknown number were held in a breeding group at Cologne, F.R. Germany (8).
L. f. sanfordi: in September 1986 there were reportedly 18 in captivity, 14 of these at the Duke University Primate Center, the remainder on loan from here (30).
L. f. albocollaris: two are in captivity at the Faculty of Medicine in Strasbourg (29).

REMARKS For description of animal see (10,11,23). Many recent authors, following Schwarz (1936) have placed *Lemur fulvus* in synonymy with *Lemur macaco* (13,23). Discrete populations of the two species are, however, now known to exist in sympatry west of the Galoka mountains in northern Madagascar (18,23), and separate specific status is now generally accepted (23,28).

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BLACK LEMUR

Lemur macaco macaco Linneaus, 1766 Primates: Lemuridae

SUMMARY Endemic to north-west Madagascar where it is restricted to the humid forests and the coastal islands of Nosy Bé and Nosy Komba. The species comprises two subspecies, *macaco* and *flavifrons*. Although *L. m. macaco* adapts to secondary and isolated forest zones, numbers are declining because of loss of habitat. Protected by law but difficult to enforce. Occurs in two reserves. Breeds well in captivity. Needs a conservation management plan. Listed on Appendix I of CITES, and Class A of the African Convention.

DISTRIBUTION Malagasy Republic. Confined to the north-west coastal areas and the neighbouring coastal islands of Nosy Bé and Nosy Komba (2,4,13,18). Its range extends from the region of Anivorano Nord to the area of Befandriana Nord (in the interior) and to some distance south of Maromandia (along the coast) (18). The precise limits remain undetermined but include the Tsaratanana Massif, the Ampasindava Peninsula, as well as the two islands (18). For maps see (12,18).

POPULATION Total numbers unknown. In 1975 Richard and Sussman described the species as declining (along with all Malagasy lemurs) (14).

HABITAT AND ECOLOGY Seasonally humid Sambirano forests; in both primary and secondary forest provided a few tall trees are available for sleeping. Largely diurnal and feeds on fruits and leaves (2,5,10,18). Arboreal (4), preferring to travel through the continuous canopy where available (18). Moves conspicuously through the forest in social groups of about 10 animals (range 4-15); at night three or more groups may join together to sleep (5,10,13,18). Groups contain more males than females (sex ratio 1.4:1) (5,10). Mating on Nosy Bé was observed in April, birth in September; one young per female is the norm (10).

THREATS Major threat is habitat destruction as forests are cleared for settlement and for shifting agriculture (6,13,14,18). The Sambirano area is ideally suited to crop cultivation and cocoa and ylang-ylang plantations (11). The coastal forests have long been colonized and exploited and the greater part have been destroyed; the remainder is patchy, not continuous (6). Lesser threats are hunting for food and as a crop pest (2,6,11,14).

CONSERVATION MEASURES Protected by law but this is difficult to enforce. Occurs in two reserves: Natural Reserve 6 -- the 11 sq km Lokobé Reserve on Nosy Bé Island which contains a few hundred Black Lemurs (2,6,11), and Natural Reserve 4 -- the remote 593 sq km Tsaratanana Reserve (2,6). A few troops are also directly protected by the villagers on the Island of Lavalohalika, Nosy Komba and in the village of Ankazomborona where the Black Lemur is regarded as sacred; it is therefore forbidden to eat, kill or even mistreat it, including capture and removal from home territories (13). The Lemurs on Nosy Komba are a thriving tourist attraction although crop raiding animals are occasionally killed (20,21,22). The main conservation requirement is effective protection of suitable forest areas and also better protection from hunting. Since the species has adapted to feed in plantations and is more numerous there than in the natural forest (11), these areas could be used to provide animals for reintroductions.

All species of Lemuridae are included in Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products therefore being subject to strict regulation by ratifying nations, and trade for primarily commercial purposes banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1984 at least 80 males and 78 females (most captive bred) were held in 22 zoological collections (8). Breeds readily in captivity and has hybridized with *L. fulvus*. St Louis Zoo has been particularly successful with the species (1,3). The studbook keeper is Roger Birkel, St Louis Zoo, F, Missouri 63110, U.S.A. (8).

REMARKS For description of animal see (2,4,7,9,12,13,18). Readily recognized by its ear tufts (4). The most strikingly sexually dichromatic of all the lemurs (18); males are black and females golden brown (4,13). The newborn baby of either sex is uniformly black (4,17). *Lemur macaco* taxonomy has been subject to change. Hill (1953) recognised *L. macaco* (with no subspecies) as distinct from *L. fulvus* (4). However based on morphological and biogeographical studies Petter in 1962 (10) followed Schwarz (1931) (16) and suggested that *L. macaco* and *L. fulvus* (with six subspecies: *L. f. fulvus, L. f. rufus, L. f. albifrons, L. f. sandfordi, L. f. collaris* and *L. f. flavifrons*) belonged to a single species *L. macaco*, which thus included seven different subspecies. However chromosomal studies reported in 1975 tentatively suggested the maintenance of *L. macaco* as a separate species but including the subspecies *flavifrons* (15), and discrete populations of *L. fulvus* and *L. macaco* are now known to exist in sympatry west of the Galoka mountains (17). In 1982, Tattersall considered *L. macaco* to be monotypic, describing *L. m. flavifrons* as an 'enduring myth' based on a specimen which lacked the characteristic eartufts (18). However, it has subsequently been shown that *L. m. flavifrons* is a valid taxon; it has been studied in the wild and several captive colonies now exist (19,21). *Flavifrons* has no ear tufts, and in the adult has blue eyes; *L. m. macaco* has orange eyes (21).

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SCLATER'S LEMUR

Lemur macaco flavifrons (Gray, 1867) Primates: Lemuridae

SUMMARY Endemic to a coastal forest strip in the north-west of Madagascar. Little is known of its population status or ecology, though it is likely to be threatened by loss of its forest habitat. Protected by law but does not occur in a reserve. A few animals are held in captivity. Listed on Appenix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Malagasy Republic where it occurs along the north-west coast in a forest strip between Maromandia and Befotaka (2) about 100 km north of Ampasindava Bay (5).

POPULATION No specimens had been sighted for many years (5), until rediscovered in November 1983 (2).

HABITAT AND ECOLOGY Coastal forest (5), as far as the limit of the Sambirano forest (2). Probably folivorous and frugivorous (2).

THREATS The coastal forest has been exploited or burned down (5), and the remaining patches continue to be subjected to such pressures (2). The Sambirano area is ideally suited to crop cultivation and cocoa and ylang-ylang plantations (5).

CONSERVATION MEASURES Protected by law, though difficult to enforce. Does not occur in a reserve. Survey urgently needed as basis of a conservation plan (5). Behavioural studies began in November 1984 (2).

All species of Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products therefore being subject to strict regulation by ratifying nations, and trade for primarily commercial purposes banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING As of 1986 there were 5 animals in the Faculty of Medicine of Strasbourg, France, where they have bred (11), 4 at Duke University Primate Center, U.S.A. (10) and 3 in Parc Tsimbazaza, Madagascar (2).

REMARKS For description of animal see (4). *Lemur macaco* taxonomy has been subject to change. Hill (1953) recognised *L. macaco* (with no subspecies) as distinct from *L. fulvus* (1). However based on morphological and biogeographical studies Petter in 1962 suggested that *L. macaco* and *L. fulvus* (with six subspecies: *L. f. fulvus*, *L. f. rufus*, *L. f. albifrons*, *L. f. sandfordi*, *L. f. collaris* and *L. f. flavifrons*) belonged to a single species *L. macaco*, which thus included seven different subspecies (4). However chromosomal studies reported in

1975 tentatively suggested the maintenance of *L. macaco* as a separate species but including the type *flavifrons* (6), and discrete populations of *L. fulvus* and *L. macaco* are now known to exist in sympatry west of the Galoka mountains (7). In 1982, Tattersall considered *L. macaco* to be monotypic; describing *L. m. flavifrons* as an 'enduring myth' based on a specimen which lacked the characteristic eartufts (8). However it has subsequently been shown that *L.m flavifrons* is a valid taxon; it has been studied in the wild and several captive colonies now exist (2,9). *Flavifrons* has no ear tufts and in the adult has blue eyes; *L.m. macaco* has orange eyes (9).

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MONGOOSE LEMUR

Lemur mongoz Linnaeus,1766 Primates: Lemuridae

SUMMARY One of the two lemur species which is not solely confined to Madagascar since it also occurs on the Comorian Islands of Moili (Mohéli) and Ndzouani (Anjouan). By the 1980s it was considered gravely endangered in its mainland habitat of the north-western forests and was considered severely threatened on the Comoro Islands where in the early 1970s it had been thought secure. Protected by law, has been the subject of studies and occurs in Ankarafantsika Natural Reserve. Adequately protected reserves are essential for its long-term survival. Breeds well in captivity, but only for a short period after capture; captive populations now apparently declining. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Madagascar and the Republic of the Comoros (5,7,15). Occurs in the deciduous forests of north-west Madagascar and on the Comorian islands of Moili (Mohéli) and Ndzouani (Anjouan) (15,16). The few lemurs on Ngazidja (Grande Comoro) are all captive animals (of the Comorian population) which have escaped or been set free (13). The species was almost certainly introduced to the Comoro Islands from Madagascar but when and how is unknown; it could well have arrived by rafting on the floodwaters of the Betsiboka River, though equally and perhaps more plausibly could have been introduced by man (13). On the mainland southern and western limits are not precisely known; the species exists in the area of Lake Kinkony, just to the south of Mitsinjo and to the west of the River Mahavavy, but is not known from the Tsingy de Namoroka Reserve, 20 km due south of Soalala. It does occur, however, both to the east and to the west of the Betsiboka River in the region of

Ambato-Boéni. To the north its range extends as far as the Bay of Narinda (15). Tattersall remarks that largely because of numerous misidentifications the range of the species is often misquoted (15). For maps see (7,15).

POPULATION In 1982 reported by Tattersall to be 'gravely endangered' on the mainland, to be in a critical situation on Ndzouani, and its status becoming precarious on Moili (16). Since then, on January 11 1983 Moili was struck by cyclone Elena. The vegetation of the island was reportedly ravaged terribly, and was apparently followed by extensive brush fires (16). The effect of this on the lemur population is unknown but presumably could have been catastrophic. Tattersall during his 1982 trip to the islands noted that there had been a marked decline in lemur numbers since his fieldwork in 1974 and 1975 (13,16); then *L. mongoz* had been abundant all over Moili, although was much less abundant on Ndzouani (13).

HABITAT AND ECOLOGY The north-western forests. On the Comoros vegetation is almost entirely secondary, but the lemurs are able to thrive in such regrowth as long as it contains sufficient numbers of large trees which produce the bulk of the diet (16). On Ndzouani, *L. mongoz* population density is highest in the relatively undisturbed cloud forest of the central peaks (16). Seemingly either nocturnal or diurnal depending on local conditions (2,11,14,15,17). In Madagascar the species lives in small family groups, however some variation was found in the Comores, especially on Moili where it appeared that the smaller dry-season groupings coalesced in the wet season (10,15,17). On the mainland home ranges were small (1.15 ha) and overlapped (15,17). Diet is highly specialized, at least seasonally. Observations in July and August 1973 indicated that the species fed on only five species of plant and mainly on the nectar-producing parts (flowers and nectaries) of four of these species. It spent most of its feeding time licking nectar from the flowers of the Kapok tree, *Ceiba pentandra*, and is probably a major pollinator of this tree in Madagascar. A dietary preference for nectar is unusual amongst primates (10).

THREATS Threatened mainly as a result of habitat destruction and degradation. Tattersall's visit to the Comores in November 1982 found that within the decade since his last visits there had been a great deal of forest loss (16). On Ndzouani extensive forest clearance of this overpopulated island had drastically reduced the area available to *L. mongoz*. Even in the cloud forests of the central peaks there had been considerable encroachment and lemurs were drastically less evident (16). Similarly, continuing clearance of the vegetation elsewhere on the island had further diminished the area of secondary habitat exploitable by lemurs. This accelerating habitat destruction was linked directly with expansion of the island's human population, up from 250 people per sq. km in 1974 to upwards of 350 per sq. km in 1982. Of particular impact had been the arrival of several thousand refugees from Madagascar, many of whom had settled in the interior in areas adjacent to what remained of the forest (16). On Moili although the human population density was still comparatively low, at about 60 people per sq. km (up from 40 per sq. km in 1974) vegetation clearance was in evidence and further destruction seemed set for the future (16). Tattersall noted that lemur abundance on the island had declined and could be expected to continue to do so (16). No details have been located about threats on the mainland.

CONSERVATION MEASURES Legally protected in Madagascar and the Comores. On the Comores local customs and existing legislation have combined to assure a reasonable level of protection (although the influx of refugees from Madagascar, many of whom are used to eating lemurs, may soon affect this) (16). Ultimately the establishment of adequately-wardened forest reserves will probably be the only way of assuring the eventual survival of the Comoro lemurs. Tattersall, in 1975, noted that legal restraints also existed in the Comoro's against the destruction of vegetation within 15 metres of a watercourse. Enforcement of such a law he felt would probably ensure an adequate habitat for the lemurs, and would certainly do so if the limit were doubled to 30 metres. However in many areas forest had already been destroyed right up to the water's edge, with the result that many streams which formerly ran throughout the year were now only seasonal. Protection of the forests, especially the humid forests of the Ndzouani highlands, was thus essential for economic as well as conservation interests (13). Similar habitat protection was required on the mainland. The species occurs in Natural Reserve 7 (Ankarafantsika) (6,9,18), protection of the reserve needs to be improved. The species has been studied in the wild (1,2,10,11,12,13,14,16,17).

All species of Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1984 there were at least 45 males and 40 females held in 26 collections, most presumed captive bred (4). Long term prospects for captive breeding have been considered poor: although animals breed well in captivity for a short time after capture, progressive sterility sets in, perhaps related to weight gain (8); however Wright noted in 1986 that the species was breeding relatively well by then at Duke University Primate Center, U.S.A., which held 24 individuals at that time (18).

REMARKS For description of animal see (3,5,7,15). This species was in the past thought to have two subspecies: *L. m. mongoz* and *L. m. coronatus*. However *L. m. coronatus* has since been elevated to species status.

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RED-BELLIED LEMUR

Lemur rubriventer I. Geoffroy, 1850 Primates: Lemuridae

SUMMARY Endemic to the eastern forests of Madagascar, large areas of which are disappearing because of shifting agriculture and logging. It appears to be generally scarce, though has been found to be locally abundant. Protected by law and occurs in at least 3 reserves. A brief ecological study has been carried out. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Madagascar. Appears to occur, if only sparsely, throughout the mid-altitude eastern forest, from the Tsaratanana Massif in the north, at least as far south as Ivohibé at the southern end of the Andringitra Massif (6). It has recently been recorded in the Zahamena Reserve (ca 17°30'S, 49°00'E), at Périnet (18°30'S, 48°20'E) and in the region of Fianarantsoa, around Ranomafana (21°16', 47°28'E) and at Kianjavato due east of this (7). According to Tattersall there is no reliable basis for reports that it occurs, or at least occurred, in western Madagascar (6). For map see (6).

POPULATION No overall estimates are available; although generally regarded as scarce, it is evidently not uncommon in some areas, such as the south-east, and can be locally abundant, as at Ranomafana where densities of 40 per sq. km were recorded in 1986 (7). Wright has assessed its overall status as vulnerable (7) and it is generally assumed to be declining, along with virtually all other lemurs (5).

HABITAT AND ECOLOGY The species is relatively little known; it appears to be confined to forests at medium to high altitudes (6) and is generally found in the forest canopy (4), though has been recorded on the ground (2). A brief study carried out at Ranomafana during the austral winter found that during June the diet consisted entirely of fruit (95% ripe and unripe fruit of *Psidium cattleyanum*); during July, when fruit was scarce, diet consisted very largely (89%) of flowers, 7% of leaves and 4% of fruits (8). Group sizes of 7 groups censused ranged from 2 to 4, groups consisting either of adult male-female pairs with associated offspring or all male groups of 2-3 animals (8). Young of the year (apparently single) were 6-8 months old in August (7). Home ranges covered 12-15 ha (8). They lemurs showed a diel activity pattern, being active at night as well as during the day; the proportion of time spent active was inversely related to the availability of fruit (8).

THREATS Richard notes that no information is available on the overall status of the species, but since its preferred habitat is the canopy of primary forest then it must be suffering from the destruction of the eastern forests caused by shifting agriculture and logging (4); it is notable, however, that the study at Ranomafana (see above) found them to feed very largely, at least for part of the year, on fruits of the introduced guava *Psidium cattleyanum*, an invasive species of secondary forest formations.

CONSERVATION MEASURES Protected by law though difficult to enforce. Has been recorded in Natural Reserve 3 (Zahamena) and 4 (Tsaratanana) and the Special Reserve at Périnet (5).

All species of Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1986 there were at least 10 individuals in captivity: 1 male and 2 females at the Faculté of Medicine of Strasbourg, 2 animals in the Zoological Garden of Mulhouse, and 5 animals (including 2 pairs) at the Duke Primate Center, U.S.A. (1,7).

REMARKS For description of animal see (2,3,6).

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NB. The taxonomic status of the various populations of the widely distributed *Lepilemur* is highly complex (4). Recent classifications of the genus have ranged from a single species with five subspecies (3) to seven species, one with four subspecies (2). *Mammal Species of the World* by Honacki, Kinman and Koeppl (1982), which is here followed, recognises seven species of *Lepilemur* (*dorsalis, edwardsi, leucopus, microdon, mustelinus, ruficaudatus* and *septentrionalis*) (1). This follows the work of Rumpler and his co-workers who have carried out cytogenetic studies of six taxa (all the above except *microdon*) and shown them to be caryotypically distinct (5,6,7,8); these they regard as separate species, although it is noteworthy that there is also considerable caryotypic variation within *septentrionalis* (8).

Tattersall prefers at the present time to regard all sportive lemurs as belonging to a single species *L. mustelinus* with six subspecies (*mustelinus, ruficaudatus, dorsalis, leucopus, edwardsi,* and *septentrionalis*) (4). He notes that it is certain that a number of distinct populations of *Lepilemur* exist, but that it is not clear exactly how many or at what taxonomic level they should be separated. He further notes, however, that certain - possibly all - of these taxa may ultimately deserve to be assigned separate specific status, or that some may require subdivision while others may prove not to be distinct even at the subspecies level (4).

Some authors (4) place *Lepilemur* in its own family the Lepilemuridae along with *Hapalemur*; they are here retained in the Lemuridae, following (1).

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RED-TAILED SPORTIVE LEMUR

Lepilemur ruficaudatus A. Grandidier, 1867 Primates: Lemuridae

SUMMARY Endemic to western Madagascar. Reported to have been numerous at one time but by the early 1970s was seriously depleted. No recent data on status have been located. Main threat was, and undoubtedly still is, habitat loss, although in 1972 over-hunting was considered to be possibly a contributory factor. Legally protected and occurs in Analabe private reserve. A survey is needed to assess current status of existing populations and to recommend appropriate conservation measures, if needed. Has been maintained and bred in captivity though, none are in captivity at the present time. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Malagasy Republic where it occurs in the western forests. Limits of range are ill defined. Southwards it reaches at least as far as the Onilahy River. In the north the boundary with *Lepilemur edwardsi* (if the two taxa are in fact distinct) appears to be the Tsiribihina River (10). In 1972 Petter reported that due to forest destruction the species' range had become more and more restricted and discontinuous (4,7). For map see (10).

POPULATION No estimate of numbers exists; however it is believed to have seriously declined (4,7).

HABITAT AND ECOLOGY Inhabits the dry, deciduous forests of the west. A nocturnal forest dweller sheltering by day in hollow tree trunks (2,4,7). Petter reported that it can occur in great concentrations in the better protected forests (4,7). A study of its feeding habits in the Marosalaza Forest near Beroboka found that leaves were its staple food, augmented in the summer with the seeds of fruits, especially those of *Diospyros* spp. (2). The females produce a single young in about September; pregnant animals have been collected in June, August, and September and new born young in October (4,7). Gestation is 4-5 months (4).

THREATS In 1972 Petter reported the main threat to be habitat destruction, although he thought over-hunting might be a contributory factor (4,7). Throughout western Madagascar forests are rapidly disappearing as a consequence of repeated forest fires and excessive and often illegal exploitation. The animals are also reported to be sought after by woodcutters who relish their flesh (4,7).

CONSERVATION MEASURES Legally protected but this is difficult to enforce. Occurs in Analabe private reserve (4,7). Surveys are needed to determine current status and to recommend conservation action, if needed. A captive breeding programme should be initiated.

All species in the family Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora; trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING Although none are reported to occur in zoological gardens (5), captive specimens have been held at Brunoy and a birth did occur (2).

REMARKS For description of animal see (6,9,10). The species has in the past been regarded as a subspecies of *Lepilemur mustelinus* and was so treated in the 1972 Red Data Book (4).

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GRAY-BACKED or NOSY BE SPORTIVE LEMUR

Lepilemur dorsalis Gray,1870 Primates: Lemuridae

SUMMARY Endemic to Madagascar where it inhabits the Sambirano region of the north-west and Nosy Bé Island. Threatened by loss of habitat, the Sambirano region being especially suited to plantations of sugarcane, as well as cocoa and vanilla. Protected by law and occurs in Lokobé Natural Reserve; protection of the reserve needs strengthening. None in captivity at the present time and a captive breeding programme should be intitiated. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Madagascar, where confined to the eastern forests of Nosy Bé off the north-west coast, and to the mainland facing the island (the coastal region of High Sambirano) (6,7,10). For map see (10).

POPULATION Present status unknown. In 1972 Petter considered the species to be 'Rare' and reported that numbers were very limited (3,7). His remarks however were confined to the island population since at the time the species's presence on the mainland had not been confirmed (3).

HABITAT AND ECOLOGY Seasonally humid 'Sambirano' forests. Nocturnal; spends the day rolled in a ball asleep in the fork of a tree (1,6). Solitary and maintains a small home range (1). Feeds on leaves, fruit and bark (6). The female has a single young born between September and November (6).

THREATS Main threat is habitat destruction as forests are cleared for settlement, agriculture and shifting cultivation. The Sambirano area is ideally suited to crop cultivation - cocoa, coffee, vanilla, ylang-ylang plantations, and especially sugarcane (1). The coastal forests have long been colonized and exploited and the greater part has been destroyed; the remainder is patchy in distribution (4). In 1972 Petter reported that some animals were caught by fishermen and sold (7).

CONSERVATION MEASURES Legally protected, although this is not enforced. Occurs in Natural Reserve 6 - (Lokobe); protection of the reserve needs to be strengthened. The *Lepilemurs* are most numerous along the edeges of the reserve and are therefore particularly vulnerable to human incursions at the perimeter (7). Surveys are needed to determine current status and to suggest appropriate conservation measures, if needed. A captive breeding programme is required.

All species in the family Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING None in captivity at the present time (5). The animal is difficult to maintain in captivity; one birth has been recorded at Parc Tsimbazaza in Antananarivo (7).

REMARKS For description of animal see (6,9,10). This species has in the past been considered a subspecies of *Lepilemur mustelinus* and was so treated in the 1972 Red Data Book (3).

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WHITE-FOOTED SPORTIVE LEMUR

Lepilemur leucopus Forsyth Major in Forbes, 1894 Primates: Lemuridae

SUMMARY Endemic to southern Madagascar. Believed to be declining because of habitat loss, but can be locally very abundant. Adapted to the very dry regions of the south - a habitat that is being destroyed. Protected by law and occurs in several protected areas. Surveys of its current range are needed. None is in captivity and a breeding programme is recommended. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Madagascar, where it occurs in the dry forests of the south from Taolanaro westward at least to Ejeda, and possibly to the Onilahy River (1,3,12). For map see (12).

POPULATION No surveys have been undertaken, however the species is considered to be declining in number because of loss of habitat, although in some areas, as at Berenty, it is locally abundant (13). In 1972 considered 'Endangered' by Petter (5,8).

HABITAT AND ECOLOGY The species mostly frequents the xerophytic southern thorn forest, characterised by plants of the endemic family Didiereaceae, but can also be found in the remnant gallery forests which grow along the rivers (1,5,11). Essentially nocturnal (1,2,11,12), resting during the day in tree hollows or thick vine cover. Social organization possibly centres around long-term bonds formed between related females. The animals live in very small territories, usually less than 0.36 ha (1,2,12). Lepilemurs in general are almost exclusively folivorous and are highly specialized in various anatomical and physiological features. Observations at Berenty showed that the leaves and flowers of the tall, spiny *Alluaudia procera* and *A. ascendens* made up the bulk of the diet, with the leaves of four other species and the green fruit of another composing the remainder (1,2,12).

THREATS Its habitat is being destroyed by poor land use, fire, cattle and goats. The increasing degradation of the plant cover and its effects (erosion and lowering of the water table) endangers the whole of southern Madagascar. The Didiereaceae forest does not regenerate after certain crops such as sisal have been grown on the land (5,8).

CONSERVATION MEASURES Protected by law although difficult to enforce. Known to occur in Natural Reserve 11 (Andohahela), the Special Reserve of Beza Mahafaly and in Berenty private reserve; it also probably occurs in Natural Reserve 10 (Tsimanampetsotsa) (1,2,11,12,13). Also exists in the Mahafaly Tomb area near Evasy, south of Ampanihy where, for religious reasons that are still fairly strictly observed, the vegetation is for the most part protected (5,8). In 1972 Petter suggested that it might be possible to take advantage of the taboo to create a protected area which would be acceptable to the local people. Such a reserve would also protect *Propithecus verreauxi.* The future of this animal is dependent on the survival of representative areas of the southern thorn forest. Extension of the areas protected in the south is essential to the survival of this habitat and its wildlife.

The species has been the subject of ecological studies at Berenty (1,2,11). Surveys are needed to determine current status and to suggest appropriate conservation action, if needed. A captive breeding programme should be initiated.

All species in the family Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora; trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING None recorded in captivity at the present time (6).

REMARKS For description of animal see (7,10,12). This animal has in the past been considered a subspecies of *Lepilemur mustelinus* and was so treated in the 1972 Red Data Book (5).

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WEASEL or SPORTIVE LEMUR

Lepilemur mustelinus I. Geoffroy, 1851 Primates: Lemuridae

SUMMARY Endemic to eastern Madagascar. Status unknown and surveys are required to determine whether conservation action is needed. Protected by law and probably occurs in several reserves. None in captivity and a captive breeding programme should be initiated. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Malagasy Republic where it occurs in the northern part of the eastern forests between Tamatave and Antalaha (1,3). A single early collecting record suggests that *mustelinus* formerly ranged north just beyond the limits of the humid forest, to the area of Vohémar (6); however, no *L. mustelinus* were encountered in searches north of the Lokoho River, south of Sambana (7).

POPULATION No data located regarding numbers or status.

HABITAT AND ECOLOGY The forests of the east are dense and humid. The species has not been studied so virtually no data exist regarding ecology.

THREATS No data located but presumably habitat loss may be a threat.

CONSERVATION MEASURES Protected by law although difficult to enforce. This *Lepilemur* is probably the one which occurs in Natural Reserves 1 (Betampona) and 3 (Zahamena). The species has not yet been studied. Surveys are needed to determine current status and to suggest appropriate conservation measures, if needed. A captive breeding programme should be initiated.

All species in the family Lemuridae are listed on Appendix I of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING None recorded in captivity (2).

REMARKS For description of animal see (3,5,6).

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MICRODON SPORTIVE LEMUR

Lepilemur microdon Forsyth Major in Forbes, 1894 Primates: Lemuridae

SUMMARY Endemic to eastern Madagascar. Status unknown and surveys are required to determine whether conservation action is needed. Protected by law and probably occurs in several reserves. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Malagasy Republic where it occurs in the southern part of the eastern forests (3), from Périnet to Taolanaro (1).

POPULATION No information located on overall status; densities of 2 individuals per ha have been recorded at Périnet-Analamazoatra (7).

HABITAT AND ECOLOGY Eastern forests. No information located on ecology.

THREATS No information located, although presumably habitat loss could be a threat.

CONSERVATION MEASURES Protected by law although difficult to enforce. *Lepilemur microdon* occurs in the Special Reserve at Périnet and in Natural Reserve No.11 (Andohahela); its range also includes Natural Reserve No.5 (Andringitra). Has not been studied. Surveys are needed to determine any necessary conservation action.

All species of Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora; trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING None recorded in captivity (2).

REMARKS For description of animal see (3,4).

Tattersall regards *microdon* as a synonym of *mustelinus* (7).

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NORTHERN SPORTIVE LEMUR

Lepilemur septentrionalis Rumpler & Albignac, 1975 Primates: Lemuridae

SUMMARY Endemic to Madagascar where it occurs in the extreme north. Status unknown and surveys are required to determine whether conservation action is needed. Protected by law and probably occurs in Mt d'Ambre National Park. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Malagasy Republic where it occurs in the extreme north, north of Ambilobé and Route National 5A, and to the south and east of Mt d'Ambre (8). For map see (7,8,10).

POPULATION No information located on numbers or status.

HABITAT AND ECOLOGY *Lepilemur* spp. are generally nocturnal folivores (1,6,8); *L. septentrionalis* has been found resting in holes in trees during the day (10).

THREATS No data located but presumably habitat loss could be a threat.

CONSERVATION MEASURES Protected by law although difficult to enforce. Its range includes Mt d'Ambre National Park. Information is needed on current status, as the basis for a conservation plan, if needed.

All species of Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING None recorded in captivity (4).

REMARKS For description of animal see (6,7,8,9).

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MILNE-EDWARD'S SPORTIVE LEMUR

Lepilemur edwardsi Forsyth Major in Forbes, 1894 Primates: Lemuridae

SUMMARY Endemic to western Madagascar. Status unknown and surveys are required to determine whether conservation action is needed. Protected by law and probably occurs in several reserves. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Malagasy Republic where it occurs in the west from the Bay of Mahajamba south at least as far as Antsalova and possibly to the Tsiribihina River (5). For map see (5).

POPULATION No data located on numbers or status.

HABITAT AND ECOLOGY Occurs in dry deciduous forest at Ampijoroa (6).

THREATS No data located but the species's range is without doubt contracting through habitat loss; it is also likely to be hunted for food (7).

CONSERVATION MEASURES Protected by law although difficult to enforce. Known to occur in Natural Reserve 7 (Ankarafantsika), and Natural Reserves 8 (Namoroka) and 9 (Bemaraha) are within its range. The species has not yet been studied. Surveys are needed to determine current status and to suggest appropriate conservation measures.

All species of Lemuridae are listed on Appendix 1 of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora; trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING None recorded in captivity (2).

REMARKS For description of animal see (3,5). This taxon is similar in appearance to *Lepilemur ruficaudatus* from which it may not in fact deserve distinction. In general, however, individuals of *edwardsi* may tend to be a little darker in coloration than those of *ruficaudatus* (5).

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RUFFED LEMUR

Varecia variegata (Kerr, 1792) Primates: Lemuridae

SUMMARY Endemic to the eastern humid forests of Madagascar. Two subspecies are recognised and both appear seriously threatened because of forest destruction. The nominate subspecies comprises four distinct varieties and if these prove to be valid subspecies then each is highly endangered. Surveys are needed to determine current status and distribution and to suggest appropriate conservation action. Protected by law, occurs in a number of protected areas and breeds well in captivity. Listed in Appendix 1 of CITES, and Class A of the African Convention.

DISTRIBUTION Malagasy Republic where it occurs in the eastern forests. Tattersall provisionally recognises two subspecies: a northern one *V. v. rubra* and a southern one *V. v. variegata.* The latter, however, exhibits at least four distinct and consistent coat patterns, and better knowledge of the distributions of these varieties might ultimately suggest their recognition as distinct subspecies (14). The distribution of *V. v. variegata*, the Black and White Ruffed Lemur, is very poorly documented and the question of the allopatry or otherwise of the various types described is not resolved. The subspecies is found throughout most of the remaining humid forest of the eastern strip, from somewhere north and west of Maroantsetra, where the River Antainambalana seems to separate it from *V. v. rubra*, to a point south of Farafangana but north of the Mananara River, which flows south-east to meet the sea at Vangaindrano (14). It also occurs on Nosy Mangabe in the Antongil Bay (7) where it is thought to have been introduced (15,21). *V. v. rubra*, the Red-ruffed Lemur, is confined to the Masoala Peninsula, to the east of the River Antainambalana. It is particularly rare in the north of this range and may already be extinct north of Cap Est (14). For map see (14).

POPULATION Tattersall (1982) implied that *V. v. variegata* was disappearing at a very rapid rate and he reported that *V. v. rubra* was very rare throughout its range and possibly extinct in the north of it (14). If the four varieties of *V. v. variegata* prove to be distinct subspecies then each is almost certainly highly endangered (21).

HABITAT AND ECOLOGY The eastern humid forests. Little known about this species since it remains virtually unstudied in the wild. Certainly active during the daytime and is heard to vocalize at night (14). Appears to live in pair-bonded units; groups of more than three individuals have only rarely been reported, and Petter *et al* (1977) suggest that the relatively rapid development of young Ruffed Lemurs allows them to leave their parents at the end of their first year (11,14). The uniformly small size of counts of *Varecia* groups is somewhat surprising in view of the marked tendency towards multiple births in this lemur; one possibility is that a relatively high level of infant mortality is associated with the 'parking' of infants (10,14), i.e. the species builds nests in which it leaves young infants, older infants may be carried in the mouth and parked on a branch (5). Gestation is 102-103 days (4). Few observations have been made on feeding but it has been suggested that the species is frugivorous (4,11,14); indeed Pollock has observed the species feeding on fruit (12).

THREATS No specific information located but undoubtedly forest loss is a factor threatening this species's survival.

CONSERVATION MEASURES Protected by law although difficult to enforce. Occurs in Natural Reserve 1 (Betampona), 3 (Zahamena), 5 (Andringitra) and the Special Reserve of Nosy Mangabe (13,14), where Mittermeier observed in 1984 that it was abundant on the island (7). The species has not been studied in the wild although it has been studied in captivity (1,2,3,4,6). Surveys are needed to determine what conservation action is required.

All species of the family Lemuridae are included in Appendix I of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, trade in them or their products between acceding nations is therefore subject to strict regulation and trade for primarily commercial purposes is banned.

All Lemuroidae are listed in Class A of the African Convention, 1969, i.e., they may be hunted, killed, captured or collected only on the authorization of the highest competent authority, if required in the national interest or for scientific purposes.

CAPTIVE BREEDING In 1984 at least 223 males, 172 females and 4 of undetermined sex were held in 61 zoological collections (most captive bred). The studbook is maintained by Diane Brockman at the Zoological Society of San Diego (POB 551, San Diego, California 92112, U.S.A.) (8). There has been much research on the reproductive biology of captive *Varecia* (e.g. 16,17,18). Some concern has been expressed over inbreeding in *V. v. ruber*: living Red Ruffed Lemurs trace their ancestry to seven wild-caught individuals and their contributions are quite unequal. However, as yet there is no evidence for fitness depression associated with inbreeding (20).

REMARKS For description of animal see (9,11,14). The species is frequently described as *Lemur variegatus*.

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APPENDIX 3.C. REPTILES

Full data sheets for the following endemic chelonian species are provided, being slightly modified versions of those in Groombridge, B. (1982). *The IUCN Amphibia - Reptilia Red Data Book. Part 1. Testudines, Crocodylia and Rhynchocephalia.* IUCN, Gland.

- V *Geochelone radiata*
- E *Geochelone yniphora*
- I *Pyxis planicauda*
- I *Pyxis arachnoides*
- I *Erymnochelys madagascariensis*

In addition, brief summaries for the following species have been taken from the same source (where full reference lists will be found).

- E *Eretmochelys imbricata*
- E *Chelonia mydas*
- E *Lepidochelys olivacea*
- V *Caretta caretta*
- V *Crocodylus niloticus*

PART I. ENDEMIC CHELONIAN SPECIES

RADIATED TORTOISE or SOKAKE — VULNERABLE

Geochelone radiata (Shaw 1802) — Testudines: Testudinidae

(synonyms: *Testudo radiata, Asterochelys radiata*)

SUMMARY A large terrestrial species with a very attractive 'starred' pattern, endemic to Madagascar. Restricted to xerophytic *Didierea* forest with associated thornbush and grasses, in the arid south and southwest extremity of Madagascar. Remains relatively common (1974 survey) in the more inaccessible areas of the Mahafaly and Karimbola Plateaus, but severely depleted or eliminated in the east and west of the range. Large numbers were exported to the Mascarene Islands for food during the 18th and 19th centuries. There is significant current exploitation for food, pets, varnished shell curios, and also the live animal trade, although the latter has declined substantially as a result of trade controls. Survival prospects for *G. radiata* may be adequate providing substantial portions of the range remain free of heavy exploitation and habitat destruction. Present in the Natural Reserve of Lake Tsimanampetsotsa. Protected by Malagasy law, export is restricted. Listed on CITES Appendix 1. Further field research into basic biology and the impact of current exploitation is required.

DISTRIBUTION An endemic Madagascar species. Restricted to the *Didierea* forest occurring in a narrow arc across southern Madagascar, *G. radiata* has been recorded from near Amboasary in the southeast to near Morombe on the southwest coast (9).

POPULATION Relatively common in 1974 (9) in the more inaccessible areas of the Mahafaly and Karimbola Plateaus, forming the present core of the range, but severely depleted in or eliminated from the extremities of the range, in the vicinity of Taolanaro (=Fort Dauphin) in the east, and Toliara (= Tuléar) and Morombe in the west (9). A relatively high density has been recorded along National Route 10 where it penetrates into prime *radiata* habitat; after heavy rain (when tortoise activity is most apparent) one tortoise may be encountered per kilometre of road. The species has been subject to heavy collection in this area for several years, suggesting that population densities may be satisfactory in more inaccessible areas (9). The species still appears to maintain good numbers south of the Onilahy River, in the territory of the Mahafaly and Antandroy (18).

Although populations are reported to be declining (2), at least locally (8), the short-term prospects for the survival of *G. radiata* may be adequate insofar as significant portions of the present range remain relatively free of heavy exploitation or habitat destruction (9, 1974 data).

HABITAT AND ECOLOGY A large terrestrial species, reaching around 15 inches (38cms) carapace length, and 28lbs (13kg) weight (14). Restricted to xerophytic forests of the cactus-like *Didierea* in the arid south and southwestern extremity of Madagascar, with an erratic annual rainfall of less than 400mm. Within this forest type, *G. radiata* apparently prefers areas with low thornbush and grass cover, rather than dense thickets of *Didierea* itself (the former may offer better food resources) (9).

Most aspects of the biology of *G. radiata*, including feeding and reproductive ecology, remain largely unstudied in the wild. Probably the species feeds on fruit, grass and other green vegetation. In captivity, melon (14), *Opuntia* pads and fruit, and red items in particular (6) are favoured. It has been reported that, in the wild, a clutch of about 12 eggs is laid in September (13), but clutches of 3,4 and 6 are known in captivity (17). The eggs are almost spherical (36 to 42 mm in greatest diameter), and are laid in a flask-shaped nest six to eight inches (15 to 20cm) deep dug by the hind feet (17).

THREATS Depletion or extinction of *G. radiata* around the port towns of Toliara, Morombe and Taolanaro is largely attributed to heavy commercial exploitation during the 18th and 19th centuries when large numbers were shipped to the nearby Mascarene Islands, notably Réunion, for food. Present exploitation is for food or pets (occasionally kept with the village chickens in the belief that their presence will ward off poultry diseases), or commercial collecting (with resale as food, varnished shell curios, or for the live animal trade) (9). Although the two indigenous tribes in the range of *G. radiata* (the Antandroy and Mahafaly) do not eat tortoises (18), they are a favoured food item for people from other parts of Madagascar, generally coming into the area as government workers (3). People now travel by boat southward across the mouth of the Onilahy in order to collect *G. radiata* for food (18). Present protective legislation is only weakly enforced although it is widely known that *radiata* is protected, the species can still be ordered secretly in many restaurants in the south (3). Prepared tortoise shells can be seen everywhere in Toliara (3), there has been a lively trade in tortoise carapaces at Tananarive market (11). In Toliara in 1976 an adult specimen could be bought for 100 Fmg (US$ 0.5), or less than the price of a chicken (18). Vehicles often stop along the National Route 10, connecting Taolanaro (Fort Dauphin) and Toliara (Tuléar) to allow passengers to collect tortoises seen on the road (9). There seems to be no regular large-scale collection (9), although heaps of carapaces from tortoises used for food may be seen from time to time (18). The species has also suffered from habitat destruction (4).

CONSERVATION MEASURES TAKEN The aridity and harshness of the habitat, and the sparsity of the human population, have afforded *G. radiata* a significant degree of protection. Furthermore, the indigenous Antandroy and Mahafaly tribespeople consider the species sacred and are inhibited from eating it by a traditional taboo (*fady*) (9).

The species is present in the Lake Tsimanampetsotsa Natural Reserve in the Mahafaly Plateau (1) and in the Beza Mahafaly Special Reserve, and is protected under Decree No.61.096 of July 13, 1961 (infringements punishable by fine or imprisonment) (8). Export of live or preserved *G. radiata* is restricted, an export tax of Fmg 20 000 is levied on each specimen (18). Listed under Category 'A' of the 1968 African Conservation Convention (8).

Listed on Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Appendix I listing requires that trade in the taxon and its products is subject to strict regulation by ratifying states and international trade for primarily commercial purposes is prohibited.

Trade controls appear to have resulted in a substantial decline in numbers of *G. radiata* leaving Madagascar (9), this now occurs only exceptionally (18) and there is apparently no traffic through the capital Antananarivo (18).

CONSERVATION MEASURES PROPOSED Field research on the biology and population status of *G. radiata* is necessary. The impact of present exploitation requires evaluation. Existing conservation laws could be more rigidly enforced.

CAPTIVE BREEDING Numerous specimens are present in various collections (8). Breeding has occurred on several occasions, in zoos in Cairo, Mauritius, Sydney, Zurich (7), also Colorado, Florida, and Texas in the U.S.A., but rarely with amateur collectors. Notably, *G. radiata* has been bred regularly since 1973 at the Gladys Porter Zoo, Brownsville, Texas (6). A 22 per cent fertility rate resulted from 110 eggs laid by one pair (over several years) (6).

REMARKS The Radiated Tortoise *Geochelone radiata* is widely regarded as extremely beautiful, by virtue of its large size and prominent black and yellow 'starred' pattern (6,9,14). The species figures on a Fmg 20 airmail stamp of the Malagasy Democratic Republic.

G. radiata is probably the nearest relative of the endangered Angonoka *G. yniphora*, of northwest Madagascar; the range of their hypothesized common ancestor in generally xeric regions may have been split into southern and northwest enclaves as more mesic conditions spread after a Pleistocene arid phase (10).

There are several groups comprising many adult specimens introduced on Reunion, where breeding occurs with some regularity; the young are sold as pets (150 FF, £15), adults are very occasionally eaten (18).

The celebrated Tonga tortoise, 'Tu'i Malila', has been identified as a specimen of *G. radiata* with the starred pattern obscured by age. There is considerable doubt (15) about the story that this tortoise was presented to a Tongan chief by Captain Cook in 1773 or 1777. It was present from at least the 1880s and died in 1966 (17).

Until quite recently (12,14) this species, with many others, had been assigned to the genus *Testudo*, this usage is maintained by some authorities (16). The species has also recently (5) been assigned to the genus *Asterochelys*, this usage is not yet widespread. This account is based mainly on information very kindly provided by J. Andrianarivo, C. Blanc, R. Bour and J. Juvik.

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ANGONOKA **ENDANGERED**

Geochelone yniphora (Vaillant 1885) Testudines: Testudinidae

(synonyms: *Testudo yniphora, Asterochelys yniphora*)

SUMMARY A large terrestrial species, endemic to Madagascar, and restricted to a very small area around Baly Bay in the northwest. Extremely rare and in imminent danger of extinction. Maximum density is not likely to exceed five individuals per square kilometre, and the total species population, within the area of suitable habitat of less than 100 km^2, may be only a few hundred individuals. The species prefers habitat comprising 'islands' of xeric scrub forest, such as thickets of *Terminalia* and bamboo *Nastus*, in exposed rocky or coastal areas, or in anthropogenic savanna-grassland. Herbivorous. *Terminalia-Nastus* thickets provide shelter during dry season inactivity (May-October), at night, and the hotter parts of the day. No data on reproductive ecology. Threatened by commercial and subsistence exploitation, habitat modification, and predation by feral pigs. Present exploitation for food or pets does not appear of major significance, but the species was exported for food to the Comoro Islands in large numbers, from the 17th to late 19th centuries. Protected by Malagasy law, export is restricted. Listed on CITES Appendix I. Strict protection of natural habitat is essential, Cape Sada provides a suitable reserve area. Further field research into basic biology is required.

DISTRIBUTION An endemic Madagascar species. Largely restricted to three 'islands' of forest within an area of about 60 km by 25 km in the vicinity of Baly Bay (including Cape Sada) in northwest Madagascar (3,4,10,11).

POPULATION *Geochelone yniphora* is exceedingly rare and considered to be in imminent danger of extinction (4). During approximately 375 hours spent in directly searching for *G. yniphora*, over a five-year period between 1971 and 1976, only five specimens were encountered in the wild. These comprise four found at Cape Sada in the wet season, and one near Ankoro on the opposite (west) side of Baly Bay, in addition, fresh tortoise droppings were found at two other localities east of Cape Sada. These findings represent one tortoise sighting per 75 man-hours in the field. This contrasts with one per eight hours reported for another Madagascar endemic *G. radiata* (1). It is estimated that density of *G. yniphora* is unlikely to exceed five individuals per square kilometre, even in the optimum scrub forest habitats. With less than 100km^2 of suitable habitat remaining within the species known range, this suggests a total possible species population of only a few hundred individuals (4). However, some recruitment is still occurring since, of the four Cape Sada specimens, one was a juvenile and one intermediate between juvenile and adult sizes (4). One recent estimate is that only 10-20 individuals remain (9). However, specimens are extremely well-camouflaged despite their size, suggesting that some individuals may be overlooked (10). A 1983 expedition also considered that the wild population was likely to lie between 100 and 400 individuals, along with some 50 in captivity in villages in the area (14).

HABITAT AND ECOLOGY A large terrestrial species (to around 45 cm carapace length, or 70 cm if measured over the dome), preferring mixed habitat, comprising 'islands' of xeric scrub forest within anthropogenic savanna-grassland or exposed rocky or coastal areas. The natural climax vegetation in much of the region is tropical deciduous forest, including such species as *Erythrophleum couminga*, *Terminalia bovinii* and *Acridocarpus excelsus*, frequently with an understory of bamboo *Nastus* spp. In the Baly Bay area this formation is frequently degraded to scrub forest or grassland by annual burning by local inhabitants, intended to promote herbaceous growth for grazing of cattle.

Both the natural closed-canopy deciduous forest, with scarcity of herbaceous tortoise food plants, and the anthropogenic grasslands, with the danger of fires, are avoided by *G. yniphora*. The favoured mixed habitats appear to combine open herbaceous zones for foraging and dense thickets for protection and concealment. Such mixed habitats comprise only a small proportion of the vegetation of the Baly Bay area (4).

Precipitation at Soalala, on the southeast of Baly Bay, is strongly seasonal, with over 90 per cent of the mean annual rainfall of 1231 mm occurring from December to March. The soil appears to have a low moisture storage capacity, much of the year's rainfall is lost as runoff and there is a moisture deficit during most of the dry season (May-October). (4).

The species is entirely herbivorous. Droppings collected from two adult tortoises at Cape Sada contained 90 per cent (volume) leaves of the leguminous shrub *Bauhinia* cf. *pervillei*, generally swallowed whole, with the remainder consisting of the grass *Heteropogon contortus* (bitten off in 2 cm lengths). A sample from another individual contained 95 per cent leaves of *Foetidia retusa* and *Erythrophleum couminga*, with 5 per cent sedges and grasses. One immature female at Cape Sada was observed feeding on newly-emerged shoots of *Pycreus mundtii* in open rocky terrain, droppings from this individual contained equal amounts of *Pycreus* and *H. contortus* (4).

Geochelone yniphora appears to be largely inactive during the dry season (May-October), when it shelters amid surface litter in *Terminalia-Nastus* thickets. The dry season is also the season of lowest temperatures (mean low in coldest months, June and July, 24°C; mean high in hottest month, December, 33°C). Seasonal growth differences are apparently reflected in the well-marked growth rings on the carapace scutes. Specimens were encountered actively foraging only in the morning (0800-1000h) and late afternoon (after 1600h), with surface temperatures below 45°C. Shelter is sought in *Terminalia-Nastus* thickets during the night and the middle of the day (4).

No data are available on reproductive biology of wild populations. See under Captive Breeding for observations of reproductive behaviour in captive individuals.

THREATS The endangered status of *G. yniphora* is attributable to commercial and subsistence exploitation, habitat modification, and predation by feral pigs (4,10,11). The species is further at risk by virtue of its extremely restricted range, and the reduced chances of contact between remaining isolated individuals.

From at least the 17th century, Arab traders collected large numbers of this species at Soalala for export to the nearby Comoro Islands as a food source (the first specimens known to science were obtained in the Comoros) (4). This trade extended into the late 19th century, but around Soalala at this time the species could still be readily collected using trained dogs (4). The indigenous people of the Baly Bay area regard *G. yniphora* as taboo (*fady*) and do not eat it, although other ethnic groups may sometimes do so. The species is occasionally kept locally as a pet (often with the village chickens, in the belief that it will ward off poultry diseases by eating the chicken droppings). Current commercial exploitation for food or the live animal trade does not appear to be a major factor in the species's decline (4). A specimen was offered in Soalala in 1974 for 20 000 Fmg (£40) (10).

The expansion of savanna grassland at the expense of dry tropical forest, produced by intentional annual burning to promote fresh herbage for cattle grazing, may have contributed to range contraction in the past and is a significant threat to remaining *G. yniphora*.

A recent decision to develop major iron ore reserves in the Soalala area can be expected to have a significant impact on the environmental and economic structure of the region (4). The possible development of the beach at Cape Sada and extension of agricultural usage north of Cape d'Amparafaka are potential threats (10). Citation of predation by feral pigs as a threat rests on circumstantial evidence. Feral pigs are known to have a substantial impact on Galapagos Giant Tortoise *Geochelone elephantopus*, and in *G. yniphora* habitat around Baly Bay, pig trails and rooting activities are evident everywhere (4).

CONSERVATION MEASURES TAKEN The species is protected by Malagasy law, and is protected from local use as food by a taboo (*fady*) maintained by the indigenous people. Listed under Category 'A' of the 1968 African Conservation Convention.

In 1986 a captive colony of *G. yniphora* held by the Madagascan Government on the east coast, near Toamasina, an area considered too humid for the species, was relocated to the Ampijoroa Forest Station, adjacent to the Ankarafantsika Natural Reserve, in an attempt to establish a breeding group (16). This area is relatively near Baly Bay and has very similar climatic conditions.

Listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Appendix I listing requires that trade in the taxon and its products is subject to strict regulation by ratifying states, and international trade for primarily commercial purposes is prohibited.

CONSERVATION MEASURES PROPOSED Survival of *G. yniphora* in the wild is critically dependent on preservation of suitable natural habitat in the Baly Bay area (4). The Cape Sada peninsula has been proposed as the optimum site (2), combining presence of tortoises, absence of people, lack of agricultural or pastoral importance, suitable habitat including fire-resistant vegetation, and ease of protection. Tortoises held by local inhabitants could be moved to such a reserve, which should be adequately guarded. Eggs and young should be protected from feral pig predation (2). Existing laws should be enforced. International support and local interest (see 11) is essential in the realisation of such aims (4).

The IUCN/SSC Tortoise Specialist Group plans a highest priority project on conservation of *G. yniphora*. Field research on the biology of the species is required, following immediate implementation of conservation action.

CAPTIVE BREEDING As of late 1986, a captive breeding group was in the process of being established at Ampijoroa Forest Station, adjacent to the Ankarafantsika Natural Reserve south-east of Mahajanga (see above). In 1971 Honolulu Zoo established a captive colony with six individuals (2 males, 4 females), two of which were wild-caught specimens and four village captives (4,5,12). In 1973 a further three individuals were obtained (2 males, 1 female). Two of these were deposited with the San Antonio Zoo and the third in the private collection of W. Zovickian, New York Zoological Society. Since then three individuals (2 males, 1 female) have died. In 1981 one male and three females, including one female on loan from the San Antonio Zoo, were held at Honolulu, and a pair, (the male on loan from San Antonio) were with Zovickian (12). In 1983 one young was successfully reared at Honolulu (14). Courtship behaviour is similar to that of the closely related *G. radiata* (see 13). One distinctive element sometimes seen is the repeated pushing of the male's enlarged epiplastral projection into the female's rear leg socket apparently to push or lift the female's shell. Since 1979 one female has laid several clutches. All eggs have been artifically incubated but none were fertile. Clutch size ranged from three to six eggs. Eggs were white, nearly spherical with a mean maximum diameter of 42-47 mm and weighed between 40.5 and 50 gm. Flask-shaped nest holes were excavated in moist soil, to an average depth of 11.1 cm and with average basal width of 11.6cm. Nesting typically took place in early morning. Sometimes several 'test holes' were started before the final nest was constructed. Current research is directed towards investigating the fertility of the male in the colony. The closely related *G. radiata* has been successfully bred in captivity and this may give cause for optimism with regard to the breeding of *G. yniphora* (12). In 1983 there were also reportedly 3 females at Pietermaritzburg in South Africa and 1 female at Tokuyama, Japan (14).

REMARKS *Geochelone yniphora* is noteworthy for the median anterior horn-like projection of the plastron, formed by extension of the two epiplastrals and fused gular plates (seen to a lesser extent in the South African Bowsprit Tortoise *Chersina angulata*) (5).

G. yniphora is probably the nearest relative of the vulnerable Radiated Tortoise *G. radiata*, of southern Madagascar; the range of their hypothesized common ancestor in generally xeric regions may have been split into northwest and southern enclaves as more mesic conditions spread after a Pleistocene arid phase (4).

Until quite recently (6,7) this species, with many others, had been assigned to the genus *Testudo*, this usage is maintained by some authorities (8). The species has also recently (3) been assigned to the genus *Asterochelys*, this usage is not yet widespread. This account is based on information kindly supplied by A.J. Andrianarivo, C. Blanc, R. Bour and J. Juvik.

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MADAGASCAR FLAT-TAILED TORTOISE or KAPIDOLO **INDETERMINATE**

Pyxis planicauda (Grandidier 1867) Testudines: Testudinidae

(Synonym: *Acinixys planicauda*)

SUMMARY A very small terrestrial species, endemic to Madagascar. Restricted to the Andranomena forest, an area of approximately 100 sq. km near Morondava on the central-west coast of the island. No precise population estimate available, but reported to be declining due

to habitat destruction, and currently restricted to a very small area largely surrounded by unsuitable habitat modified for agriculture; at least part of its remaining habitat is included in the Analabe Private Reserve. Aestivates underground during long dry season. Clutch comprises a single large egg, number of clutches per year unknown. Biology and status poorly known and require urgent investigation. Listed on CITES Appendix II.

DISTRIBUTION An endemic Madagascar species. Apparently restricted to the Andranomena forest, an area of approximately 100 sq. km situated 20 km northeast of Morondava on the central-west coast of Madagascar. Records outside this area are unconfirmed (3), the species may occur as far north as Maintirano (8) but no specimens have been found in apparently suitable forests around the Andranomena area (4).

POPULATION No precise estimates are available, but the species is restricted to a very small area, and is reported to be certainly threatened (2) and declining (1).

HABITAT AND ECOLOGY A very small (c 125 mm carapace length) terrestrial species, occurring in dry lowland deciduous forest and bush, relatively less arid than bush zones further south in the range of the related species *P. arachnoides*. Mean temperature in the coolest month is above 20°C, annual rainfall, restricted to a four or five month period, is between 600 and 800 mm. Numerous ponds are present in the Andranomena forest area (3). Virtually nothing is known of the biology of *P. planicauda*. The single egg is relatively large, 25-30 x 33-35 mm (3), and weighs 15-20 gm (7). Number of clutches per year unknown. The species aestivates underground during the long dry period (3).

THREATS Habitat destruction is cited as the cause of population decline (1). The present refuge of the species, the Andranomena forest, is largely surrounded by modified habitat and agricultural development. A vast area of cleared forest is devoted to a maize-growing scheme (3). Other remaining forest areas, although apparently suitable for *P. planicauda*, have not been found to hold the species (4). Bush-pig populations are increasing throughout Madagascar, and are considered a threat to tortoise eggs and young (10).

CONSERVATION MEASURES TAKEN The Andranomena area is privately owned, at least part of it comprises the Analabe private reserve (9).

Listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Appendix II listing implies that commercial trade is allowed providing a permit from the country of export is obtained, this can provide a method of monitoring trade levels.

CONSERVATION MEASURES PROPOSED Protection of remaining habitat should be maintained. Field study on the status and biology of *P. planicauda* is urgently required (3).

CAPTIVE BREEDING A pair have been maintained at Knoxville Zoo, Tennessee, since 1975, no eggs have yet been produced (April 1981) (8).

REMARKS This species has widely been treated as forming a separate monotypic genus *Acinixys* (5). Recent re-assessments (3,6,11) support treating *planicauda* as the northern representative of the genus *Pyxis* (the second species, *P. arachnoides*, occurs along western and southern coastal regions of Madagascar).

This account is primarily based on information kindly provided by C. Blanc and R. Bour.

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MADAGASCAR SPIDER TORTOISE or TSAKAFY, KAPILA — **INDETERMINATE**

Pyxis arachnoides Bell 1827 — Testudines: Testudinidae

SUMMARY A very small terrestrial species endemic to Madagascar. Restricted to xeric thorn-bush scrub of coastal regions in the south and southwest, from Morombe in the north to Amboasary in the south, extending 10-50 km inland. No precise population estimates available, but reported to be declining due to habitat destruction and over-collection. Rarely used for food, partly protected by impenetrability of its habitat. Aestivates underground during long dry season. Clutch comprises a single large egg, number of clutches per year unknown. Biology and status poorly known and require urgent investigation. Listed on CITES Appendix II. Representative populations require protection.

DISTRIBUTION An endemic Madagascar species. Restricted to south and southwest regions near the coast, extending from 10 to 50 km inland, reaching from Morombe in the north to Amboasary (near Fort Dauphin) in the south (4).

POPULATION No precise estimates available, but is reported to be declining (1), perhaps rapidly (8), and localized although apparently not rare north of the Onilahy river (4). Although the potential distribution area is relatively large, populations are often remote from one another, and contain a variable number of individuals (8).

HABITAT AND ECOLOGY A very small (to c 15cm carapace length) terrestrial species, found in arid or semi-arid thorn-bush scrub including *Didierea*. Mean temperature of the coldest month c 19°C, the sparse annual rainfall of less than 500 mm falls within a two to four month period. The tortoises aestivate underground during the long dry season. The clutch comprises a single large egg, 25-30 x 33-35 mm in size (4). Number of clutches per year unknown. Very little is known of the biology of *P. arachnoides*.

THREATS Habitat destruction (by man and by bush fires) and over-collection for the pet trade and other purposes, are cited as the main threats (1,8). The species is sometimes used in barter, at the port of Toliara for example (4). Only rarely used for food.

CONSERVATION MEASURES TAKEN Protected to some extent by the aridity and harshness of its habitat (partly shared with *Geochelone radiata*). Probably exists within the Lake Tsimanampetsotsa Natural Reserve.

Listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Appendix II listing implies that commercial trade is allowed providing a permit from the country of export is obtained, this can provide a method of monitoring trade levels.

Each specimen exported is subject to a tax of Fmg 5000 (1).

CONSERVATION MEASURES PROPOSED Field research on biology, distribution and status is required. It would be desirable to have legislative protection of the species and suitable segments of habitat.

There is interesting clinal variation in plastral mobility; in the southern subspecies *P. a. matzi* the anterior lobe of the plastron is highly mobile, it is less so (especially in adults) in the southwestern subspecies *P. a. arachnoides*, and rigid in the western form *P. a. brygooi* (3). Conservation measures should thus cover populations from different parts of the range (8,9).

CAPTIVE BREEDING In 1984 there were reported to be 10 individuals in 5 collections (11). At that time only Leipzig in F.R. Germany apparently had both males and females (11). A colony of 2 males and 2 females at Knoxville Zoo, Tennessee had by then shrunk to 2 males. Egg laying had occurred repeatedly here in the late 1970s but all eggs had been infertile (9).

REMARKS This species until quite recently (6) had been assigned to the genus *Testudo*, this is maintained by a few authorities (7). Sub-species of *P. arachnoides* have recently been discussed by Bour (3,10).

This account is mainly based on data kindly provided by C. Blanc and R. Bour.

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MADAGASCAR SIDENECK TURTLE or RERE **INDETERMINATE**

Erymnochelys madagascariensis (Grandidier 1867) Testudines: Pelomedusidae

(Synonym: *Podocnemis madagascariensis*)

SUMMARY An endemic Madagascar aquatic turtle. Present in large slow-moving rivers, backwaters and lakes in the west of the island, from the Mangoky river in the southwest to the Sambirano in the north. Found in savanna and forest regions, up to 800m. No precise population estimates available, but widely considered rare, and may be declining. Clutch comprises up to 24 eggs, 30 x 40 mm, number of clutches per year unknown. Biology little known. Adults are exploited for food, also suffering from habitat modification. Biology and status require investigation. A species of great zoogeographic interest, most closely related to South American turtles of the genus *Podocnemis*.

DISTRIBUTION An endemic Madagascar species. Present in the more extensive aquatic habitats at low to moderate altitudes in the west and northwest of the island from the Mangoky river and Lake Ihotry near Morombe in the southwest, northward to the Sambirano basin west of the Massif de Tsaratanana (3,4,8).

POPULATION No precise estimates available. Widely considered rare (1,2,3,4) and reported to be declining (2,3), but also reported abundant (date unknown) in permanent lakes along the Tsiribihina and its affluents (8). Population status requires investigation.

HABITAT AND ECOLOGY A moderate size aquatic species, sometimes reaching 500mm in length and 15kg (8), inhabiting quiet slow-moving stretches of large rivers, also backwaters, lakes and pools. Most widely distributed in the lowlands, but may extend to 800m (4). Present in both savanna and forest regions. Much of the range has a dry tropical climate with eleven to eight dry months, but a summer monsoon affects the northwest where the dry period last five to six months. Annual rainfall ranges from around 500 mm in the southwest to around 1600 mm in the northwest (8). Populations subject to low winter temperatures may aestivate in the mud during this period, and emerge as temperatures rise with the start of the summer rainy season (8).

Carnivorous in habits, the species feeds on molluscs, arthropods, fish and amphibians (8).

Egg-laying has been observed in July and in January. The clutch comprises up to 24 oval eggs, 39-42mm long by 29-30.5mm (8). Number of clutches per year unknown.

THREATS Adults are exploited for food (3,4,8). Large numbers are eaten by the riverine Sakalava people and others living around Lake Kinkony (near Soalala in the northwest), where the surroundings of the village huts may be strewn with empty sun-bleached *Erymnochelys* carapaces (8). Habitat modification, notably transformation of river banks into rice plantations (impairing reproduction), is a second cause of decline (2,3). It has been suggested (6) that the Madagascar form of *Pelusios castaneus*, of a widespread and expansive African genus, may eventually out-compete *E. madagascariensis* (although at present they occur on opposite sides of the island).

CONSERVATION MEASURES TAKEN Since 1974 not sold in Antananarivo market, and not supposed to be served in hotels or restaurants. However, in 1976 it was still to be found on butchers' stalls in the Maevatanana market, for example (4). Occurs in Analabe Private Reserve north of Morondava (9).

All species of *Podocnemis* are listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); until recently *Erymnochelys madagascariensis* was generally also regarded as a species of *Podocnemis*, and the intention may have been to list this species also, regardless of a change in generic assignment. This point requires clarification. It has been recommended that the species should be listed on Appendix II (3). Appendix II listing implies that commercial trade is allowed providing a permit from the country of export is obtained, this can provide a method of monitoring trade levels.

CONSERVATION MEASURES PROPOSED A thorough investigation of the biology and population status is required, in part to provide a basis for rational management of the species as a valuable food resource. Protection should be made effective in nominally protected areas, such as Lake Kinkony (3).

CAPTIVE BREEDING No information. Probably difficult (3).

REMARKS This account is based primarily on data kindly provided by Ch. Blanc and R. Bour.

This species is of very great zoological interest as the only living *Podocnemis*like turtle outside South America. It was long assigned to the South American genus *Podocnemis* by most authorities, but recent karyological (7) and serological (5) data, combined with certain morphological differences, have led to assignment of *madagascariensis* to a separate monotypic genus *Erymnochelys*. Fossil *Podocnemis* turtles are known from Africa (where the genus is now extinct) and South America.

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II. NON-ENDEMIC CHELONIANS AND NILE CROCODILE

HAWKSBILL TURTLE — ENDANGERED

Eretmochelys imbricata (Linnaeus 1766) — Testudines: Cheloniidae

Overall range and status

A circumtropical species, nesting on beaches of tropical seas in the Atlantic, Indian and Pacific Oceans. The species is still widespread but exists in only low density almost throughout the extensive range. Most populations are known or thought to be severely depleted. Moderate population levels appear to persist around the Torres Straits islands, in the Red Sea and Gulf of Aden, and probably around the Arnavon Islands (Solomons), northern Australia, Palau group, Persian Gulf islands, Oman, parts of the Seychelles, possibly the Maldives and northwest Madagascar. Often nests on small islands but sometimes on mainland coasts. Threatened primarily by long-term and intensifying trade in 'tortoiseshell', continuing demand in international trade having raised shell prices to the point where Hawksbills are pursued even when only rarely encountered. Hawksbill eggs are eaten by man in most parts of the range and adults are also eaten widely. Highly effective spearguns are replacing less efficient nets as hunting equipment in some areas, notably the Caribbean.

Range and status in Madagascar

Good numbers still nest, mainly along the northern third of the island and in the south-west, but these appear to represent only a remnant of former numbers. Tortoiseshell was exported in great quantitiy from at least the early 17th century until a sudden decline in the 1920s attributed to overexploitatin. In the mid 1800s exports reached 4000 kg of shell, representing a kill of about 1600 adult hawksbills, this level continued for around 100 years. Most Hawksbills are taken by the Vezo people in the south-west, hunting also occurs in the north-east, but north-west populations may suffer less exploitation. It is estimated that over 2500 hawksbills are killed annually, mostly juveniles of less than 40 cm length, but about one quarter being adults.

Ecology

Feeds largely on benthic invertebrates associated with coral reefs; may be largely sedentary though tag records show that at least some long-distance movements occur. Nesting is generally diffuse, often with only single females emerging on any one beach during any one night; at several localities fewer than ten females may emerge in one night, and very exceptionally larger numbers have been recorded. Clutch size varies between populations, correlated with size of female, range from 73 to 182. Between two and four clutches per season, females may re-migrate to nest mainly at three-year intervals (few data available).

Conservation measures in Madagascar

Legally protected and there are apparently some turtle-nesting beaches where all exploitation is forbidden.

GREEN TURTLE **ENDANGERED**

Chelonia mydas (Linnaeus 1758) Testudines: Cheloniidae

Overall range and status

A circumtropical species, nesting mainly in tropical and subtropical regions. Only about a dozen large populations with around 2000 or more nesting females per year are known at present; these occur on Ascension, around western and northern Australia, Costa Rica (Tortuguero Beach), Europa and nearby islands in the Mozambique Channel, Pacific Mexico, Oman, Pakistan, and possibly the Philippines, Sabah and Sarawak. In a good year over 10 000 females may nest on Europa, and up to 80 000 at Raine Island (Australia); these appear to be the only stable populations not heavily exploited. Although very many nesting locations are known worldwide, most populations are depleted and many are declining, some have already been extirpated (e.g. in the Caribbean). Heavily utilized in most of the range; adults and eggs for food, juveniles for curios, and adults also for hide and oil. Incidental catch causes much mortality.

Range and status in Madagascar

Small scale nesting occurs on the mainland and offshore islands.

Ecology

Predominantly herbivorous, feeding on sea grasses and algae. Highly migratory, with well-developed homing abilities. Females appear to nest on their ancestral nest beach, and mating occurs offshore from this nest beach; thus each nesting colony behaves as a separate reproductive unit. There is considerable difficulty in applying the traditional species concept in such a situation. Average clutch size 110, females can lay 3-7 clutches per season, and some have been shown to re-migrate at 2-4 year intervals. Females may not attain maturity in the wild for 15-50 years.

Conservation measures in Madagascar

Legally protected (though apparently largely unenforced); there are apparently four turtle nesing beaches which are specifically protected.

OLIVE RIDLEY
or PACIFIC RIDLEY

ENDANGERED

Lepidochelys olivacea (Eschscholtz 1829)

Testudines: Cheloniidae

Overall range and status

A circumglobal species, present in tropical regions of the Atlantic, Indian and Pacific Oceans. Typically nests on mainland beaches; there is little nesting on islands of the Indian Ocean, southeast Asia or Oceania, and no nesting in the Caribbean. Overall, although the Olive Ridley remains relatively widespread and numerous, most nest sites support only small or moderate-scale nesting (up to around 1 000 females per year), and most populations worldwide are known or thought to be depleted, often severely so. Where population densities are high enough, females emerge to nest in synchronised aggregations ("arribadas"), sometimes comprising up to 150 000 turtles. Very large arribadas now occur in only two areas; at two beaches in Orissa State (India) and at two beaches in Pacific Costa Rica. Of the several former major arribada sites in Pacific Mexico only La Escobilla (Oaxaca) retains mass nesting, but even this population is reported to have declined severely due to over-exploitation. Threatened by legal and illegal commercial harvest of adults (mainly for food or skin for the leather trade), incidental catch in shrimp trawls and massive harvest of eggs from nest beaches. Nominally protected by legislation in much of the range, including India and Mexico, often ineffectually.

Range and status in Madagascar

No large-scale nesting known; nesting has been recorded in the northwest, although other reports indicate presence of a feeding population only.

Ecology

A small-sized sea turtle, mean carapace length to around 68 cm, foraging in tropical neritic waters and feeding mainly on benthic crustaceans, sometimes at considerable depth. There is very little information on the biology of Olive Ridleys away from the nesting beach, but there is evidence that some groups make moderately extensive post-nesting migrations, in the east Pacific for example, from nest sites in Mexico and other parts of central America southward to feeding grounds off Ecuador. Sexual maturity possibly attained at 7-9 years. Mean clutch size from 105 to 116. Females may nest twice in a season, sometimes three times. Most remigrating females return to nest at either one or two year intervals.

LOGGERHEAD SEA TURTLE

VULNERABLE

Caretta caretta (Linnaeus, 1758)

Testudines: Cheloniidae

Overall range and status

A circumglobal species, nesting mainly in temperate and subtropical regions. Populations are still widespread, although some are known to have declined and others are suspected to have declined. The largest known nesting populations are those on Masirah Island (Oman), with a minimum of 30 000 females annually, and in Florida (U.S.A.), with between 6000 and 15 000. Good numbers nest in Australia. Elsewhere numbers are either unknown, or low to moderate.

In the Indian Ocean there is large scale nesting in southern Africa, notably on Paradise Island, Mozambique, mainland Mozambique, and on the Tongaland coast of South Africa. Tag returns from Tongaland indicate that Mozambique and Tanzania are important feeding grounds for the nesting populations in southern Africa. Three major threats affect populations: Loggerheads are caught in trawl nets, particularly bottom trawlers fishing for shrimp and demersal fish, and often drown or are battered to death; loss of nesting habitat to coastal development severely affects some populations and has been particularly significant in the United States and the

Mediterranean; Loggerheads are exploited for meat, eggs and tourist curios - the meat is generally regarded as less palatable than Green Turtle but is sought after in some areas. Nominally protected by legislation in much of the range, but nesting occurs on relatively few protected beaches.

Range and status in Madagascar

Important nesting sites occur on Madagascar particularly in the southeast around Fort Dauphin with some nesting on the west coast as far north as Morondava. Annual nesting females are estimated at around 300, but despite protective legislation, all marine turtles are under pressure from exploitation.

Ecology

A carnivorous species, feeding mainly on benthic invertebrates, especially molluscs and crustaceans, also sponges. Most nesting beaches are north or south of the tropics, in subtropical or temperate zones, although the species does feed within the tropics. Nesting generally occurs in late spring and summer, usually at night. Eggs 40-42 mm diameter, mean clutch size from 101 (Masirah) to 126 (S. Carolina). Females typically nest 4-5 times a season, and can remigrate at 2-3 year intervals. There is some evidence that nesting *Caretta* show less site fixity, between or within seasons, than Green Turtles. Primarily a neritic species; although long-distance movements are known, these often appear to take place along coastlines, not over open sea. Tagging programmes have demonstrated several apparently regular dispersal routes. Turtles from the Tongaland (South Africa) population move northward after nesting, to Mozambique and Tanzania (with a few tag returns from Madagascar and South Africa). There is evidence that very young Loggerheads may spend the first several months of life associated with mats of *Sargassum* weed.

Conservation measures in Madagascar

Legally protected, though exploitation still apparently occurs; although there are no marine reserves, some turtle beaches are apparently specifically protected.

NILE CROCODILE **VULNERABLE**

Crocodylus niloticus Laurenti, 1768 Crocodilia: Crocodilidae

Overall range and status

Widely distributed in Africa south of the Sahara (and Madagascar), though absent from arid regions of the north-east and much of the south-west. Range has reduced in historic times; the species has been subject to many years of intensive hide-hunting and populations are widely depleted, often severely so.

Range and status in Madagascar

Now reportedly very diffuse and rare; during the nineteenth centry reported very common in most waters, especially the Betsiboka River, and still widespread and reasonably abundant up to at least the mid 1950s.

Ecology

A large crocodilian species, typical adult length c 3.5 m, very occasionally to around 5 m. Present in a variety of mainly freshwater habitats, notably larger rivers, lakes and freshwater swamps, though also recorded from river mouths, estuaries and mangrove swamps. Fish, often those predatory on human food fishes, form a major part of the diet of animals over 1 m in length though as individuals increase in size larger mammals and birds are often taken; smaller individuals feed mainly on a wide variety of invertebrates and amphibians. Sexual maturity attained at around 12-15 years, length 2-3 m. A hole-nesting species, clutch size 16-80. The female attends the nest, opens the nest at hatching time and carries the hatchlings to water. Both parents defend their creche of hatchlings for 6-8 weeks.

Conservation measures in Madagascar

1962 legislation classifies the Nile Crocodile as a vermin species (see Appendix 1). This legislation does not appear to have been repealed; it is recommended that the species is reclassified as a protected species.

Supplementary note:

At the 1985 CITES meeting in Buenos Aires the Nile Crocodile population in Madagascar (with those in eight other countries) was transferred from Appendix I to Appendix II of CITES, thus facilitating legal trade. Trade is subject to an export quota of 1000 skins per year.

APPENDIX 3.D. LEPIDOPTERA

Data sheets for the following three Papilionid species are included, taken from: Collins, N.M. and Morris, M.G. (1985) *Threatened Swallowtail Butterflies of the World. The IUCN Red Data Book.* IUCN, Cambridge.

V *Papilio grosesmithi*
R *Papilio mangoura*
R *Papilio morondavana*

All three are members of the subfamily Papilioninae in the tribe Papilionini.

Papilio (Princeps) grosesmithi Rothschild, 1926 **RARE**

SUMMARY *Papilio grosesmithi* has a slightly wider distribution than *P. morondavana* in the deciduous forests of western Madagascar. The two species are often confused by collectors. Commercial collecting needs to be monitored, but the main threat is habitat destruction. For description see (3).

DISTRIBUTION *Papilio grosesmithi*, like *P. morondavana*, is endemic to western Madagascar, but is found over a slightly wider area. Its known range extends from Mahajanga (Majunga) in the north, to Sakaraha, Toliara and the Lambomakondro forest in the south.

HABITAT AND ECOLOGY *P. grosesmithi* was first collected in the deciduous forests of north-western Madagascar and is now known from the Ankarafantsika forest (Majunga Province), the Marofandilia forest near Morondava, the Lambomakandro forest in the Sakaraha region, the Zombitsy special reserve, the banks of the Fiherenana, and in the Androvonory forest east of Toliara (2). *P. grosesmithi* is in the *demoleus* group, as is *P. morondavana.* Comments under that species also apply here. In some of its localities *P. grosesmithi* may be seasonally relatively abundant but its globally restricted range in an area subject to extremely rapid alteration by man is cause for concern.

THREATS Since the range of *P. grosesmithi* is virtually sympatric with that of *P. morondavana*, the threats from agriculture and forest clearance are similar. The two species are not usually distinguished by local collectors, although they are by commercial outlets, so monitoring and perhaps local control should apply to both species (1).

CONSERVATION MEASURES No specific measures have been taken to conserve this butterfly and no data are available on the level of commercial collecting of the *demoleus* group in Madagascar. As stated in the review of *P. morondavana*, biological studies are needed to ensure a sustainable yield of these species (1). Protected areas which probably contain this species are listed under *P. morondavana.* It seems that extra resources may be needed to ensure the long-term integrity of these areas.

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Papilio (*Princeps*) *morondavana* Grose-smith, 1891 **VULNERABLE**

SUMMARY *Papilio morondavana*, the Madagascan Emperor Swallowtail, is an attractive swallowtail found in the deciduous forests of western Madagascar. Commercial collecting needs to be monitored, but the main threat is habitat destruction. For description see (1,6,7).

DISTRIBUTION *Papilio morondavana* is confined to the forests of western Madagascar. Its known range extends from the region around the towns of Morondava and Mahabo north towards Mahajanga (Majunga) and Ambato-Boeny and south to Andranovory and Toliara (3,6).

HABITAT AND ECOLOGY *P. morondavana* is recorded from the Ankarafantsika forest in Mahajunga Province to the Andronovory forest in Toliara Province (4,6). These forests are deciduous and increasingly arid towards the south. Ankarafantsika is a dense, dry forest with the characteristic trees *Dalbergia*, *Commiphora* and *Hildegardia*, numerous Leguminosae and Myrtaceae and many lianas. Some plants are adapted to survive aridity, e.g. *Pachypodium*, Ampelidaceae and Passifloraceae.

Papilio morondavana is in the *demoleus* species group (3), which generally use Rutaceae and Umbelliferae as hosts, rarely other plants. There are no published records of the host-plants of *P. morondavana*, or of the young stages. The butterfly may be locally common, and has its main brood in November (8).

THREATS The area occupied by *P. morondavana* is subject to forest destruction for agriculture by local people (2), a process which eliminates a large proportion of the insect fauna (9). In addition, the species is increasingly popular with commercial collectors (4), a situation which requires monitoring and perhaps local control. The Ankarafantsika forest and other western forests are reported to suffer from uncontrolled burning. The lack of resources to ensure the long-term integrity of these areas is a cause for international concern.

CONSERVATION MEASURES No specific measures have been taken to conserve this butterfly. There are four established reserves in western Madagascar. *P. morondavana* is certainly found in the Réserve Naturelle Integrale de l'Ankarafantsika (60 520 ha), it may occur in the R.N.I. du Tsingy de Namoroka (21 742 ha) and the R.N.I. du Tsingy de Bemaraha (152 000 ha), but is unlikely to be found in the R.N.I. du lac de Tsimanampetsotsa (43 000 ha, mostly water). These reserves are not open to the public but are closed to any human interference except official scientific activities (5). However, there is some concern that the reserves are not adequately policed.

The level of commercial exploitation may be a matter for concern. It is important that any commercially useful insect should be the subject of a careful biological study. Only then can the species be managed and exploited in a way that will ensure a sustainable local industry without a decline in butterfly populations.

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Papilio (Princeps) mangoura Hewitson, 1875 **RARE**

SUMMARY *Papilio mangoura* flies only in the eastern rain forests of Madagascar. Only one quarter of these forests are still untouched and with rapid population growth and deforestation the status of this and many other forest butterflies should be monitored.

DISTRIBUTION *Papilio mangoura* is found in eastern Madagascar, from Maroantsetra in the north to Taolanaro in the south. A list of localities is given by Paulian and Viette (7).

HABITAT AND ECOLOGY This butterfly is a species of the eastern rain forests of Madagascar and is closely related to the much more common *P. delalandei*. No details of their biology have been published and the early stages of both species are unknown (3).

THREATS The main threat to this and any other creature endemic to Madagascar's rain forests is the alarming rate at which degradation of the vegetation and soils is occurring (2). Madagascar has 10.3 million hectares of closed canopy broad-leaved forest, but only one quarter of this is believed to be primary (2). The rate of deforestation during the period 1981-85 has been estimated at 150 000 hectares per year, a slight lowering from 165 000 hectares per year in 1976-80 (2). The main pressure is from population growth and the rapid spread of shifting cultivation ('tavy'), but timber exploitation adds to the problem (2). About 650 000 hectares of former forest is now too degraded to be utilized for further timber exploitation (2). Fortunately about 1.75 million hectares of forest are on land too steep to be exploited, and approximately a further one million hectares are for various reasons legally protected from exploitation (2,#6). It therefore seems likely, but by no means certain, that most forest butterflies will survive in protected areas and relict forest patches. However, this is no cause for complacency and does not detract from the enormous difficulties facing conservationists in Madagascar.

Other butterflies possibly threatened in a similar way include the rare danaid *Amauris nossima* (locally common in Montagne d'Ambre (8)), the nymphalids *Euxanthe madagascariensis, Charaxes cowani, C. phraortes, C. andranodorus, Neptis decaryi, N. metella gratilla, N. sextilla* and *Apaturopsis kilusa, A. pauliani* and the acraeids *Acraea sambarae* and *A. hova* (5). *Graphium endochus*, another forest papilionid, is apparently well distributed at present but may require monitoring as deforestation progresses. Other families have not been assessed, but would undoubtedly add to this list of threatened butterflies.

CONSERVATION MEASURES Control of population growth and shifting cultivation are the basic requirements of programmes for rational land use, development and conservation in Madagascar. In addition, the system of national parks and natural reserves in eastern Madagascar is inadequate for the protection of the flora and fauna of lowland forest and requires considerable expansion. The Réserves Naturelles de Tsaratanana, Marojejy and Andringitra include mostly montane vegetation (4), although the latter has some excellent forest at medium altitude (6). However, R.N. de Zahamena has rainfall of 1500-2000 mm per year and includes a fine stand of rich lowland rain forest (8). R.N. d'Andohahela includes an area of forest, but this is virtually the southern extremity of this vegetation type. The Réserve Spéciale de Périnet-Analamazaotra apparently includes good rain forest in which the Indris (*Indri indri*) lives, but the reserve is too small (810 ha) to be significant (4). In addition there are a number of small reserves on the east coast. Possibly the only large expanse of rain forest is in the Masoala peninsula, once a reserve of 76 000 ha, but given over to forest exploitation in 1964. If managed on a sustainable basis this forest could still be an important refuge for wildlife (6).

There is too little information on any of the rain forest butterflies, including *Papilio mangoura*, to make specific conservation recommendations. Clearly, more surveys and a great deal more biological study are needed in order that the very high endemicity of the forest fauna may be properly conserved. On an optimistic note, if butterfly foodplants are able to survive on steep ground then relict forest patches on the eastern slopes of the central massif and in the Masoala peninsula may effectively prevent wholesale extinctions.

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APPENDIX 4

This appendix contains lists of the succulents and palms of Madagascar with preliminary IUCN categories.

Succulents

'Succulents' do not form a natural taxonomic plant grouping, consisting rather of taxa from a variety of genera and families which may contain many non-succulent species. They are, however of considerable horticultural interest; this has resulted in more information being available on their wild status than for other groups. Some 424 endemic taxa (species and varieties) of succulent plants are listed for Madagascar; of these, 64 are considered definitely threatened, 24 are definitely not threatened while insufficient data are available to determine whether the remaining 336 are threatened or not.

Palms

The palms are represented in Madagascar by 117 species in 21 genera; 13 of the genera and all but 4 of the species are endemic, and so botanically they are one of the more significant families on the island. Of the non-endemic genera, two are also found in Africa and Asia; one is also found in Africa, Asia and Malaysia (in a botanical sense); one also in Asia and Malaysia, and one also in the Comoros and Pemba.

Madagascan palms are of exceptional interest both in terms of evolution and geography and are crucial to understanding the family as a whole; yet they are still incompletely known. The flora is much richer and more diverse than that of Africa. *Ravenea* and *Louvelia* are members of a relatively unspecialized tribe, Ceroxyleae, with other members in S. America and Australasia. *Beccariophoenix* appears to be a primitive member of the tribe Cocoeae, which consists almost entirely of New World palms except for *Jubaeopsis* in S. Africa and the coconut itself. Most of the Madagascan palms, however, belong to tribe Areceae, very diverse in Madagascar and Asia, and also in S. America, but with only one species in Africa. It appears that the Madagascan palm flora has probably been isolated for a very long time.

Palms are one of Madagascar's most highly threatened plant groups; many are rainforest species and are vulnerable to forest destruction. Also, virtually all Madagascan palm species are utilized in some way or other, and are therefore selectively destroyed, especially for the edible terminal bud. Several species are known only from few collections: *Beccariophoenix*, for example, was described in 1915 as being on the verge of extinction through the overexploitation of its fibre; the last undisputed record of its occurrence was in 1947 - only two undoubted collections have ever been made. An even more extreme example is *Louvelia* which is represented by three species; each one has only ever been collected once!

CMC would like to acknowledge the help of Dr J. Dransfield of the Royal Botanic Gardens, Kew, for help in compiling this appendix.

MADAGASCAR SUCCULENTS

ENDEMIC TAXA	CATEGORY
APOCYNACEAE	
Pachypodium ambongense L.Poisson	K
Pachypodium baronii Costantin & Bois var. baronii	I
Pachypodium baronii var. windsori (L.Poisson) Pichon	E
Pachypodium brevicaule Baker	V
Pachypodium decaryi L.Poisson	E
Pachypodium densiflorum Baker var. densiflorum	R
Pachypodium densiflorum var. brevicalyx H.Perrier	I
Pachypodium geayi Costantin & Bois	K
Pachypodium horombense Pichon	R
Pachypodium lamerei Drake var. lamerei	K
Pachypodium lamerei var. ramosum (Costantin & Bois) Pichon	R
Pachypodium rosulatum Baker var. rosulatum	I
Pachypodium rosulatum var. drakei (Costantin & Bois) Markgraf	I
Pachypodium rosulatum Baker var. gracilius H.Perrier	R
Pachypodium rutenbergianum Vatke var. rutenbergianum	K
Pachypodium rutenbergianum var. meridionale (M.Pichon) H.Perrier	K
Pachypodium sofiense (L.Poisson) H.Perrier	K
ASCLEPIADACEAE	
Ceropegia albisepta Jum. & H.Perrier var. albisepta	I
Ceropegia albisepta var. truncata H.Huber	I
Ceropegia albisepta var. viridis (Choux) H.Huber	I
Ceropegia ampliata E.Meyer ssp. madagascariensis Lavranos	K
Ceropegia armandii Rauh	I
Ceropegia bosseri Rauh & Buchloh	I
Ceropegia dimorpha Humbert	I
Ceropegia leroyi Rauh & Marn.-Lap.	I
Ceropegia racemosa N.E.Br. ssp. racemosa	I
Ceropegia racemosa ssp. glabra H.Huber	I
Cynanchum ampanihense Jum. & H.Perrier	K
Cynanchum aphyllum (Thunb.) Schltr.	K
Cynanchum compactum Choux var. compactum	K
Cynanchum compactum var. imerinse Descoings	K
Cynanchum cucullatum N.E.Br.	K
Cynanchum decaisnianum Descoings	K
Cynanchum helicoideum Choux	K
Cynanchum implicatum (Jum. & Perr.) Jum. & Perr.	K
Cynanchum luteifluens (Jum. & H.Perrier) Descoings	K
Cynanchum macrolobum Jum. & H.Perrier	K
Cynanchum madecassum Descoings	K
Cynanchum mahafalense Jum. & H.Perrier	K
Cynanchum marnieranum Rauh	K
Cynanchum messeri (Buchenau) Jum. & H.Perrier	K
Cynanchum napiforme Choux	K
Cynanchum nodosum (Jum. & Perr.) Descoings	K
Cynanchum pachylobum Choux	K
Cynanchum perrieri Choux	nt
Cynanchum pycnoneuroides Choux	K
Cynanchum rauhianum Descoings	K
Cynanchum rossii Rauh	V
Folotsia aculeatum (Descoings) Descoings	K
Folotsia floribundum Descoings	K
Folotsia grandiflorum (Jum. & Perr.) Jum. & Perr.	K
Folotsia madagascariense (Jum. & H.Perrier) Descoings	K
Folotsia sarcostemmoides Costantin & Bois	K
Karimbolea verrucosa Descoings	K
Sarcostemma decorsei Costantin & Gallaud	K
Sarcostemma insigne (N.E.Br.) Descoings	K
Sarcostemma madagascariense Descoings	K
Stapelianthus arenarius Bosser & Morat	K
Stapelianthus decaryi Choux	V
Stapelianthus hardyi Lavranos	K
Stapelianthus insignis Descoings	V
Stapelianthus keraudrenae Bosser & Morat	K
Stapelianthus madagascariensis (Choux) Choux	V
Stapelianthus montagnacii (Boiteau) Boiteau & A.Bertrand	V
Stapelianthus pilosus (Choux) Lavranos & Hardy	V
BALSAMINACEAE	
Impatiens tuberosa H.Perrier	K
BOMBACACEAE	
Adansonia alba Jum. & H.Perrier	K
Adansonia fony Baillon var. fony	K
Adansonia fony var. rubristipa (Jum. & H.Perrier) H.Perrier	K
Adansonia grandidieri Baillon	K
Adansonia madagascariensis Baillon	K
Adansonia suarezensis H.Perrier	K
Adansonia za Baillon var. za	R
Adansonia za var. boinensis H.Perrier	K
Adansonia za var. bozy (Jum. & H.Perrier) H.Perrier	K
BURSERACEAE	
Commiphora madagascariensis Jacq.	K
CACTACEAE	
Rhipsalis baccifera (J.Miller) Stearn	K
Rhipsalis fasciculata (Willd.) Haw.	K
Rhipsalis horrida Baker	K
COMPOSITAE	
Senecio antandroi Scott Elliot	K
Senecio antitensis Baker	K
Senecio baronii Humbert	K
Senecio barorum Humbert	K
Senecio boiteaui Humbert	K
Senecio canaliculatus Bojer ex DC.	I
Senecio capuronii Humbert	K
Senecio cedrorum Raynal	K
Senecio crassissimus Humbert	K
Senecio decaryi Humbert	K
Senecio descoingsii (Humbert) H.J.Jacobsen	K
Senecio hildebrandtii Baker	K
Senecio hirto-crassus Humbert	K
Senecio kalambatitrensis Humbert	K
Senecio leandrii Humbert	K
Senecio longiflorus (DC.) Schultz-Bip. var. longiflorus	K
Senecio longiflorus var. madagascariensis (Humbert) Rowley	K
Senecio madagascariensis Poir.	K
Senecio marnieri Humbert	I
Senecio melastomaefolius Baker var. melastomaefolius	K
Senecio melastomaefolius var. longibracteatus Bojer ex DC.	K
Senecio mesembryanthemoides Bojer ex DC.	I
Senecio meuselii Rauh	I
Senecio navicularis Humbert	K
Senecio neobakeri Humbert	K
Senecio neohumbertii Rowley	K
Senecio quartziticolus Humbert	K
Senecio saboureaui Humbert	K
Senecio sakalavorus Humbert	K
Senecio sakamaliensis (Humbert) Humbert	K
CRASSULACEAE	
Crassula cordifolia Baker	K
Crassula fragilis Baker	K
Crassula humbertii Descoings	K
Crassula micans Vahl ex Baillon	K
Crassula nummulariifolia Baker	K
Kalanchoe adolphi-engleri Raym.-Hamet	K
Kalanchoe ambolensis Humbert	K
Kalanchoe arborescens Humbert	K
Kalanchoe aromatica H.Perrier	K
Kalanchoe beauverdii Raym.-Hamet var. beauverdii	K
Kalanchoe beauverdii var. guignardii Raym.-Hamet	K
Kalanchoe beauverdii var. parviflora Manning & Boit.	K
Kalanchoe beharensis Drake var. beharensis	K
Kalanchoe beharensis var. aureo-aeneus H.J.Jacobsen	R
Kalanchoe beharensis var. subnuda H.J.Jacobsen	R
Kalanchoe bergeri Raym.-Hamet var. bergeri	K
Kalanchoe bergeri var. glabra Manning & Boit.	K
Kalanchoe bitteri Raym.-Hamet	I
Kalanchoe blossfeldiana Poelln.	K
Kalanchoe boissii Raym.-Hamet & H.Perrier	K
Kalanchoe bouvetii Raym.-Hamet & H.Perrier	K
Kalanchoe bracteata Scott Elliott	K

CRASSULACEAE (contd.)	
Kalanchoe campanulata (Baker) Baillon var. campanulata	K
Kalanchoe campanulata var. orthostyla Manning & Boit.	K
Kalanchoe daigremontiana Raym.-Hamet & H.Perrier	K
Kalanchoe ebracteata Scott Elliott	K
Kalanchoe eriophylla Hils. & Bojer	K
Kalanchoe fedtschenkoi Raym.-Hamet & H.Perrier var. fedtschenkoi	K
Kalanchoe fedtschenkoi var. isalensis Manning & Boit.	K
Kalanchoe gastonis-bonnieri Raym.-Hamet & H.Perrier	K
Kalanchoe gentyi Raym.-Hamet & H.Perrier	K
Kalanchoe globulifera H.Perrier	K
Kalanchoe gracilipes (Baker) Baillon	K
Kalanchoe grandidieri Baillon	K
Kalanchoe heckelii Raym.-Hamet & H.Perrier	K
Kalanchoe hildebrandtii Baillon	K
Kalanchoe integrifolia Baker	K
Kalanchoe jongmansii Raym.-Hamet & H.Perrier var. jongmansii	K
Kalanchoe jongmansii var. ivohibensis Humbert	K
Kalanchoe laxiflora Baker var. laxiflora	K
Kalanchoe laxiflora var. stipitata Manning & Boit.	K
Kalanchoe laxiflora var. subpeltata Manning & Boit.	K
Kalanchoe laxiflora var. violacea Manning & Boit.	K
Kalanchoe linearifolia Drake	K
Kalanchoe macrochlamys H.Perrier	K
Kalanchoe manginii Raym.-Hamet & H.Perrier	K
Kalanchoe marnierana H.J.Jacobsen	K
Kalanchoe millotii Raym.-Hamet & H.Perrier	K
Kalanchoe miniata Hils. & Bojer var. miniata	K
Kalanchoe miniata var. andringitrensis H.Perrier	K
Kalanchoe miniata var. anjirensis H.Perrier	K
Kalanchoe miniata var. confertifolia H.Perrier	K
Kalanchoe miniata var. peltata Baker	K
Kalanchoe miniata var. sicaformis Manning & Boit.	K
Kalanchoe miniata var. subsessilis H.Perrier	K
Kalanchoe mortagei Raym.-Hamet & H.Perrier	K
Kalanchoe nadyae Raym.-Hamet	K
Kalanchoe orgyalis Baker	K
Kalanchoe peltata (Baker) Baillon var. peltata	K
Kalanchoe peltata var. mandrakensis H.Perrier	K
Kalanchoe peltata var. stapfii (Perr.) Raym.-Hamet & H.Perr.	K
Kalanchoe poincarei Raym.-Hamet	K
Kalanchoe porphyrocalyx (Baker) Baillon var. porphyrocalyx	K
Kalanchoe porphyrocalyx var. sambiranensis Humbert	K
Kalanchoe porphyrocalyx var. sulphurea Baker	K
Kalanchoe prolifera (Bowie) Raym.-Hamet	K
Kalanchoe pseudocampanulata Manning & Boit.	K
Kalanchoe pubescens Baker var. pubescens	K
Kalanchoe pubescens var. alexiana Manning & Boit.	K
Kalanchoe pubescens var. brevicalyx Manning & Boit.	K
Kalanchoe pubescens var. decolorata Manning & Boit.	K
Kalanchoe pubescens var. grandiflora Manning & Boit.	K
Kalanchoe pubescens var. subglabrata Manning & Boit.	K
Kalanchoe pubescens var. subsessilis Manning & Boit.	K
Kalanchoe pumila Baker	K
Kalanchoe rhombopilosa Manning & Boit.	K
Kalanchoe rolandi-bonapartei Raym.-Hamet & H.Perrier	K
Kalanchoe rosei Raym.-Hamet & H.Perrier var. rosei	K
Kalanchoe rosei var. seyrigii Manning & Boit.	K
Kalanchoe rosei var. varifolia Guill. & Humbert	K
Kalanchoe rubella (Baker) Raym.-Hamet	K
Kalanchoe schizophylla (Baker) Baillon	K
Kalanchoe serrata Manning & Boit.	K
Kalanchoe streptantha Baker	K
Kalanchoe suarezensis H.Perrier	K
Kalanchoe synsepala Baker	K
Kalanchoe tetraphylla H.Perrier	K
Kalanchoe tomentosa Baker	K
Kalanchoe trichantha Baker	K
Kalanchoe tuberosa H.Perrier	K
Kalanchoe tubiflora (Harvey) Raym.-Hamet	nt
Kalanchoe uniflora (Stapf) Raym.-Hamet var. uniflora	K
Kalanchoe uniflora var. brachycalyx Manning & Boit.	K

CRASSULACEAE (contd.)	
Kalanchoe viguieri Raym.-Hamet & H.Perrier	R
Kalanchoe waldheimii Raym.-Hamet & H.Perrier	K
Sedum madagascariense H.Perrier	K
CUCURBITACEAE	
Seyrigia bosseri Keraudren	K
Seyrigia gracilis Keraudren	K
Seyrigia humbertii Keraudren	K
Seyrigia multiflora Keraudren	K
Xerosicyos danguyi Humbert	nt
Xerosicyos decaryi Guillaumin & Keraudren	K
Xerosicyos perrieri Humbert	K
Xerosicyos pubescens Keraudren	K
DIDIEREACEAE	
Alluaudia ascendens (Drake) Drake	K
Alluaudia comosa Drake	K
Alluaudia dumosa Drake	K
Alluaudia humbertii Choux	K
Alluaudia montagnacii Rauh	K
Alluaudia procera Drake	nt
Alluaudiopsis fiherensis Humbert & Choux	R
Alluaudiopsis marnierana Rauh	R
Decaryia madagascariensis Choux	K
Didierea madagascariensis Baillon	K
Didierea trollii Capuron & Rauh	K
EUPHORBIACEAE	
Euphorbia alcicornis Baker	K
Euphorbia alluaudii Drake ssp. alluaudii	K
Euphorbia alluaudii Drake ssp. oncoclada (Drake) Friedm. & Cremers	K
Euphorbia analalavensis Leandri	K
Euphorbia ankarensis Boit.	I
Euphorbia arahaka H.Poisson ex Humbert & Leandri	K
Euphorbia beharensis Leandri	K
Euphorbia biaculeata Denis	K
Euphorbia boinensis Denis ex Humbert & Leandri	K
Euphorbia boissieri Baillon	K
Euphorbia boiteaui Leandri	K
Euphorbia bosseri Leandri	K
Euphorbia brachyphylla Denis	K
Euphorbia cap-saintemariensis Rauh var. cap-saintemariensis	K
Euphorbia cap-saintemariensis var. tulearensis Rauh	I
Euphorbia capuronii Ursch & Leandri	nt
Euphorbia caput-aureum Denis	K
Euphorbia commersonii (Baillon) Denis	K
Euphorbia croizatii Leandri	K
Euphorbia cylindrifolia Marn.-Lap. & Rauh ssp. cylindrifolia	K
Euphorbia cylindrifolia ssp. tuberifera Rauh	I
Euphorbia decaryi Guillaumin	I
Euphorbia decorsei Drake	K
Euphorbia delphinensis Ursch & Leandri	K
Euphorbia denisiana Guillaumin	K
Euphorbia didieroides Denis & Leandri	I
Euphorbia duranii Ursch & Leandri var. duranii	nt
Euphorbia duranii var. ankaratrae Ursch & Leandri	K
Euphorbia enterophora Drake ssp. enterophora	K
Euphorbia enterophora ssp. crassa Cremers	K
Euphorbia famatamboay Friedm. & Cremers ssp. famatamboay	K
Euphorbia famatamboay ssp. itampolensis Friedm. & Cremers	K
Euphorbia fianarantsoae Ursch & Leandri	K
Euphorbia fiherensis L.Poiss.	K
Euphorbia francoisii Leandri	nt
Euphorbia genoudiana Ursch & Leandri	K
Euphorbia guillauminiana Boit.	K
Euphorbia guillemetii Ursch & Leandri	nt
Euphorbia hedyotoides N.E.Br.	K
Euphorbia horombensis Ursch & Leandri	nt
Euphorbia intisy Drake var. intisy	nt
Euphorbia intisy Drake var. maintyi (Decorse) L.Poiss.	K
Euphorbia isaloensis Drake	K
Euphorbia laro Drake	K
Euphorbia leandriana Boit.	K
Euphorbia leucodendron Drake	nt

EUPHORBIACEAE (contd.)

Euphorbia leuconeura Bois	K
Euphorbia lophogona Lam.	K
Euphorbia mahafalensis Denis var. mahafalensis	K
Euphorbia mahafalensis var. xanthodenia (Denis) Leandri	K
Euphorbia mainty Denis ex Leandri	K
Euphorbia mangokyensis Denis	K
Euphorbia milii Des Moul. var. milii	K
Euphorbia milii var. betsiliana Leandri	K
Euphorbia milii var. bevilaniensis (Croizat) Ursch & Leandri	K
Euphorbia milii var. bosseri Rauh	K
Euphorbia milii var. breonii (Nois.) Ursch & Leandri	K
Euphorbia milii var. hislopii (N.E.Br.) Ursch & Leandri	K
Euphorbia milii var. imperatae (Leandri) Ursch & Leandri	K
Euphorbia milii var. longifolia Rauh	K
Euphorbia milii var. roseana Marn.-Lap.	K
Euphorbia milii var. splendens (Bojer ex Hook.) Ursch & Lean.	K
Euphorbia milii var. tananarivae Leandri	K
Euphorbia milii var. tulearensis Ursch & Leandri	K
Euphorbia milii var. vulcanii Leandri	K
Euphorbia millotii Ursch & Leandri	K
Euphorbia moratii Rauh	R
Euphorbia neohumbertii Boit. var. neohumbertii	nt
Euphorbia neohumbertii var. aureo-viridiflora Rauh	I
Euphorbia orthoclada Baker ssp. orthoclada	K
Euphorbia orthoclada ssp. vepretorum (Drake) Leandri	K
Euphorbia pachypodioides Boit.	I
Euphorbia pauliani Ursch & Leandri	R
Euphorbia pedilanthoides Denis	R
Euphorbia perrieri Drake var. perrieri	R
Euphorbia perrieri var. elongata Denis	K
Euphorbia plagiantha Drake	nt
Euphorbia platyclada Rauh var. platyclada	K
Euphorbia platyclada Rauh var. hardyi Rauh	K
Euphorbia primulifolia Baker	I
Euphorbia quartziticola Leandri	R
Euphorbia ramipressa Croizat	nt
Euphorbia razafinjohanii Ursch & Leandri	K
Euphorbia rossii Rauh & Buchloh	V
Euphorbia salota Leandri	K
Euphorbia stenoclada Baillon ssp. stenoclada	K
Euphorbia stenoclada ssp. ambatofinandranae (Leandri) Cremers	K
Euphorbia tardieuana Leandri	K
Euphorbia tsimbazazae Leandri	K
Euphorbia viguieri Denis var. viguieri	nt
Euphorbia viguieri var. ankarafantsiensis Ursch & Leandri	K
Euphorbia viguieri var. capuroniana Ursch & Leandri	nt
Euphorbia viguieri var. tsimbazazae Ursch & Leandri	K
Euphorbia viguieri var. vilandrensis Ursch & Leandri	K
Euphorbia zakamenae Leandri	K

GERANIACEAE

Pelargonium caylae Humbert	K

LABIATAE

Coleus spicatus Benth.	K
Perrierastrum oreophilum Guillaumin	K

LILIACEAE

Aloe acutissima H.Perrier var. acutissima	nt
Aloe acutissima var. antanimorensis G.Reyn.	K
Aloe albiflora Guillaumin	K
Aloe andringitrensis H.Perrier	K
Aloe antandroi (Decary) H.Perrier	K
Aloe bakeri Scott Elliot	nt
Aloe bellatula G.Reyn.	K
Aloe betsiliensis H.Perrier	K
Aloe boiteaui Guillaumin	K
Aloe buchlohii Rauh	K
Aloe bulbillifera H.Perrier var. bulbillifera	K
Aloe bulbillifera var. pauliana G.Reyn.	K
Aloe calcairophila G.Reyn.	V

LILIACEAE (contd.)

Aloe capitata Baker var. capitata	nt
Aloe capitata var. cipolinicola H.Perrier	K
Aloe capitata var. gneissicola H.Perrier	K
Aloe capitata var. quartziticola H.Perrier	K
Aloe capitata var. silvicola H.Perrier	K
Aloe compressa H.Perrier var. compressa	R
Aloe compressa var. rugosquamosa H.Perrier	R
Aloe compressa var. schistophila H.Perrier	R
Aloe conifera H.Perrier	R
Aloe cremersii Lavranos	K
Aloe cryptoflora G.Reyn.	K
Aloe decaryi Guillaumin	K
Aloe decorsei H.Perrier	K
Aloe deltoideodonta Baker var. deltoideodonta	nt
Aloe deltoideodonta var. brevifolia H.Perrier	K
Aloe deltoideodonta var. candicans H.Perrier	K
Aloe descoingsii G.Reyn.	R
Aloe divaricata A.Berger var. divaricata	nt
Aloe divaricata var. rosea (Decary) G.Reyn.	K
Aloe ericetorum Bosser	K
Aloe erythrophylla Bosser	K
Aloe fievetii G.Reyn.	K
Aloe guillaumetii Cremers	K
Aloe haworthioides Baker var. haworthioides	R
Aloe haworthioides var. aurantiaca H.Perrier	K
Aloe helenae Danguy	I
Aloe humbertii H.Perrier	K
Aloe ibitiensis H.Perrier	K
Aloe imalotensis G.Reyn.	I
Aloe isaloensis H.Perrier	K
Aloe itremensis G.Reyn.	K
Aloe laeta A.Berger var. laeta	I
Aloe laeta var. maniaensis H.Perrier	K
Aloe leandrii Bosser	K
Aloe macroclada Baker	K
Aloe madecassa H.Perrier var. madecassa	K
Aloe madecassa var. lutea Guillaumin	K
Aloe mayottensis A.Berger	K
Aloe millotii G.Reyn.	K
Aloe parallelifolia H.Perrier	V
Aloe parvula A.Berger	K
Aloe perrieri G.Reyn.	K
Aloe rauhii G.Reyn.	K
Aloe schomeri Rauh	K
Aloe silicicola H.Perrier	K
Aloe suarezensis H.Perrier	nt
Aloe subacutissima G.Rowley	K
Aloe suzannae Decary	V
Aloe trachyticola (H.Perrier) G.Reyn.	K
Aloe vaombe Decorse & L.Poisson var. vaombe	nt
Aloe vaombe var. poissonii Decary	K
Aloe vaotsanda Decary	nt
Aloe versicolor Guillaumin	K
Aloe viguieri H.Perrier	R
Lomatophyllum antsingyense Leandri	K
Lomatophyllum citreum Guillaumin	K
Lomatophyllum occidentale H.Perrier	K
Lomatophyllum oligophyllum (Baker) H.Perrier	K
Lomatophyllum orientale H.Perrier	K
Lomatophyllum prostratum H.Perrier	K
Lomatophyllum roseum H.Perrier	K
Lomatophyllum sociale H.Perrier	K
Lomatophyllum viviparum H.Perrier	K

MORACEAE

Dorstenia cuspidata Hochst.	K

MORINGACEAE

Moringa drouhardii Jum.	R

PASSIFLORACEAE

Adenia epigea H.Perrier	K
Adenia firingalavensis (Drake) Harms	K
Adenia olaboensis Claverie	K
Adenia peltata Schinz	K
Adenia refracta Schinz	K

PEDALIACEAE	
Uncarina abbreviata (Baillon) Ihlenf. & Straka	K
Uncarina decaryii Humbert	K
Uncarina grandidieri (Baillon) Stapf	K
Uncarina leandrii Humbert	K
Uncarina leptocarpa (Decne.) Ihlenf. & Straka	K
Uncarina peltata (Baker) Stapf	K
Uncarina perrieri Humbert	K
Uncarina sakalava Humbert	K
Uncarina stellulifera Humbert	K
VITACEAE	
Cyphostemma cornigerum Descoings	K
Cyphostemma coursii Descoings	K
Cyphostemma echinocarpum Descoings	K
Cyphostemma elephantopus Descoings	K
Cyphostemma laza Descoings var. laza	I
Cyphostemma laza var. parviflora Descoings	I
Cyphostemma montagnacii Descoings	K
Cyphostemma roseiglandulosa Descoings	K
Cyphostemma sakalavense Descoings	K

NON-ENDEMIC TAXA	COUNTRY CATEGORY	WORLD CATEGORY
BOMBACACEAE		
Adansonia digitata L.	K	K
CUCURBITACEAE		
Telfairia pedata (Smith) Hook.f.	K	K
EUPHORBIACEAE		
Euphorbia pyrifolia Lam.	K	K
LILIACEAE		
Sansevieria canaliculata Carriere	K	K
MORINGACEAE		
Moringa hildebrandtii Engl.	R	R
PEDALIACEAE		
Pedalium murex L.	K	K
VITACEAE		
Cissus quadrangularis L.	K	K

MADAGASCAR PALMS

ENDEMIC TAXA

PALMAE

Antongilia perrieri Jumelle	I
Beccariophoenix madagascariensis Jumelle & H.Perrier	E
Bismarckia nobilis Hildebr. & H.Wendl.	nt
Borassus madagascariensis Bojer	I
Borassus sambiranensis Jumelle & H.Perrier	I
Chrysalidocarpus acuminum Jumelle	I
Chrysalidocarpus ankaizinensis Jumelle	I
Chrysalidocarpus arenarum Jumelle	I
Chrysalidocarpus auriculatus Jumelle	I
Chrysalidocarpus brevinodis H.Perrier	I
Chrysalidocarpus canescens Jumelle & H.Perrier	I
Chrysalidocarpus decipiens Becc.	I
Chrysalidocarpus fibrosus Jumelle	I
Chrysalidocarpus lutescens H.Wendl.	I
Chrysalidocarpus madagascariensis Becc. var. madagascariensis	I
Chrysalidocarpus madagascariensis var. lucubensis Becc.	I
Chrysalidocarpus madagascariensis var. oleraceus Jumelle & H.Perrier	I
Chrysalidocarpus mananjarensis Jumelle & H.Perrier	I
Chrysalidocarpus midongensis Jumelle	I
Chrysalidocarpus onilahensis Jumelle & H.Perrier	I
Chrysalidocarpus paucifolius Jumelle	I
Chrysalidocarpus pilulifera Becc.	I
Chrysalidocarpus rivularis Jumelle & H.Perrier	I
Chrysalidocarpus ruber Jumelle	I
Chrysalidocarpus sahanofensis Jumelle	I
Dypsis angusta Jumelle	I
Dypsis boiviniana Becc.	I
Dypsis fasciculata Jumelle	I
Dypsis forficifolia Mart. var. forficifolia	I
Dypsis forficifolia var. reducta Jumelle & H.Perrier	I
Dypsis glabrescens Becc.	I
Dypsis gracilis Bory ex Mart.	I
Dypsis hildebrandtii Becc.	I
Dypsis hirtula Mart.	I
Dypsis humbertii H.Perrier var. humbertii	I
Dypsis humbertii var. angustifolia H.Perrier	I
Dypsis lanceana Baillon	I
Dypsis linearis Jumelle	I
Dypsis littoralis Jumelle	I
Dypsis longipes Jumelle	I
Dypsis louvelii Jumelle & H.Perrier	E
Dypsis mananarensis Jumelle	I
Dypsis masoalensis Jumelle	I
Dypsis mocquerysiana Becc.	E
Dypsis monostachya Jumelle	I
Dypsis plurisecta Jumelle	I
Dypsis procera Jumelle	I
Dypsis sambiranensis Jumelle	I
Dypsis viridis Jumelle	I
Halmoorea trispatha J.Dransf. & N.Uhl.	E
Louvelia albicans Jumelle	I
Louvelia lakatra Jumelle	I
Louvelia madagascariensis Jumelle & H.Perrier	I
Marojejya darianii J.Dransf. & N.Uhl.	E
Marojejya insignis Humbert	E
Masoala madagascariensis Jumelle	E
Neodypsis baronii Jumelle	I
Neodypsis basilongus Jumelle & H.Perrier	I
Neodypsis canaliculatus Jumelle	I
Neodypsis ceraceus Jumelle	I
Neodypsis compactus Jumelle	I
Neodypsis decaryi Jumelle	I
Neodypsis heteromorphus Jumelle	I
Neodypsis lastelliana Baillon	I
Neodypsis ligulatus Jumelle	I
Neodypsis lobatus Jumelle	I
Neodypsis loucoubensis Jumelle	I
Neodypsis nauseosus Jumelle & H.Perrier	I
Neodypsis tanalensis Jumelle & H.Perrier	I

PALMAE (contd.)

Neodypsis tsaratananensis Jumelle	I
Neophloga affinis Becc.	I
Neophloga bernieriana Becc.	I
Neophloga betamponensis Jumelle	I
Neophloga brevicaulis Guillaumet	I
Neophloga catatiana Becc.	I
Neophloga commersoniana Baillon	I
Neophloga concinna Becc. var. concinna	I
Neophloga concinna var. triangularis Jumelle	I
Neophloga corniculata Becc.	I
Neophloga curtisii Becc.	I
Neophloga digitata Becc.	I
Neophloga heterophylla Becc.	I
Neophloga humbertii Jumelle	I
Neophloga integra Jumelle	I
Neophloga lanceolata Jumelle	I
Neophloga linearis Becc. var. linearis	I
Neophloga linearis var. distachya Jumelle	I
Neophloga littoralis Jumelle	I
Neophloga lucens Jumelle	I
Neophloga lutea Jumelle var. lutea	I
Neophloga lutea var. transiens H.Perrier	I
Neophloga majorana Becc.	I
Neophloga mananjarensis Jumelle & H.Perrier	I
Neophloga mangorensis Jumelle	I
Neophloga montana Jumelle	I
Neophloga occidentalis Jumelle	I
Neophloga oligostachya (Becc.) H.Perrier	I
Neophloga pervillei Becc.	I
Neophloga poivreana Becc.	I
Neophloga procumbens Jumelle & H.Perrier	I
Neophloga pygmaea Pichi-Serm.	I
Neophloga rhodotricha Becc.	I
Neophloga scottiana Becc.	I
Neophloga simianensis Jumelle	I
Neophloga thiryana Becc.	I
Orania longisquama (Jumelle) J.Dransf. & N.Uhl.	E
Phloga gracilis (Jumelle) H.Perrier	I
Phloga polystachya Noronha ex Mart. var. polystachya	K
Phloga polystachya var. stenophylla Becc.	K
Ravenea amara Jumelle	I
Ravenea glauca Jumelle & H.Perrier	I
Ravenea latisecta Jumelle	I
Ravenea madagascariensis Becc. var. madagascariensis	E
Ravenea madagascariensis var. monticola Jumelle & H.Perrier	E
Ravenea rivularis Jumelle & H.Perrier	I
Ravenea robustior Jumelle & H.Perrier var. robustior	E
Ravenea robustior var. kona Jumelle	E
Ravenea sambiranensis Jumelle & H.Perrier	I
Ravenea xerophila Jumelle	I
Vonitra crinita Jumelle & H.Perrier	I
Vonitra fibrosa (C.H.Wright) Becc.	E
Vonitra nossibensis (Becc.) H.Perrier	I
Vonitra utilis Jumelle	E

APPENDIX 5. ETHNOBOTANY

This appendix contains tables on Madagascan plants and their uses, taken and adapted from information supplied in: Plotkin, M., Randrianasolo, V., Sussman, L. and Marshall, N. (1985). Ethnobotany in Madagascar. Overview/Action Plan/Database. Report to IUCN/WWF. Unpd, 653 pp.

Table 1 lists plant species taxonomically (alphabetically by family and within each family by species); for each species the local Madagascan name (where known) is listed along with the uses of the plant or its derivatives and the parts of the plant specified for each usage. Numbered references are given; these are detailed in full at the end of Table 2.

Table 2 is organized alphabetically by categories of use; for each use a list of relevant plants is provided, arranged alphabetically by family. In this table several of the family names have been abbreviated; full family names (arranged alphabetically) are given in table one and there should thus be no possibility of confusion.

Both tables can be fully cross-referenced. These tables should be regarded as draft outputs - for example considerable further work needs to be done to rationalise and systematise the categories of use in table 2; at present they are largely listed alphabetically as they appear in the literature. Terms which have not been translated from the original French are given in inverted commas.

ETHNOBOTANICAL DATA BASE OF MADAGASCAR

TABLE 1: alphabetically by taxon

Key: FAMILY
Genus species Authority, any infraspecific taxa [Vernacular name (Dialect)]
Use: Part used (References)

References are given at the end of table 2.

(LICHEN)
Parmelia perforata Ach.
Scurf: ? (41a,21)
Syphilitic chancres: ? (41a,21)
ACANTHACEAE
Justicia gendarussa Burm.
Chronic rheumatism: Leaves, Roots, Flowers (41a,21)
Dysentery, Depurative: Roots (41a,21)
Emetic: Roots (41a,3)
Jaundice: Roots (41a,21)
Justicia sp. [Voanalakely]
Antiseptic: ? (41a)
Neuralgia: ? (12a)
Rhinacanthus aspera L.
Impetigo: Roots, Leaves (41a,21)
Rhinacanthus osmospermus Boj.
Anti-spasmodic: Stem leaves (41a)
Aphrodisiac: Roots (41a,21)
Herpes: Roots, Leaves (41a,21)
ADIANTACEAE
Acrostichum aureum Willd. [Saro (Mah.)]
Stomach ache: Leaves (12a)
AIZOACEAE
Mollugo nudicaulis Lamk.
Anaemia: Entire plant (41a)
Anti-spasmodic:
Antitussive: ? (12a)
Cardiac tonic: Entire plant (41a)
Chronic enteritis: Entire plant (41a,21)
Coughs: ? (12a)
Coughs, Whooping cough: Entire plant (41a,1,16)
Stomach cramps: Leaves (41a,21)
Tonic: ? (41a,53)
Vermifuge: ? (41a)
AMARANTHACEAE
Achyranthes aspera L.
Bronchitis: Roots (41a)
Dropsy, Diuretic: ? (41a,3,21)
Ophthalmia: ? (41a,21)
Puerperal ailments: Roots (41a,21)
Pyrosis: Entire plant (41a)
Rheumatism: Fruits (41a,21)
Skin maladies: ? (41a,21)
Syphilis: Roots (41a,21)
Alternanthera sessilis R.Br.
Galactogogue: ? (41a,21)
Itching: ? (41a,21)
Amaranthus spinosus L.
Blennorrhagia, Chancre: Roots (41a,21)
Diuretic: Roots (41a,21)
Cyathula prostrata Blume
Venereal ailments: ? (41a,21)
Cyathula uncinulata (Schrad) Schinz [Tangogo (Merina)]
Stomach/Liver: ? (12a)
Henonia scoparia Moq. [Kifafa (Sak.)]
Children's headaches/Diarrhoea: Leafy stems (12a)
Diuretic: Stem leaves (41a)
Flatulence: ? (41a)
AMARYLLIDACEAE
Crinum firmifolium Bak.
Condyloma: ? (41a,42)
Ear troubles: Leaf sap (41a)
Emetic: Bulb (41a,21)
Inflamation: Bulb (12a)
Leprosy: Bulbs (41a,21)
Resolutive: Bulb (41a,3)
Scabies, Burns, Anthrax, "Panaris": ? (41a,21)

AMARYLLIDACEAE (contd.)
Crinum modestum Bak.
Resolutive: Bulb (41a,3)
ANACARDIACEAE
Gluta tourtour March.
Vesicant, Corrosive: Resin (55)
Mangifera indica L.
Blennorrhagia: Leaves (41a,33)
Depurative: Fruits (41a,21)
Depurative: Leaves (41a,3)
Dysentery: Bark (41a)
Febrifuge: Fruits (41a,21)
Liver congestion: Wood, Bark (41a,56)
Scabies: ? (41a)
Sore throat: Green fruits (41a)
Vermifuge: Seeds (41a,21)
Operculicarya hyphaenoides H.Perr. [Zabe (Mah.)]
Tonic/Childbirth: Bark, Leaves (12a)
Operculicarya monstruosa H.Perr. [Talaby (Mah.)]
Haemostatic: ? (12a)
Poupartia caffra Perr.
Antiseptic: ? (41a)
Pains: Leaves (41a)
Poupartia minor (Boj.) L.Marchand [Talaby (Mah.)]
Diarrhoea: ? (12a)
Rhus taratana (Bak.) H.Perr. [Taratana (Merina)]
Malaria: Leaves (41a,1)
Stomach/Witchcraft antidote: Leafy stems/ (12a)
Vermifuge: ? (41a,53)
ANNONACEAE
Annona muricata L. [Senasena (Merina)]
Antitussive: Seeds (12a)
Uvaria catocarpa Diels
Antiseptic: Fruits (41a,9)
Astringent: Fruit (41a,9,3)
Coughs, Whooping cough: Fruits (41a,9)
Purgative: Bark and roots (41a,9,3)
Tonic, Aperitif: Fruits (41a,9)
Toothache: Roots (41a,9)
Vermifuge: Fruits (41a,9)
Uvaria manjensis Cav. & Ker. [Lambo (Sak.)]
Rheumatic pains: Leaves (12a)
APOCYNACEAE
Cabucala madagascariensis Pich.
Blennorrhagia: Stem leaves (41a)
Diseases of the spinal marrow: Stem leaves (41a)
Gout: Stem leaves (41a)
Rheumatism: ? (41a)
Stomach troubles: Leaves (41a,21)
Tonic: ? (41a,53)
Vermifuge: Leaves (41a,21)
Carissa edulis Vahl
Dysentery: Leaves, Roots (41a,12)
Febrifuge: Roots (41a)
Tonic: Syem and leaves (41a)
Catharanthus lanceus Pich.
Congestion of the breasts: 41a
Diuretic: Aerial parts (41a)
Fever/Ocytocic : Roots/ (12a)
Haemostatic: ? (41a,21)
Neuralgia: Aerial parts (41a)
Purgative, Emetic: ? (41a)
Scurf: ? (41a,21)
Tonic: ? (41a,53)
Toothache: Roots (41a,4)
Vermifuge: Roots (41a)

APOCYNACEAE (contd.)
Catharanthus roseus G.Don
Galactogogue: Leaves (41a,21)
Haemostatic: ? (41a,21)
Liver congestion: ? (41a,3)
Purgative, Emetic, Depurative: Roots, Leaves (41a)
Scurf: ? (41a,1)
Tonic: ? (41a)
Toothache: Roots (41a)
Vermifuge: Roots (41a,21)
Catharanthus trichophyllus Pich.
Aphrodisiac: ? (41a)
Haemostatic: ? (41a,54)
Purgative, Emetic: ? (41a)
Scurf: ? (41a,1)
Toothache: Roots (41a)
Vermifuge: ? (41a)
Cerbera venenifera (Poir.) Steud.
Wounds: Berrie (41a,21)
Cardiac tonic, Palpitations: Seeds (41a,21,53)
Charm/Vomitory/Poison antidote: Leaves/Berries/ Berries (12a)
Trembling, Paralysis: Fruits (41a,21)
Urinary incontinence: Fruits (41a,21)
Craspidospermum verticillatum Boj. [Vandrika (Merina)]
Syphilis: Aerial part (12a)
Echitella lisianthiflora Pich.
Anthrax: Leaves (41a,55)
Hazunta modesta (Bak.) Pich. subvar methuenii Mgf. [Feka (Mah.)]
Suppurating sores, Wounds/Tonic: Roots/Stem
Pachypodium rosulatum Bak.
Boils: ? (41a,1)
Resolutive: ? (41a,1)
Plectaneia elastica Jum. & Perr.
Enlarged spleen: ? (41a)
Roupellina boivini (H.Bn.) Pich. [Lalondo (Sak.); Lalondo (Mah.); Hiba (Bar.)]
Cardiac tonic: ? (41a,3)
Poison/Anti-itch: Entire plant/Bark (12a)
Voacanga thouarsii Roem. & Schult.
Heart troubles: ? (41a)
Tonic: ? (41a,53)
AQUIFOLIACEAE
Ilex mitis Radlk.
Skin ailments: ? (41a)
ARACEAE
Colocasia esculenta Schott
Haemostatic: Petiole sap (41a,21)
Pothos chapelieri Schott. [Ramatsatso (Merina)]
Stomach/Diabetes/Tobacco substitute/Poison antidote/ Alcoholism: Leaves and stems / Leafy stems/Leaves (12a)
ARALIACEAE
Cussonia bojeri Seem.
Diarrhoea: Leaves (41a,1)
Liver/Digestion/Stomach/Neuralgia: Leafy stem/Leaves (12a)
Syphilis: Stem leaves (41a)
Cussonia sp. [Tsingila (Merina)]
Liver: Entire plant (12a)
Pain and stiffness: ? (12a)
Polyscias sp. [Voatsevana (Merina)]
Liver: Entire plant (12a)
ARISTOLOCHIACEAE
Aristolochia acuminata Lamk.
Malaria: Roots (41a,3)
ASCLEPIADACEAE
Asclepias curassavica L. [Treniombilahy (Betsim.)]
Cicatrizant: ? (12a)
Cryptostegia madagascariensis Boj.
Cardiac tonic: ? (41a,3)
Fractures: ? (41a,12)
Toothache: Roots (41a,55)
Ulcers, Dermatoses, Scabies: Latex (41a,21)
Cynanchum aphyllum Schlechtr. [Ranga (Mah.)]
Coughs/Children's stomach ache: Stem (12a)
Cynanchum sp. [Tadilava (Merina)]
Syphilis: ? (12a)

ASCLEPIADACEAE (contd.)
Folotsia sarcostemmoides Const. & Bois. [Folotse (Mah.)]
Rickets: Roots (12a)
Gomphocarpus cornutus Decne.
Purgative: ? (41a,3)
Gomphocarpus fruticosus R.Br. [Fanoro, Fanory, Poaka (Mer.); Matsivina (Bs.); Tandemy (Bl.)]
Asthma: Leaves (41a,21)
Cardiac tonic: Stem leaves (41a)
Emetic: Leaves, Roots (41a,38,53)
Neuralgia: Stem leaves (41a)
Otitis: Latex (41a,47)
Teeth/Coughs/Stiffness/Swelling: Latex/Seeds/ (12a)
Toothache: ? (41a,47)
Gymnema sylvestre R.Br.
Blennorrhagia: Stem leaves (41a)
Hypoglycemia: Leafy stems (12a)
Harpanema acuminatum Decne.
Coughs, Whooping cough: Stem leaves (41a,21)
Leptadenia madagascariensis Decne. [Mojy (mah.)]
Childbirth/Aperitif: Stem (12a)
Menabea venenata H.Bn.
Cardiac tonic: ? (41a,3)
Liver ailments: Roots (41a,19,20)
Purgative, Stomach troubles: Roots (41a,21)
Pentopetia androsaemifolia Decne.
Anthrax: Leaves, Roots (41a,55)
Coughs/Toothache: Aerial part/ (12a)
Febrifuge: ? (41a,21)
Gout: ? (41a,2)
Haematuria: Leaves (41a,3)
Haemostatic: Leaves (41a)
Jaundice, Biliousness: Leaves (41a,3)
Rheumatism: ? (41a)
Syphilis: Stem leaves (41a,53)
Pentopetia sp. [Vahilava (Merina]
Anodyne: Leafy branches(12a)
Coughs: ? (12a)
Sarcostemma viminale R.Br.
Blennorrhagia: Stem leaves (41a,55)
Secamone ligustrifolia Decne.
Galactogogue: ? (41a,21)
Lactation: Aerial part (12a)
Syphilis: Wood (41a)
Secamone obovata Decne.
Gonorrhoea: ? (12a)
Secamone sp. [Vahilahikely (Merina)]
Stomach/Anodyne: ? (12a)
Throat: Entire plant (12a)
Secamonopsis madagascariensis Jum.
Anthrax: Leaves (41a,55)
Sores: ? (33)
AZOLLACEAE
Azolla pinnata L.
Depurative, Haemorrhoids: Entire plant (41a)
BALSAMINACEAE
Impatiens baroni Bak.
"Eutocique": Leaves, Roots (41a,21)
Blennorrhagia: ? (41a,1)
Diuretic: ? (41a,3)
Impatiens emirnensis Bak.
"Eutocique": Leaves, Roots (41a)
Diuretic: ? (41a,2)
Impatiens madagascariensis Wight & Arn.
"Eutocique": Leaves, Roots (41a)
BIGNONIACEAE
Colea fusca H.Perr.
Head colds: Leaves (41a)
Kigelia pinnata D.C.
Rheumatism: Leaves, Roots (41a,55)
Ophiocolea floribunda H.Perr.
Eczema: ? (41a,53)
Neuralgia/Fever/Witchcraft: Leafy stems/ (12a)
Ophiocolea sp.
Stomach/Neuralgia: ? (12a)
Phyllarthron bernierianum Seeman [Lavaraviny, Tohiravy (Sak.); Tailoravy (Mah.)]
Febrifuge/Nerve sedative: Leaves (12a)

BIGNONIACEAE (contd.)
Phyllarthron madagascariensis K.Schum. [Zahana (Merina); Tokandilana (Merina)]
Condyloma: Leaves (41a,42)
Stiffness/Gonorrhoea/Coughs: ? (12a)
Syphilitic sores: ? (41a,38)
Rhodocolea telfairiae Perr.
Hysteria: Leaves (41a,21)
Stereospermum arcuatum H.Perr.
Anthrax: Leaves (41a,55)
Stereospermum euphorioides D.C.
Haemostatic: ? (41a)
Stereospermum variabile H.Perr. [Mahafangalitsy (Mah.)]
Aid growth/Strengthen newborns: Leaves and stems (12a)
Anthrax: Leaves (41a,55)
BIXACEAE
Bixa orellana L.
Scabies: Seeds (41a,3)
Stimulant: Leaves (41a,1)
BOMBACACEAE
Adansonia digitata L.
Dysentery: Leaves (41a,21)
Febrifuge: Leaves (41a,21)
Haemoptysis: Fruit pulp (41a,21)
Urogenital ailments: Fruits (41a)
Adansonia madagascariensis H.Bn.
Dysentery: Leaves (41a)
Epilepsy: Bark (41a,55)
Febrifuge: ? (41a)
Adansonia za H.Bn.
?: ?
BORAGINACEAE
Heliotropium indicum L.
Diuretic: ? (41a,3)
Emmenagogue: Leaves (41a,21)
Paralysis: ? (41a,21)
BROMELIACEAE
Ananas sativus Schult.
Vermifuge: Leaves (41a,56)
BURSERACEAE
Canarium madagascariense Engl.
Antiseptic: Roots (41a,21)
Blennorrhagia: Leaves, Resin (41a)
Rheumatism: Resin (41a)
Toothache: Resin (41a,49)
Tumours: Resin (41a,21)
Commiphora pterocarpa H.Perr. [Daro]
Vulnerary for ulcerated sores: Trunk bark (12a)
BUXACEAE
Buxus madagascariensis Baill. [Mandakolahy (Bara)]
Purgative/Ocytocic agent/Abortifacient: Bark/Bark w/ Malleastrum sp./Bark w/ Malleastrum sp. (12a)
CACTACEAE
Opuntia dillenii Haw.
Anti-abortifacient: Roots (41a,55)
CAMPANULACEAE
Dialypetalum floribundum Benth. [Paokaty (Merina)]
Dandruff/Vomitive property: ? (12a)
CANELLACEAE
Cinnamosma fragrans H.Bn.
Biliousness: Aerial parts (41a)
Diuretic: Aerial parts (41a)
Stomachic: Bark (41a,21)
Syphilis: ? (41a,49)
Taenifuge: Bark (41a,21)
Whooping cough: ? (41a,49)
Cinnamosma madagascariensis Dang.
Coughs: Bark (41a)
Dysentery: Bark (41a)
CANNABACEAE
Cannabis sativa L.
Stimulant, Narcotic: ? (41a,42,53)
CAPPARACEAE
Capparis chrysomeia Boj. [Rohavitse (Mah.); Bepako (Sak.)]
Headaches: Decoction of leaves and roots (12a)
Physena madagascariensis Steud. & Thou.
Blennorrhagia: Roots (41a,21)
Cathartic: Roots (41a,53)
Febrifuge: ? (41a,1)
CAPPARIDACEAE
Maerva filiformis Drake [Somangy (Mah.)]
Edible/Headaches & nosebleed: Fruits/Leaves (12a)
CARICACEAE
Carica papaya L.
Diptheria: Fruits (41a,1)
Dyspepsia: Fruits (41a,1)
CARYOPHYLLACEAE
Drymaria cordata (L.) Willd. ex Roem. & Schult. [Anatarika (Merina)]
Stimulant: ? (12a)
Stellaria emirensis P.Danguy [Voananjananjana (Merina)]
Vermifuge: ? (12a)
CELASTRACEAE
Celastrus madagascariensis Loes. [Tandrokosy (Merina)]
Fever/Stomach: Leaves and stems/ (12a)
Evonymopsis longipes H.Perr. [Tsihonjonina (Merina)]
Headaches: ? (12a)
Gymnosporia polyacantha (Sond.) Szyszyl. [Filofilondranto (Bara); Tsingilofilofilo]
Expel placenta and treat rheumatism: Decoction of leaves and roots (12a)
Hippocratea bojeri Tul.
Syphilis: Entire plant (41a)
Hippocratea sp. [Fanolehana (Merina)]
Neuralgia/Syphilis/Sores: ? (12a)
Hippocratea urceolus Tul. [Vahipendy]
Oral antiseptic: ? (12a)
Maytenus fasciculata Loes.
Kidney stones: ? (41a,1)
Mystroxylon aethiopicum (Thunb.) Loes.
Anti-spasmodic: Stem leaves (41a)
Stomach/Hypertension/Liver/Albuminuria/Neuralgia/ Diuretic/ Tonic: ? (12a)
CHENOPODIACEAE
Chenopodium ambrosioides L.
Cardiac tonic: Stem leaves (41a)
Febrifuge, Enlarged spleen: Oil (41a,1)
Hookworm, Ascaris, Taenifuge: Leaves (41a,42,55)
Measles, smallpox: ? (41a,1, 38,48)
Syphilis: ? (41a,38)
CLUSIACEAE
Calophyllum inophyllum L.
Ophthalmia: Leaves (41a,21)
Orchitis: Bark (41a,21)
Poison/Haemorrage: Berries/Kernels (12a)
Rheumatism: Oil, Seeds (41a,21)
Ulcers, Scabies: Seed oil (41a,21)
Vulnerary: Resin (41a,21)
Wounds, Cicatrizant: Resin (41a,21)
Calophyllum parviflorum Boj.
Ulcers: Roots (41a,21)
Wounds, Cicatrizant: Roots (41a,21)
Ochrocarpos orthcladus H. Perr. [Andriapitoloha (Merina)]
Syphilis/Back pains: Leafy stems/ (12a)
Symphonia fasciculata Benth. & Hook.
Contusions: Seeds (41a,21)
Leprosy: Seeds (41a,21)
Rheumatism: Seeds (41a,21)
Scabies, Ulcers: Seeds (41a,21)
COMBRETACEAE
Calopyxis grandidieri H.Perr.
Vermifuge: Seeds (41a,29)
Calopyxis phaneropetala H.Perr.
Ascaris, Vermifuge: Bark, Fruits, Roots (41a,29)
Calopyxis subumbellata Bak.
Hiccups: Bark (41a,29)
Hookworm, Ascaris, Taenifuge: Bark (41a,29)
Calopyxis villosa Tul.
Vermifuge: Fruits (41a,29)
Poivrea coccinea D.C.
Vermifuge: Bark, Fruits, Roots (41a,29)
Poivrea sp. [Voatamenaka (Merina)]
Vermifuge: ? (12a)
Terminalia catappa L.
Blennorrhagia: Leaves (41a,33)
Sores: Leaves (41a,33)

COMMELINACEAE
Commelina benghalensis L.
Malaria: Entire plant (41a,42)
Sprains: Entire plant (41a)
Commelina madagascarica Clarke [Nifinakanga (Merina)]
Galactogogue: Leaves (41a,53)
Facial pimples: Stem (12a)
COMPOSITAE
Ageratum conyzoides L.
Bruises: Leaves (41a,21)
Cirrhosis: Stem leaves (41a)
Diaphoretic: ? (41a,53)
Leprosy: Leaves, Stems (41a,21)
Ophthalmia: ? (41a,21)
Stomach/Coughs: Flowers/Aerial parts (12a)
Bidens pilosa L. [Tsipolotra (Merina)]
Sores: Leaves (12a)
Bojeria speciosa D.C.
Syphilis: Leaves (41a,21)
Brachylaena perrieri Humb.
Blennorrhagia: Stem leaves (41a)
Brachylaena ramiflora Humb. [Hazotokana (Merina); Mananitra (Merina)]
Epilepsy: Wood (41a,53)
Febrifuge, Malaria: ? (41a,3)
Low blood pressure/Constipation/Stomach/Fever/Urine inconsistency/Gonorrhoea/Diabetes/Ulcerous sores/Ocytocic agent ? (12a)
Vermifuge: Leaves (41a,53)
Conyza aegyptiaca Ait. var. lineariloba DC.
Biliary stones: Aerial parts (41a)
Diuretic, Kidney ailments: ? (41a,22)
Febrifuge, Malaria: Entire plant (41a,3)
Gout, Anaemia: Entire plant (41a)
Haemostatic: Sap (41a,1)
Tonic: ? (41a,2)
Toothache: ? (41a,21)
Whooping cough, Pneumonia: Entire plant (41a)
Conyza garnieri Klatt. [Miandramiondrika (Merina)]
Toothache: Leaves (12a)
Hepatic fever: Aerial parts (41a)
Crassocephalum bojeri (DC) Robyns [Vahavandana (Merina)]
Syphilis: Entire plant (12a)
Crassocephalum sarcobasis (DC) Moore [Anadrambo (Merina)]
Leprosy: Aerial part (12a)
Dichrocephala latifolia DC.
Boils: Leaves (41a,22)
Dichrocephala lyrata DC.
Adenitis: ? (41a,47)
Conjunctivitis: Leaves (41a,11,21)
Ear troubles: Leaves (41a,11)
Dichrosephala lyrata DC.
Wounds: ? (41a,21)
Eclipta erecta L.
Dermatoses: ? (41a)
Elephantopus scaber L.
Anaemia, regulates bleeding: Leaves (41a,22)
Blennorrhagia, Syphilis: ? (41a,53)
Diuretic: ? (41a,3)
Stomach/Dysentery/Haemostatic: ? (12a)
Vermifuge: ? (12a)
Emilia amplexicaulis Bak.
Condyloma: ? (41a,1)
Emilia citrina D.C.
Scabies: ? (41a,1,2)
Condyloma: Leaves (41a,1,42)
Burns/Haemostatic/Eczema/Ulcerous sores: Leaves, Juice from fresh plant/ (12a)
Syphilis: ? (41a,53)
Emilia graminea D.C.
Chancre, Syphilis: Leaves (41a,1)
Scabies: Leaves (41a,1)
Emilia humifusa D.C.
Condyloma: Leaves (41a,22)
Epallage dentata D.C. [Angeha (Merina); Trakamena (Merina)]
Ocytocic agent/Syphilis: Aerial part/ (12a)

COMPOSITAE (contd.)
Erigeron naudinii E.Bonnet [Kelivoloina (Merina); Maitsoririnina (Merina)]
Coagulant/Coughs: Leaves/ (12a)
Ethulia conyzoides L. [Keliomandra, Tangentsahona (Mer.)]
Asthma, Haemoptysis: Entire plant (41a,21)
Scabies: ? (41a,21)
Etulia conyzoides L.
?: Leaves (41a,21)
Chancre, Syphilis: Leaves (41a,21)
Gerbera elliptica H.Humb. [Fotsiavadika (Merina)]
Vermifuge/Stomach/Antidote to Cerbera venenifera: Leaves/ (12a)
Grangea maderaspatana Poir.
Anti-spasmodic: Leaves (41a,21)
Gynura rubens Muscher
?: Leaves (41a,1)
Antifungal agent: ? (41a,21)
Eczema, Scabies: ? (41a,1)
Kidney ailments: ? (41a,22)
Gynura sarcobasis D.C.
Facial sores of venereal origin: Entire plant (41a)
Helichrysum benthami R.Vig. & H.Humb. [Tsimonomonina (Merina)]
Albuminuria: ? (12a)
Diseases of the spinal marrow: Aerial parts (41a)
Syphilis, Blennorrhagia: Aerial parts (41a)
Helichrysum bracteiferum Humb.
Stimulant: ? (41a,53)
Helichrysum cordifolium D.C. [Fotsiavadika (Merina); Tsimanandrana (Merina)]
Colic/Witchcraft/Cicatrizant after circumcision: ? (12a)
Helichrysum emirnense DC.
?: Stem leaves (41a,12)
Diuretic: ? (41a,53)
Helichrysum faradifani Sc. Ell.
Cicatrizant: Stem leaves (41a)
Gonorrhoea/Coughs/Fever/Stomach/Decontracturant: ? (12a)
Helichrysum fulvescens D.C.
Jaundice: ? (12a)
Helichrysum gymnocephalum Humb.
Angina: ? (41a,21)
Antiseptic: ? (41a,37)
Aphrodisiac, Galactorrhoea, Amenorrhea, Dysmenorrhea: ? (41a,21)
Goiter, Rickets: ? (41a,21)
Headaches: Aerial parts (41a,4,49)
Herpes: Leaves (41a)
Stimulant: ? (41a,53)
Ulcers: ? (41a)
Helichrysum mutisiaefolium H.Humb. [Ahitrorana (Merina); Kelilimeladia (Merina)]
Haemostatic/"Tambavy": Juice (12a)
Helichrysum rusillonii Hochr.
Cicatrizant, Antiseptic: ? (41a,22)
Gout: Aerial parts (41a)
Rheumatism: ? (41a)
Helichrysum sp. [Tsatsambaitra (Merina)]
Ocytocic agent/Diabetes/Coughs: ? (12a)
Haemostatic: ? (12a)
Urine inconsistency/Syphilis/Diuretic/: Entire plant (12a)
Inula speciosa (DC) O.Hoffm. [Lelanomby (Merina); Salakanny mpiosy (Merina)]
Gonorrhoea/Liver/Coughs: Leaves/Leaves/Leaves (12a)
Lactuca welwitschii Sc. Ell.
Febrifuge: ? (41a,22)
Laggera alata Sch. Bip.
Antiseptic: ? (41a,38)
Diseases of the nervous system: ? (41a,47)
Dizziness/Headaches: Leaves? (12a)
Febrifuge: ? (41a)
Flu, Head cold: ? (41a,47)
Scabies: Leaves (41a,11)
Melanthera madagascariensis Bak.
Wounds: ? (41a,53)

COMPOSITAE (contd.)
Parthenium hysterophorus L.
Anti-spasmodic: ? (41a,2)
Malaria: ? (41a,3)
Psiadia altissima Benth. & Hook.
Condyloma: Leaves (41a,1,22)
Scabies, Eczema: Stem (41a)
Sores/Diarrhoea: ? (12a)
Syphilis: Ashes (41a,21)
Ulcers: Leaves (41a,53)
Psiadia salviaefolia Bak. [Kijitina (Merina)]
Liver/Diabetes/Boils: ? (12a)
Psiadia sp. [Dingadingana (Merina)]
Pneumonia: Leaves (12a)
Pterocaulon decurrens Moore
Diaphoretic: ? (41a,53)
Leprosy: ? (41a,42)
Senecio adscendens Boj.
Scabies: Leaves (41a,22)
Syphilis: Leaves (41a,22)
Senecio canaliculatus Boj. ex. DC. [Ramijaingy (Merina)]
"Tambavy"/Syphilis: ? (12a)
Senecio cochlearifolius Boj. [Fotsiavadika (Merina)]
Liver: ? (12a)
Senecio erechtitoides Bak.
Asthma, Consumption: ? (41a,21)
Measles: ? (41a,21)
Syphilis: Leaves (41a,53)
Senecio faujasioides Bak. [Anadraisoa (Merina); Kiboiboy (Merina)]
Condyloma: Leaves (41a,1)
Sores/Syphilis/Facial pimples: ? (12a)
Syphilis: Leaves (41a,49)
Wounds, Abcesses, Chapped feet: Leaves (41a,58)
Senecio longiscapus Boj. ex DC. [Tsiavaramonina (Merina); Manavitrana (Merina)]
"Tambavy"/Syphilis/Sores/: ? (12a)
Senecio myricaefolius DC.
Condyloma: Leaves (41a,22)
Syphilis: Leaves (41a,53)
Senecio resectus Boj. ex. DC. [Tsimonina avaratra (Merina)]
Syphilis: ? (12a)
Senecio sp. [Fiandry vava ala (Merina)]
Abnormally obese children: Entire plant (12a)
Gonorrhoea/Syphilis: Entire plant/ (12a)
Stomach/Neuralgia/Syphilis: Aerial parts (12a)
Syphilis/Eczema/Boils/Anthrax: ? (12a)
Siegesbeckia orientalis L.
Blennorrhagia, Syphilis: Entire plant (41a)
Gout: Entire plant (41a)
Haemostatic: Entire plant (41a)
Stimulant: Entire plant (41a)
Vulnerary: ? (41a,3)
Spilanthes acmella Murr.
Galactogogue: Leaves (41a,21)
Diuretic: ? (41a,21)
Tonic: ? (41a,21)
Toothache: ? (41a,31)
Stenocline aricoides DC. [Mahaibe (Merina)]
Sores: ? (12a)
Stenocline inuloides D.C.
Febrifuge, Malaria: Leaves (41a,22)
Tagetes patula L.
Enlarged spleen: Capitulum (flowers) (41a,2)
Vernonia appendiculata Less.
Chicken pox, Measles: ? (41a,48)
Febrifuge: Leaves (41a,11)
Nervousness/Fever: ? (12a)
Wounds: Fruit pulp (41a,21)
Vernonia diversifolia Boj. [Mangatovo (Merina)]
Coughs: Leaves (12a)
Coughs, Consumption: Stem leaves (41a,21,49)
Wounds: Leaves (41a)
Vernonia eriophylla Drake
Diseases of the nerves: Aerial parts (41a)
Vernonia exserta Bak. [Sakatavilotra ala (Merina)]
Coughs/Vermifuge/"Tambavy": Entire (12a)
Vernonia garnieriana Klatt. [Ramanjavona (Merina)]
Fatigue/Childbirth: ? (12a)

COMPOSITAE (contd.)
Vernonia glutinosa DC. [Ningininginа (Merina); Kanda (Merina)]
Blennorrhagia, Syphilis: Entire plant (41a,21,49)
Syphilis/Neuralgia/Back pains/"Tambavy": Aerial part (12a)
Urethritis: ? (41a,22)
Vernonia moquinoides Bak. [Hazomavo (Merina)]
Swollen stomach: ? (12a)
Vernonia pectoralis Bak.
Coughs, Consumption: Leaves, Tops (sommites) (41a,21,49)
Malaria: ? (41a,1)
Tonic: ? (41a,53)
Vernonia polygalaefolia Less. [Tsialaina-alakamisy (Merina); Nanginangina (Merina)]
Anodyne/"Tambavy": ? (12a)
Vernonia secundifolia Boj. ex DC. [Ranendohazo (Merina)]
Haemostatic: Leaves or roots (12a)
Vernonia sp. [Ahibolo (Merina)]
Diarrhoea: Aerial part (12a)
Gonorrhoea: ? (12a)
Stomach: ? (12a)
Vernonia trichodesma Bak.
Coughs: ? (41a,21,49)
Malaria: Leaves (41a)
Vernonia trinervis Boj. ex DC. [Kijejalahy (Merina); Longolongo: (Merina)]
Neuralgia/Head problems/Gonorrhoea/Coughs/: Leaves/ Leaves/ (12a)
CONNARACEAE
Agelaea lamarckii Planch.
Nerve tonic: Entire plant (41a)
Tonic: Entire plant (41a)
Cnestis polyphylla Lamk.
Rabies: ? (41a,45)
Tonic: ? (41a)
CONVOLVULACEAE
Ipomoea pescaprae (L.) Sweet [Lalanda (Antaimoro)]
Gonorrhoea: Leaves (12a)
Ipomoea sp. [Marovelo]
Fractures, Dislocations: ? (41a,42)
Ipomoea wrightii Choisy
Gout: ? (41a,21)
CORNACEAE
Kaliphora madagascariensis Hook. [Ranendo (Merina)]
Nervousness/Headaches/Convulsions/Fainting: ? (12a)
CRASSULACEAE
Kalanchoe crenata Ham.
Febrifuge: ? (41a,21)
Vermifuge: Leaves (41a,21)
Kalanchoe laxiflora Bak.
Diuretic: Entire plant (41a)
Febrifuge: ? (41a)
Ophthalmia: ? (41a)
Ulcers: Entire plant (41a)
Kalanchoe prolifera Ham.
Abcesses: Entire plant (41a)
Burns, Contusions: Entire plant (41a)
Coughs, Whooping cough: ? (41a,55)
Gout: ? (41a,38)
Rheumatism, Periostitis: Leaves (41a,42)
Kalanchoe sp. [Tsikotroka (Merina)]
Stomach: ? (12a)
CRUCIFERAE
Nasturtium barbareaefolium Bak.
Abcesses: Leaves (41a,1)
CUCURBITACEAE
Adenopus breviflorus Benth.
Scabies: Roots (41a,21)
Benincasa cerifera Savi
Vermifuge: Fruits and leaves (41a,1,38)
Citrulus vulgaris Schrad.
Vermifuge/Taenifuge: Seeds (41a,3)
Cucumis sativus L.
Vermifuge: Fruits (41a,21)
Cucurbita maxima Duch.
Diuretic, Haemoglobinuria: ? (41a,47)
Jaundice: ? (41a,47)
Taenifuge: Seeds (41a,55)

CUCURBITACEAE (contd.)
Momordica charantia L.
Emmenagogue: ? (41a)
Vermifuge: Seeds (41a)
Raphidiocystis brachypoda Bak. [Vavorakala (Merina)]
Neuralgia: ? (12a)
CUNONIACEAE
Weinmannia rutenbergii Engl. [Hazoboangory (Merina)]
Headaches: ? (12a)
Weinmannia sp.
Constipation: ? (12a)
CYPERACEAE
Carex albo-viridis Clarke
Aphrodisiac: ? (41a,21)
Cyperus aequalis Vahl
Bruised wounds: ? (41a,21)
Cyperus esculentus L.
Aphrodisiac: Tubercles (41a,21)
Cyperus rotundus L.
Scabies: Roots (41a,21)
Kyllingia polyphylla Kunth. [Ahipolaka (Merina)]
Fever: Entire (12a)
Kyllingia sp.
Fever: ? (12a)
DIOSCOREACEAE
Dioscorea bulbifera L. [Hofika (Merina)]
Wounds and sores/Boils/Swelling: Bulbil (12a)
Dioscorea sansibarensis Pax.
Anthrax: Bulbil (41a,56)
Antiseptic, Contusions, Wounds: Bulbil (41a)
Dioscorea sp. [Orovy]
Febrifuge: Roots (41a)
DROSERACEAE
Drosera madagascariensis D.C.
Condyloma: Entire plant (41a,42)
Anaemia: Entire plant (41a)
Anti-spasmodic: ? (41a,2)
Coughs: Leasf stems (41a,1)
Syphilis: Entire plant (41a)
Drosera madagascariensis DC. [Mahatanando (Merina)]
Diuretic/Urine inconsistency: ? (12a)
EBENACEAE
Diospyros graceilipes Hiern.
Irritant: Bark (12a)
Diospyros humbertiana H.Perr. [Hazonta (Mah.)]
Febrifuge and headaches: Cataplasm of roots and stems (12a)
Diospyros megasepala Bak.
Smallpox: Leaves and roots (41a,12)
Taenifuge: Leaves (41a,12)
Ulcers: Leaves (41a,21)
Diospyros sp. [Tsilaitia (Merina)]
Neuralgia/Strengthener: ? (12a)
EQUISETACEAE
Equisetum ramosissimum Desf. [Tsitoitoina (Merina)]
Anorexia: ? (12a)
Conjunctivitis: ? (41a,11)
Diuretic, Retention of urine, Nephritis, Cystitis: Entire plant (41a,21)
Dysmenorrhea, Leucorrhea: ? (41a)
Liver congestion: ? (41a,2)
Pneumonia: Entire plant (41a)
ERICACEAE
Agauria polyphylla Bak. [Angavodiana (Merina)]
Itching/Syphilis: Leaves/ (12a)
Rheumatism: Leaves (41a,21)
Ulcers, Eruptions: Leaves, Seeds (41a,1,4)
Wounds: Leaves (41a,1)
Agauria salicifolia Hook. [Angavodiandrano (Merina)]
Ulcerous sores/Syphilis/Neuralgia: ? (12a)
Philippia goudotiana Klotz.
Scabies, Eczema, Ulcers, Nettle rashes: ? (41a,1,47)
Wounds: ? (41a,53)
Philippia sp. [Anjavidy (Merina)]
Syphilis: Leafy stems (12a)
ERIOCAULACEAE
Mesanthemum rutenbergianum Koern. [Savory (Merina)]
Anti-abortifacient: ? (41a,53)
Childbirth: ? (12a)

ERYTHROXYLACEAE
Erythroxylum ferrugineum Cav.
Blennorrhagia: Stem leaves (41a)
Diuretic: Stem leaves (41a)
Kidney colic: Leaves (41a,21)
Erythroxylum retusum Baill. ex O.E.Schulz. [Montsao (Sak.)]
Vermifuge: Leaves (12a)
Erythroxylum sp. [Taimboalavo (Merina)]
"Tambavy"/Breathlessness: ? (12a)
Fever: Entire (12a)
EUPHORBIACEAE
Acalypha radula Bak.
Syphilis: Stem leaves (41a)
Acalypha spachiana H.Bn.
?: ?
Aleurites triloba Forst.
Rheumatism: Leaves (41a,21)
Antidesma petiolare Tul.
Swollen fontanelles in children: Stem leaves (41a)
Bridelia pervilleana H.Bn.
Syphilis: Stem leaves (41a)
Croton cf. noronhae Baill. [Fotsiavadika (Betsim.)]
Anodyne: Leaves (12a)
Croton jennyanum Gris.
Syphilis: Stem leaves (41a)
Croton sp. [Tsiandrikandrinina (Merina)]
Adenitis/Swelling: ? (12a)
Anorexia/Fortifier: ? (12a)
Antitussive: ? (12a)
Antitussive/Post-partum stomach pains: ? (12a)
Cicatrizant/Tooth cavities: ? (12a)
Febrifuge: ? (12a)
Gonorrhoea/Intestinal troubles: ? (12a)
Lactation: ? (12a)
Laxative: ? (12a)
Nervous children/Headaches: ? (12a)
Sedative: ? (12a)
Stomach/Dandruff: ? (12a)
Dalechampia clematidifolia Boj.
Detersive, Wounds: Roots, Leaves (41a,21)
Euphorbia bojeri Hook.
Blennorrhagia: Leaves, Roots (41a,1)
Euphorbia erythroxyloides Bak.
Lumbago: Roots (41a,21)
Euphorbia hirta L.
Bronchitis, Asthma: Entire plant (41a,1)
Ulcers: Entire plant (41a)
Vermifuge: ? (41a,46)
Euphorbia laro Drake. [Laro (Mah.)]
Fish poison/Gonorrhoea: ? (12a)
Euphorbia milii Des Moulins
Blennorrhagia: Leaves, Roots (41a,1)
Neuralgia: Aerial parts (41a)
Vesicant: Latex (41a,42)
Euphorbia sp. [Matahotrantsy (Merina)]
Stomach: ? (12a)
Ulcerous sores: ? (12a)
Euphorbia trichophylla Bak.
Purgative: ? (41a,21)
Fluggea microcarpa Blume
Malaria: ? (41a,1,38)
Gelonium sp. [Hazombalala (Sak.)]
Sores: Leaves (12a)
Givotia madagascariensis H.Bn.
Leprosy: Bark (41a,53)
Hura crepitans L.
Intestinal pains: Aerial parts (41a)
Strong purgative: Seeds (41a,3)
Jatropha curcas L.
Detersive, Wounds: Latex (41a,21)
Angina: Latex (41a,21)
Baldness, Boils: Leaves (41a,47)
Emetic: Roots (41a,21)
Herpes: Leaves (41a,47)
Jaundice fever: ? (41a,55)
Malaria: ? (41a)
Purgative: Seeds (41a,21)
Wood: Astringent (41a,21)

EUPHORBIACEAE (contd.)
Jatropha mahafalensis Jum. & Perr.
Haemostatic: Latex (41a,21)
Kill lice/Reconstituent: Seed oil/Roots (12a)
Macaranga sp. [Mokaranandoha]
Blennorrhagia: Bark (41a)
Burns: ? (12a)
Manihot utilissima Pohl.
Adenitis, Boils, Ulcers: Leaves (41a,1,47)
Diarrhoea, Dysentery: Roots (41a,47)
Malaria: Leaves (41a,47)
Pneumonia: Leaves (41a,47)
Wounds, Burns: Leaves (41a,1)
Phyllanthus casticum Soy. Will.
Detersive, Wounds: Bark (41a,1)
Aphrodisiac: Roots (41a,21)
Astringent, Dysentery: Bark (41a,53)
Jaundice: Aerial parts (41a)
Venereal ailments: Sap (41a,21)
Phyllanthus distichus Muell. Arg.
Asthma, Bronchitis: Tiges feuille (41a)
Phyllanthus madagascariensis Muell. Arg.
Detersive, Wounds: Bark (41a,1)
Astringent: ? (41a,53)
Phyllanthus niruri L.
Asthma, Bronchitis: Stem leaves (41a)
Astringent: Bark (41a,3)
Blennorrhagia: ? (41a,21)
Parasitic diseases of the skin: Stem leaves (41a)
Phyllanthus sp. [Masombero (Merina)]
Childbirth: ? (12a)
Eczema/Sprains and swellings/Dizziness and fainting: Leaves/Leaves/Roots (12a)
Neuralgia/Syphilis: ? (12a)
Pneumonia: Stem leaves (41a)
Ricinus communis L.
Galactogogue: Young leaves (41a)
Angina: Leaves, Young shoots (41a,49,38)
Purgative, Emetic: Seeds (41a,1,33)
Rheumatism: Leaves (41a)
Stomach ache: Leaves (41a,49)
Securinega capuronii J.Leandr. [Hazomena (Sak.)]
Diarrhoea: Stem bark (12a)
Uapaca bojeri H.Bn.
Dysentery: Bark (41a)
FLACOURTIACEAE
Aphloia theaeformis Benn.
"Osmeomalacie": Leaves (41a,21)
Albuminuria, Diuretic, Dropsy: Leaves (41a,42,53,56)
Blennorrhagia: Stem leaves (41a)
Diarrhoea, Astringent: Branch leaves (41a,53)
Emetic: Bark (41a,3)
Haematuria, Haemoglobinuria: Young leaves (41a)
Jaundice, Biliousness, Haemoglobinurique: Stem leaves (41a,15)
Rheumatism: Leaves (41a,21)
Wounds, Bruises, Fractures, Sprains: Stems, Leaves (41a,21)
Wounds, Ulcers: Stems (41a,21)
Calantica grandiflora Jaub.
Ophthalmia: Leaves (41a,55)
Calantica sp. [Andriamanamora (Merina)]
Childbirth: ? (12a)
Casearia sp. [Hazomalefaka (Merina)]
Sedative/Ocytocique: ? (12a)
Flacourtia ramontchi L'Her.
Diuretic, Kidney colic: Berries, Seeds (41a,21,53)
Madness: Berries (41a,21)
Homalium sp. [Hazomby (Merina)]
"Tambavy"/Diabetes: ? (12a)
Kidney pain: ? (12a)
Scolopia sp. [Hazondrano lahy (Merina)]
Rheumatism: ? (12a)
FLAGELLARIACEAE
Flagellaria indica L.
Otitis: Young shoots (41a,55)

GENTIANACEAE
Tachiadenus carinatus Griseb.
Nerve disorders: ? (41a,21)
Purgative, Stomachic: Entire plant (41a,21)
Scalp ringworm: ? (41a)
Skin ailments: Entire plant (41a)
Urethritis: ? (41a,21)
Tachiadenus longifolius Sc. Ell.
Jaundice, Biliousness, Hemoglobinurique: Aerial parts (41a)
Laxative/Dyspepsia: ? (12a)
Pyrosis, Stomachic: Roots (41a,3)
Rheumatism: ? (41a)
Tonic: Entire plant (41a,53)
GERANIACEAE
Geranium simense Hochst.
Scabies: Leaves (41a,1)
GRAMINEAE
Cymbopogon citratus Stapf.
Depurative: ? (41a,3)
Neuralgia: Leaves (41a)
Cymbopogon plicatus Stapf. [Ahibero (Sak.)]
Diarrhoea/Jaundice: Leaves (12a)
Cynodon dactylon Pers.
Anti-abortifacient: Entire plant (41a,38,55)
Blennorrhagia, Syphilis: Underground parts (41a)
Diuretic, Cystitis: Roots (41a,53)
Gout: Entire plant (41a,38,55)
Rheumatism: Entire plant (41a,38)
Sprains: Roots (41a)
Eleusine indica Gaertn. [Tsipihipihina (Merina); Ahidrindrina (Merina)]
Sprains/Stomach: Juice/ (12a)
Imperata cylindrica (L.) PB [Fakatenina (Merina)]
Angina/Neuralgia: ? (12a)
Oryza sativa L.
Diarrhoea, Dysentery, Gastralgia, Flatulence, Dyspepsia: Graines (41a,53)
Stomach cramps: Entire plant (41a)
Panicum maximum Jacq. [Fataka (Merina)]
Cicatrizant: ? (12a)
Phragmites communis Tun. [Bararata (Merina)]
Heart/Ears: Culm/ (12a)
Phragmites mauritianus Kunth.
Malaria: ? (41a,38)
Otitis: Young shoots (41a,55)
Saccharum officinarum L.
Chancre: ? (41a)
Diuretic: Roots (41a,3)
Zea mays L.
Cardiac edema: Stigmates (41a,3)
Diuretic: Stigmates (41a,3)
HAMAMELIDACEAE
Dicoryphe noronhae Tul.
Amenorrhea: Fruits (41a,53)
Dicoryphe retusa Bak.
Leprosy: Bark (41a,55)
HERNANDIACEAE
Hernandia voyroni Jum.
Headaches, Stimulant: ? (41a)
Jaundice: Bark (41a)
Stimulant: Leaves (41a)
HYDROSTACHYACEAE
Hydrostachys imbricata A.Juss.
Eczema/Boils: ? (12a)
HYPERICACEAE
Haronga madagascariensis Choisy
Amenorrhea, Emmenagogue: Leaves (41a,21)
Blennorrhagia: Leaves (41a,21)
Dysentery, Diarrhoea: Leaves, Young shoots (41a,1,38,58)
Febrifuge: Leaves (41a,21)
Haemorrhoids: Bark, Leaves (41a,54)
Intellectual stimulant: Leaves (41a,49)
Intestinal debility: Leaves (41a,49)
Scabies, Eczema, Scurf, Ailments of the skin and scalp: Gum-resin (41a,1,53)
Tuberculosis, Asthma, Angina: Leaves (41a,21)
Wounds: Stems plus leaves (41a)

HYPERICACEAE (contd.)
Harungana madagascariensis Choisy [Har ngana (Merina)]
Asthma/Coughs with blood: ? (12a)
Hypericum japonicum Thunb.
Haemostatic: ? (41a,21)
Stomach troubles, Dysentery: Stem leaves (41a,21)
Psorospermum androsaemifolium Bak. [Tsifady (Merina); Fanera (Merina)]
Antidote/Neuralgia: ? (12a)
Diseases of the fontanelles: Leaves (41a,55)
Eczema, Scabies, Ulcers: Leaves, Roots (41a,1,21)
Wounds: Leaves (41a,21)
Psorospermum fanerana Bak.
Diuretic: ? (41a,47)
Psorospermum ferrovestitum Bak. [Andriambolamena (Merina)]
Miscarriage: ? (12a)
Psorospermum sp. [Harongapanihy (Merina)]
Diarrhoea: ? (12a)
ICACINACEAE
Cassinopsis madagascariensis Baill. [Hazomafaitra vavy (Merina)]
Constipation/Syphilis: ? (12a)
Malaria: Leaves, Bark (41a,27)
IRIDACEAE
Geissorhiza bojeri Bak.
Stomachic: Bulb (41a,21)
Syphilis: Bulbs (41a,21)
Ulcers: ? (41a,21)
Wounds: Bulbs (41a,21)
Gladiolus garnieri Klatt. [Fodilahimena (Merina)]
Anthrax, Adenitis: Bulbs (41a,21)
Mental: ? (12a)
Purgative: Bulb (41a,12)
Tumours: Leaves (41a,21)
LABIATAE
Coleus bojeri Benth. [Ranofarita (Merina); Ramifaritra (Merina)]
Eczema/Eyes/Syphilis: Juice/ (12a)
Coleus sp. [Amparimaso (Merina)]
Diarrhoea: ? (12a)
Urethritis: ? (41a)
Wounds: ? (41a)
Hyptis pectinata Poit. [Afolava (Merina)]
Angina: Tops (41a,53)
Anti-spasmodic: Leaves (41a,53)
Emmenagogue: ? (41a,53)
Febrifuge, Malaria, Diaphoretic: Flowering tops (41a,21,53)
Stomach troubles: ? (41a,21)
Tonic: ? (41a,53)
Vermifuge: ? (41a,21,53)
Whooping cough: ? (12a)
Whooping cough, Coughs, Colds: Entire plant (41a)
Hyptis sp. [Sangasanga (Merina)]
Stomach/"Tambavy": ? (12a)
Hyptis spicigera Lamk.
Colds: Entire plant (41a,1)
Leonotis nepetaefolia R.Br.
Anti-spasmodic, Narcotic: Stem leaves (41a,21)
Emmenagogue, Amenorrhea: ? (41a,21)
Purgative: ? (41a,21)
Skin ailments: ? (41a)
Ocimum basilicum L.
Anti-spasmodic: ? (41a,53)
Ocimum canum Sims [Rombiromby]
Accelerate hardening of fontanelles in infants: Decoction with Hazunta modesta (12a)
Blennorrhagia: Leaves (41a,54)
Dyspepsia, Antiemetic: ? (41a,53)
Ear ailments: Leaves (41a,21)
Febrifuge: Seeds (41a,49)
Migraines, Paralysis, Neuroses: Leaves, Seeds (41a,21)
Nephritis: Leaves (41a,21)
Rheumatism: Leaves (41a,21)

LABIATAE (contd.)
Ocimum gratissimum L.
Angina: Leaves (41a,21)
Anti-spasmodic, Headaches: Leaves (41a,49,53)
Antiemetic, Dyspepsia, Depurative: Flowers (41a,53,21)
Coughs, Whooping cough, Pneumonia: Entire plant (41a)
Diarrhoea with mucus: Seeds (41a,21)
Headaches/Albuminuria/Sprains/Disinfectant: ? (12a)
Uterine colic: Leaves (41a,21)
Plectranthus cymosus Bak.
Syphilis: ? (41a,21)
Plectranthus sp. [Manitrady (Merina)]
Head: ? (12a)
Pycnostachys coerulea Hook. [Mangavony (Merina)]
Neuralgia/Syphilitic stigmates/Sedative: ? (12a)
Syphilis: Stem leaves (41a)
Tetradenia fruticosa Benth.
?: Leaves, Sap and Roots (41a,12,21)
Antiseptic: Leaves (41a,21)
Diarrhoea, Dysentery, Emetic: Leaves (41a,1,38)
Scabies, Ulcers, Abcesses: Leaves, Roots (41a,21)
Syphilis: Entire plant (41a)
LAURACEAE
Cassytha filiformis L.
Rickets: Aerial parts (41a,21)
Baldness, Scalp ailments: ? (41a,21)
Blennorrhagia, Syphilis: ? (41a,21)
Diuretic: ? (41a,21)
Dysentery: ? (41a,21)
Gonorrhoea/Witchcraft: ? (12a)
Cinnamomum camphora Sieb. [Ravitsara (Merina)]
Diabetes: ? (12a)
Malaria, Febrifuge: Leaves (41a,1)
Ravensara aromatica Gmel.
Febrifuge: Leaves (41a)
Stimulant: Bark (41a,3)
Ravensara sp. [Molaliambo (Merina)]
Coughs: ? (12a)
LECYTHIDACEAE
Barringtonia racemosa Roxb.
Vermifuge: Amandes (41a,21)
Barringtonia speciosa L.
Sedative: ? (41a,53)
LEGUMINOSAE
Abrus aureus R.Vig. [Voamentilana (Betsim.)]
Coughs/Bronchitis: ? (12a)
Abrus precatorius L. [Voamentilano (Betsim.)]
Coughs: Leaves (12a)
Coughs, Bronchitis, Asthma, Whooping cough: Roots (41a,3)
Genital edema: Stems plus leaves (41a,21)
Malaria: Leaves (41a,1)
Aeschynomene laxiflora Boj.
Whooping cough: Leaves, Stems (41a,55)
Albizia adianthifolia (Schum.) W.F.Wight [Sambala (Betsim.); Volomborona (Betsim.)]
Dysentery: Leaves (12a)
Albizia fastigiata Oliv.
Diaphoretic: Bark (41a,53)
Diarrhoea: Leaves (41a,1,58)
Sores/Coughs/Asthma/Fractures/Syphilis/Neuralgia: Leaves/ (12a)
Syphilis: Leaves (41a,21)
Wounds, Antiseptic: Leaves (41a,55)
Albizia gummifera C.A.Smith
Blennorrhagia: Stem leaves (41a)
Consumption, Colds, Coughs: Tiges feuille (41a)
Diarrhoea: Wood, Leaves (41a,21)
Nerve diseases: Stem leaves (41a)
Albizia lebbek Benth.
Angina: ? (41a,21)
Syphilitic tumors: ? (41a,1,38)
Cadia sp.
Whooping cough: Stem leaves (41a,55)

LEGUMINOSAE (contd.)
Caesalpinia bonducella Fleming [Vatolalaka (Merina)]
"Eutocique": Seeds (41a,21)
Ocytocic agent/Abortifacient: Seeds/ (12a)
Antihelminthic: Seeds (41a,21)
Blennorrhagia: Leaves, Seeds, Roots (41a,38,55)
Emmenagogue: Bark, Roots, Leaves (41a,21)
Laxative, Dysentery: Seeds (41a,38)
Malaria: Seeds (41a,21)
Paralysis, Anti-spasmodic: Stems and leaves (41a)
Tonic, Aperitif: Roots, Seeds (41a,38,1)
Caesalpinia sepiaria Roxb.
Amenorrhea: Wood (41a,21)
Blennorrhagia: Wood, Leaves, Roots (41a,21,55)
Gonorrhoea/Syphilis: Entire plant/ (12a)
Cajanus indicus Spreng.
Cardiac tonic: Tiges feuille (41a)
Diuretic: Leaves (41a)
Laxative: Leaves (41a,21)
Calliandra alternans Benth. [Hazomahery (Merina); Ambilazo (Merina)]
Neuralgia: ? (12a)
Scurf: ? (41a,21)
Calliandra sp. [Ambilazo;]
Syphilis: Stem leaves (41a)
Cassia alata L.
Hypertension: ? (12a)
Skin ailments, Impetigo: Leaves (41a,1)
Cassia fistula L.
Laxative, Depurative: Fruits (41a,3)
Cassia laevigata Willd. [Anjanjana (Merina); Maroatovy (Merina)]
"Tambavy" for children/: Leaves (12a)
Biliousness: Leaves (41a,21)
Blennorrhagia, Syphilis: Stem leaves (41a)
Laxative, Depurative: Leaves (41a,3)
Cassia mimosoides L. [Kely manjakalanitra (Merina)]
Eyes: ? (12a)
Cassia occidentalis L.
Biliousness: Leaves (41a,21)
Blennorrhagia, Syphilis: Stem leaves (41a)
Diuretic, Cystitis: Roots (41a,21)
Gout, Anaemia: Tops, Stems, Leaves (41a)
Hysteria: ? (41a)
Laxative, Depurative: Leaves (41a,21)
Malaria: Leaves (41a,21)
Malaria/Diuretic/Coffee substitute: Root/Leaves/Berries (12a)
Scabies, Eczema, Scurf: Seeds (41a)
Sciatica: ? (41a)
Tonic: Roots (41a,21)
Whooping cough, Bronchitis: Leaves (41a,55)
Cassia occidentalis Sond. [Tsatsinangatra (Merina); Tsotsorinangatra (Merina)]
Jaundice/Malaria/Hypertension/Prostate/Rheumatism/ Stomach (baby)/Gonorrhoea: Legume/Root/Leaves/ Leaves/Seeds/Root/ (12a)
Cassia tora L.
Antihelminthic: ? (41a,3)
Hysteria: ? (41a,21)
Scurf, Impetigo, Scabies: Leaves, Seeds (41a,1)
Stomachic: Leaves (41a,1)
Clitoria lasciva Boj.
Chancre phagedenique: ? (41a,21)
Clitoria ternatea L.
Articular pains: ? (41a)
Diuretic, Bladder irritation: Roots (41a,21)
Gastralgia: Roots (41a,21)
Purgative: Seeds (41a,21)
Urethritis: Roots (41a,21)
Crotalaria cytisioides Hilsenb.
Dysentery: Stem leaves (41a)
Crotalaria fulva Roxb.
"Tumeurs blanches": ? (41a,21)
Scabies, Tumeurs blanches: ? (41a,21)
Crotalaria spinosa Hochst.
Malaria: ? (41a,1)
Crotalaria striata D.C.
Wounds: Leaves (41a,1)

LEGUMINOSAE (contd.)
Crotalaria uncinella Lamk.
Dysentery: Stem leaves (41a)
Desmodium barbatum Benth. & Oerst.
Dysmenorrhea: ? (41a,53)
Desmodium latifolium D.C.
Diabetes: Stem leaves (41a)
Wounds: Stem plus leaves (41a,55)
Desmodium ramosissimum G.Don
Dysmenorrhea: ? (41a,53)
Pneumonia: Roots (41a)
Dichrostachys sp. [Famahotra (Merina)]
Fainting: ? (12a)
Dolichos biflorus L.
Syphilis: ? (41a,55)
Erythrophleum couminga H.Bn.
Cardiac tonic: Stem leaves (41a,3)
Ulcers: ? (41a,21)
Wounds: ? (41a,21)
Glycine lyallii Benth.
Wounds: Stem plus leaves (41a,55)
Indigofera depauperata Drake [Hazomby (Mah.)]
Postpartum reconstituent: ? (12a)
Indigofera lyallii Bak.
Headaches: ? (41a,21)
Indigofera pedunculata Hils. & Boj.
Epilepsy, Anti-spasmodic: ? (41a,35)
Indigofera tinctoria L.
Asthma: ? (41a,21)
Children's convulsions: ? (41a,21)
Mimosa latispinosa Lamk.
Infant cholera: Stem leaves (41a)
Mimosa pudica L.
Children's convulsions: ? (41a,21)
Dysmenorrhea: ? (41a,21)
Vermifuge: ? (41a,21)
Mucuna pruriens DC.
Aphrodisiac: Seeds (41a,21)
Diuretic: ? (41a,21)
Haemorrhoids: ? (41a,21)
Intestinal worms, Ascaris: Pods (Cosse) (41a,1)
Stimulant, Hemiplegia: ? (41a,21)
Mundulea pungens R.Viguier [Taivositra (Mah.)]
Postpartum disinfectant: Stem & root bark (12a)
Mundulea scoparia R.Viguier [Sofa sofa (Mah.)]
Infant maladies: Leaves & stems (12a)
Neobaronia phylanthoides Bak.
Stomach troubles: ? (41a,21)
Phylloxylon sp. [Salama]
Tonic: Leaves & stem bark (12a)
Piptadenia chrysostachys Benth.
Abdominal pains: ? (41a,38)
Rhynchosia caribaea D.C.
Whooping cough: ? (41a,55)
Rhynchosia sp. [Vahiataka]
Aphrodisiac: Stem leaves (41a)
Sarcobotrya strigosa (Benth.) R.Vig.
Angina: Fruit pulp (41a,21)
Vermifuge: Aerial parts (41a)
Smithia chamaecrista Benth.
Headaches: Stem leaves (41a)
Tamarindus indica L. [Kily (Southwest)]
Laxative/Coughs: Fruits/Fruit pulp/Inner bark (12a)
Amenorrhea: Bark (41a,21)
Asthma: Bark (41a,21)
Biliousness: Leaves (41a,1)
Laxative, Stomach problems: Fruits (41a,1,3)
Sedative: Leaves (41a,1)
Urinary ailments: Leaves (41a,1)
Vermifuge: Leaves (41a,1)
Wounds: Leaves (41a)
Tephrosia linearis Pers.
Wounds: Stem leaves, Sap (41a)
Tetrapterocarpon geayi H.Humb. [Voaovy (Sak.)]
Sores/Toothache: Plaster of root bark/Decoction of root bark (12a)
Voandzeia subterranea Thou.
Ear discharge: ? (41a,53)

LEMNACEAE
Lemna paucicostata Hegelm.
Boils: ? (41a,21)
Syphilitic eruptions: ? (41a,21)
LILIACEAE
Aloe capitata Bak.
Cathartic, Purgative: Leaf sap (41a,42)
Dropsy: Entire plant (41a,21)
Aloe divaricata Berger. [Vohandranjo (Mah.)]
Purgative/Fractures/Ocytocique: Leaves/Leaves & sap/ (12a)
Aloe macroclada Bak.
Dropsy: Entire plant (41a,21)
Purgative: Leaf sap (41a,13,42)
Aloe sp. [Vahona (Merina)]
Dandruff: ? (12a)
Asparagus greveanus Perr.
Diuretic: Entire plant (41a,3)
Asparagus schumanianus Schlecter
Diuretic: Entire plant (41a, 3)
Asparagus simulans Bak.
Diuretic: Entire plant (41a)
Neuralgia/Stomach: ? (12a)
Asparagus vaginellatus Boj.
Chancre: ? (41a,21)
Diuretic: Entire plant (41a,3)
Gout: Entire plant (41a,3)
Dianella ensifolia (L.) Redoute [Voamasonomby (Merina); Vazahanakampo (Merina)]
Back pains/ Stomach/ Vermifuge/ Gonorrhoea/ Nervous system stimulant: ? (12a)
Dianella ensifolia Red.
Blennorrhagia: ? (41a)
Dipcadi cowani H.Perr.
Articular pains: Bulbs (41a,3)
Gout: Bulbs (41a)
Dracaena angustifolia Roxb.
Febrifuge: ? (41a,21)
Dracaena elliptica Thunb.
?: ?
Dracaena reflexa Lamk.
Diuretic: Branch leaves (41a)
Dysentery, Diarrhoea: Stem leaves (41a)
Dysmenorrhea: Tops (41a)
Febrifuge: ? (41a,21)
Haemostatic: ? (41a,21)
Rhodocodon madagascariensis Bak.
Purgative: ? (41a,2)
Smilax kraussiana Meissn. [Avoatra (Merina)]
"Tambavy"/Neuralgia/Syphilis: ? (12a)
Blennorrhagia, Syphilis: Roots, Bark (41a,21)
Depurative, Stomachic: Roots (41a,21)
Diuretic: Stem leaves (41a,3)
Eczema, Scabies, Ulcers: ? (41a,47)
Gout, Diaphoretic: ? (41a,3,58)
Promote fertility: Leaves (41a,21,58)
Wounds: ? (41a,47)
LOGANIACEAE
Anthocleista amplexicaulis Bak. [Landemy vavy (Merina)]
Constipation/Nervousness: ? (12a)
Diarrhoea, Dysentery: Bark (41a,33)
Malaria: ? (41a,1)
Anthocleista madagascariensis Bak. [Landemy lahy (Merina)]
Constipation/Nervousness: ? (12a)
Anthocleista rhizophoroides Bak.
Depurative, Laxative: Bark, Roots (41a,58)
Diuretic/Antiseptic/Gonorrhoea: Bark/Bark/Bark (12a)
Febrifuge, Malaria: Bark and roots, Leaves (41a,42,58)
Hepatitis: Bark (41a,21)
Anthocleista sp. [Dendemilahy]
Diuretic: Bark (41a)
Purgative: Bark (41a,21)
Buddleia madagascariensis Lamk. [Sevafotsy (Merina)]
Adenitis: Flowers (41a,21)
Asthma, Coughs, Bronchitis: ? (41a,21)
Depurative: Roots (41a,21)
Dysentery: ? (12a)
Gaertneria obovata Bak.
Febrifuge: ? (41a,21)

LOGANIACEAE (contd.)
Gaertneria phanerophlebia Bak.
?: ?
Nuxia capitata Bak. [Valanirana (Merina)]
Gonorrhoea/Neuralgia/Stomach/Fortifier: ? (12a)
Nuxia sp. [Lambinana (Merina)]
Fortifier for children: ? (12a)
Strychnos madagascariensis Poir. [Ampenina (Sak.-Bara); Hampeny]
Scabies: Leaves (41a,21)
Tonic/Edible fruits: Powdered bark/Fruits (12a)
Strychnos spinosa Lamk.
Scabies: Leaves (41a,21)
LORANTHACEAE
Loranthus sp.
Anti-spasmodic, Hypotensive: ? (41a,3)
Viscum sp.
?: ?
LYCOPODIACEAE
Lycopodium cernuum L. [Anatrandraka (Merina); Tongo-tsokina (Merina)]
Neuralgia: ? (12a)
Lycopodium clavatum L. [Tanatrandraka (Merina)]
Lips/Pregnant women: ? (12a)
LYTHRACEAE
Pemphis madagascariensis Perr.
Diseases of the fontanelles: Leaves (41a,55)
Woodfordia fruticosa S.Kurtz
Aphrodisiac, Urethritis: ? (41a,30)
Cystitis: Entire plant (41a)
Gout: Aerial parts (41a)
MALPIGHIACEAE
Mascarenhasia arborescens D.C.
Anthrax: Leaves (41a)
Tristellateia sp. [Andriamaneto (Merina)]
Pain: ? (12a)
MALVACEAE
Abelmoschus esculentus Moench.
Dysuria: Fruits (41a,1)
Hoarseness, Colds: Fruits (41a,1)
Syphilis: Roots (41a)
Abelmoschus moschatus Medic.
Coughs: ? (41a)
Gossypium arboreum L.
Diuretic, Haematuria: Roots (41a,3)
Dysentery: ? (41a,21)
Dysentery, Uterine hemorrhage: ? (41a)
Haemostatic: Roots (41a,3)
Scabies: ? (41a,12)
Syphilis: ? (41a,55)
Hibiscus diversifolia Jacq.
Coughs: Roots (41a,3)
Kosteletzkya velutina Garcke
Boils: Roots (41a,1)
Syphilitic chancres: Roots (41a,21)
Malva verticillata L.
Boils, Abcesses: Roots (41a)
Choking (Etouffements): Leaves (41a,1)
Haemorrhoids: Flowers (41a,47)
Laxative: Flowers (41a,3)
Rectal prolapsis: Flowers (41a,47)
Sore throat (mauxdegorge): Roots (41a,1,38)
Sprains: Roots (41a,1)
Pavonia bojeri Bak.
Purgative: Roots (41a,21)
Pavonia urens Lass.
Fractures: ? (41a,21)
Sida cordifolia L.
Diuretic, Haematuria: Roots (41a,3)
Sida rhombifolia L. [Tsindahoro (Merina); Tsimatipangady (Merina)]
Antiseptic: ? (12a)
Boils: Roots (41a,1)
Choking: Leaves (41a,1)
Coughs: Roots (41a,3)
Dysentery: Roots (41a,21)
Febrifuge: ? (41a,1)
Open abcesses: Leaves (41a,4)
Stimulant: ? (12a)
Tumours: ? (41a,49)

MALVACEAE (contd.)
Thespesia populnea Soland.
Depurative, Chronic dysentary: Bark (41a,21)
Skin ailments: Bark (41a,21)
Urena lobata L.
Blepharitis: Roots (41a,11)
Bronchitis, Coughs: ? (41a,3)
Syphilis: Roots (41a)
MELASTOMATACEAE
Antherotoma naudini Hook.f.
Diabetes, Albuminuria: ? (41a,47)
Clidemia hirta D.Don [Tsitotroko (Betsim.)]
Haemostatic: ? (12a)
Dichaetanthera crassinodis Bak.
Neuralgia: Leaves (41a)
Dichaetanthera oblongifolia Bak. [Felabarika (Merina)]
Dysentery/Diarrhoea: ? (12a)
Medinilla sp. [Matavikely (Merina)]
Contusions: Leaves and roots (12a)
Vermifuge: Stems, Leaves (41a)
Tristemma virusanum Comm. [Voatsingotroka (Merina)]
Stomach/Neuralgia: ? (12a)
MELIACEAE
Khaya madagascariensis Jum. & Perr.
Febrifuge: ? (41a)
Malleastrum sp. [Maharaoky (Bara)]
Abortifacient: ? (12a)
Melia azedarach L.
Febrifuge: Root bark (41a,3)
Vermifuge: Roots (41a,3)
Neobeguea mahafalensis Leroy [Handy (Southwest)]
Rheumatic pains/Aphrodisiac: Bark (12a)
Turraea sp. [Lafara]
Diptheria: ? (41a)
Neuralgia: Bark (41a)
Sore throat, Angina: ? (41a)
MENISPERMACEAE
Burasaia congesta Decne.
Febrifuge: ? (41a,3)
Burasaia gracilis Decne.
?: ?
Burasaia madagascariensis D.C.
Dysentery: Roots (41a)
Febrifuge: ? (41a,3)
Cissampelos madagascariensis Miers.
?: ?
Cissampelos pareira L.
Abcesses, Boils: Leaves (41a,42)
Diuretic, Bladder stones: Roots (41a,21)
Emmenagogue: Roots (41a,21)
Febrifuge, Malaria: Roots (41a,21)
Cissampelos sp. [Voriravina (Merina)]
Heart/Liver: ? (12a)
MONIMIACEAE
Tambourissa boivinii D.C.
Angina, Loss of voice: Flowering tops (41a,21)
Scabies, Skin ailments: ? (41a,21)
Tambourissa parvifolia Bak.
Emmenagogue, Uterine hemorrhage: Bark, Roots (41a,21)
Flowering tops: ? (41a,21)
Scabies, Skin ailments: ? (41a,21)
Tambourissa purpurea D.C.
Angina, Loss of voice: Flowering tops (41a,21)
Emmenagogue: Bark, Roots (41a,21)
Scabies, Skin ailments: ? (41a,21)
Tambourissa religiosa DC. [Ambora (Merina)]
Emmenagogue: Bark, Roots (41a,21)
Gums/Mouth/Neuralgia/"Tambavy"/Syphilitic stigmates/Mental: Leaves/ (12a)
Scabies, Skin ailments: ? (41a,21)
Tambourissa spp.
Amenorrhea: Bark (41a)
Tambourissa trichophylla Bak. [Amboralahy (Merina)]
Emmenagogue: Bark, Roots (41a,21)
Scabies, Skin ailments: ? (41a)
Sickness in children: Entire (12a)
MORACEAE
Artocarpus integrifolia L.
Asthma: Roots (41a,21)
Hepatic colic: Seeds (41a,1)

MORACEAE (contd.)
Chlorophora greveana (Baill.) Leandri [Vory (Bara)]
Tonic/Vermifuge: Bark (12a)
Ficus baroni Bak.
Sores: Leaves (41a,21)
Ulcers: Roots (41a,21)
Ficus cocculifolia Bak.
Diseases of the fontanelles: Bark (41a,55)
Dysentery: Leaves (41a)
Ficus megapoda Bak.
Angina: Stem leaves (41a)
Coughs: Stem leaves (41a)
Diarrhoea, Dysentery: Leaves (41a)
Sneezing/Coughs: Leaves/ (12a)
Sores: Latex (41a,53)
Ulcers: Latex (41a,54)
Ficus pyrifolia Lamk.
Anaemia, Faiblesse: Leaves (41a,53)
Bruises, Fractures: Roots (41a,14)
Coughs, Pneumonia: Leaves (41a,21,58)
Dysentery: Leaves (41a,38)
Febrifuge: ? (41a,58)
Labor pains: Leaves (41a,38)
Stimulant, Neuroses: Young stem leaves, Leaves (41a,21)
Tonic: ? (41a)
Wounds, Sores: Leaves (41a,33,58)
Ficus soroceoides Bak. [Andriambololon-kazo (Merina)]
Intestine: ? (12a)
Vermifuge, Liverflukes: Bark, Fruits (41a,21)
Ficus sp. [Nonoka (Merina)]
Fainting spells: ? (12a)
Jaundice: ? (12a)
Neuralgia/Syphilis: ? (12a)
Sprains/Swelling: ? (12a)
Syphilis: ? (12a)
Ficus trichopoda Bak.
Wounds: Latex (41a,21)
Pachytrophe dimepate Bur.
Retention of urine: Stem leaves
MORINGACEAE
Moringa pterygosperma Gaertn.
Anti-spasmodic: ? (41a,2)
Asthma: Flowers (41a,21)
Dropsy, Diuretic: Root bark (41a,21)
Febrifuge, Enlarged spleen: Bark, Roots (41a,21)
Gangrene: Leaves, Bark, Roots (41a,21)
Gout: Roots (41a,21)
Hysteria, Anti-spasmodic, Epilepsy, Paralysis: Leaves, Bark, Roots (41a,21)
Otitis: Leaves (41a,21)
Revulsive: Roots (41a,3)
Ulcers, Abcesses: Entire plant (41a,21)
Vermifuge: Leaves (41a,21)
MUSACEAE
Musa paradisiaca L.
Burns, Ulcers: ? (41a,21)
Diabetes: Stems, Leaves (41a,21)
Diarrhoea: Leaves (41a,21)
Diuretic, Haematuria, Dropsy: Inflorescences, Leaves, Shoots (41a,21,53)
Ulcers and a type of anthrax: Leaves, Fruit pulp (41a, 21,55)
Musa perrieri Clav. [Tsiroroka]
Eye problems: ? (12a)
MYRICACEAE
Myrica spathulata Mirb. [Tsilakana (Betsim.); Laka (Betsim.)]
Teeth: Bark (12a)
MYRISTICACEAE
Brochoneura acuminata Warb.
Cicatrizant: Fruits (41a,21)
Rheumatism: Seed oil (41a,21)
Scabies, Skin ailments, Affections pediculaires: ? (41a,53,54)
MYROTHAMNACEAE
Myrothamnus meschaius Baill. [Maimbelona (Merina)]
Vomiting/Witchcraft: ? (12a)
MYRSINACEAE
Ardisia fusco-pilosa Bak.
Abdominal troubles: Leaves, Bark (41a,3,21)

MYRSINACEAE (contd.)
Embelia concinna Bak.
Abdominal troubles: ? (41a)
Articular pains: Leaves (41a,12)
Burns, Ulcers: ? (41a,21)
Constipation/Vermifuge/Eczema/Swelling/Weakness/ Syphilis/ Neuralgia: ? (12a)
Diseases of the spinal marrow, Neuralgia, Neuritis: Stem leaves (41a,12)
Gout: Stem, Leaves (41a)
Syphilis, Blennorrhagia: Roots (41a,48)
Vermifuge: Roots (41a,21)
Embelia madagascariensis DC.
Abdominal troubles: ? (41a)
Burns, Ulcers: ? (41a,21)
Neuralgia, Neuritis: ? (41a,12)
Vermifuge: Roots (41a,48)
Embelia sp. [Takasina (Merina)]
Stomach/Vermifuge: ? (12a)
Maesa lanceolata Forsk.
Chicken pox, Measles: ? (41a,48)
Stinging rash: Leaves and stems (12a)
Syphilis, Blennorrhagia: Roots (41a,21)
Vermifuge: Fruits, Leaves (41a,21,48)
Wounds: ? (41a,53)
Oncostemon botryoides Bak. [Fanonobe (Merina)]
Convulsions (infants): ? (12a)
Oncostemon fusco-pilosum Mez.
Abdominal troubles: Leaves (41a,48)
Oncostemon leprosum Mez.
Abdominal troubles: Bark (41a,48)
Choking/Liver: ? (12a)
Oncostemon sp. [Tanterakala vavy (Merina)]
Fortifier/Diuretic: ? (12a)
Laxative/Stomach ailments: Bark/Bark (12a)
Nervousness: ? (12a)
Neuralgia: ? (12a)
Sores: ? (12a)
MYRTACEAE
Eugenia aromatica H.Bn.
Stimulant: ? (41a,3)
Eugenia emirensis Bak.
Astringent, Dysentery: Leaves, Bark (41a,34)
Delirium tremens: Stem leaves (41a)
Eugenia jambolana Lamk.
Diabetes: Fruit sap (41a,2)
Diarrhoea, Dysentery: Bark (41a,34)
Diuretic: Fruits (41a)
Leucorrhea: Bark (41a)
Neuralgia/Swelling/Sprains/Diarrhoea: ? (12a)
Eugenia jambos L. [Zamborozano (Merina)]
Coughs: ? (12a)
Eugenia parkeri Bak.
Diarrhoea, Dysentery: Leaves, Bark (41a,34)
Eugenia sp. [Rotran ala (Merina)]
Fortifier: ? (12a)
Insomnia: Entire (12a)
Neuralgia: ? (12a)
Eugenia tapiaka H.Perr.
Asthma: Bark, leaves (41a,28)
Psidium cattleyanum Sabine [Goavitsinahy (Merina)]
Colic/Diarrhoea: ? (12a)
Psidium guajava Berg.
Astringent, Diarrhoea, Dysentery: Leaves Bark (41a, 21,33)
Cicatrizant: ? (12a)
NEPENTHACEAE
Nepenthes madagascariensis Poir.
Bladder ailments: ? (41a,33)
NYCTAGINACEAE
Mirabilis jalapa L.
Purgative: Roots (41a,3)
NYMPHAEACEAE
Nymphaea stellata Willd.
Amenorrhea, Aphrodisiac: Rhizomes (41a,21,3)
Erysipelas: Leaves (41a,21)
Haemorrhoids: ? (41a,21)
OLACACEAE
Anacolosa pervilleana H.Bn. [Tanjaka (Bara)]
Tonic: Leaves (12a)

OLACACEAE (contd.)
Olax cf. andronensis Bak. [Bareraka (Mah.)]
Diarrhoea/Edible fruits: Stem & leaves (12a)
Ximenia perrieri Cav. & Ker. [Korro (Mah.)]
Conjunctivitis/Edible fruits: Leaves (12a)
OLEACEAE
Jasminum kitchingii Bak. [Tsilavondrivotra (Merina)]
Stiffness: ? (12a)
ONAGRACEAE
Jussiaea repens L. [Kitondratondra (Merina)]
Eczema/Boils: ? (12a)
Jussiaea suffruticosa L.
Retention of urine: Stem leaves (41a)
Ludwigia jussiacoides Desr.
Dysmenorrhea: ? (41a,53)
OPILIACEAE
Rhopalopilia cf. umbellulavo Engl. [Araty (Bara); Maleny]
Jaundice: Leaves/Rcot and stem bark (12a)
Rhopalopilia sp. [Malainavotsa (Mah.)]
Cicatrizant & disinfectant: Stem bark (12a)
ORCHIDACEAE
Cynosorchis sp. [Sirika (Merina)]
Burns: ? (12a)
Vanilla madagascariensis Rolfe [Vahinamalo (Sak.); Amalo]
Reputed aphrodisiac: ? (12a)
Vanilla planifolia Andrews
Stimulant: ? (41a,3)
OXALIDACEAE
Biophytum sensitivum (L.) DC. [Modimodia (Merina)]
Hypnotic/Fever/Sedative: Aerial parts/ (12a)
Stomach troubles: ? (41a,21)
Vermifuge: ? (41a)
Oxalis corniculata L. [Kidiadiavorona (Merina)]
Coughs: ? (12a)
Vermifuge: Leaves (41a,53)
PALMAE
Cocos nucifera L.
Haematuria: Roots (41a,3)
Raphia ruffia Mart.
Laxative: Liquid (sap?) from spathe (41a,21)
Toothache: Roots (41a,21)
PASSIFLORACEAE
Passiflora caerulea L.
Insomnia: Flowers (41a,3)
Passiflora incarnata L.
Anti-spasmodic: Stem leaves (41a)
Laxative, Emetic: Leaves (41a,3)
PEDALIACEAE
Uncarina stellulifera Humb. [Farehetsy (Mah.); Farehitra (Sak.)]
Dandruff/Baldness: Leaves (12a)
PHYTOLACCACEAE
Phytolacca dodecandra L'Her.
Articular pains: Seed oil (41a,12)
Cholagogue: Roots plus leaves (41a)
Dropsy: Leaves (41a,21)
Emetic, Vomitive: Roots, Fruits (41a,1)
Leprosy: ? (41a,12)
Narcotic: Leaves (41a)
Rabies: Leaves (41a,21)
Tonic: Rots (41a)
PIPERACEAE
Piper pachyphyllum Bak.
Asthma: Internodes (41a,21)
Blennorrhagia: ? (41a)
Febrifuge: Fruits (41a,21)
Haematuria: Leaves (41a,21)
Neuralgia: Internodes (41a,21)
Stomachic: Fruits (41a,21)
Piper pyrifolium Vahl
Asthma: Internodes (41a,21)
Blennorrhagia: Fruits (41a,21)
Febrifuge: Fruits (41a,21)
Neuralgia: Internodes (41a,21)
Stomachic: Fruits (41a,21)
Piper umbellatum L.
Wounds: Leaves (41a,21)

PITTOSPORACEAE
Pittosporum ochrosiaefolium Boj.
Abdominal troubles: Stem leaves (41a,31)
Blennorrhagia: Leaves (41a,31)
Febrifuge: ? (41a,38)
Vermifuge: Bark (41a,31)
PLUMBAGINACEAE
Plumbago aphylla Boj. [Motimoty (Mah.)]
Diarrhoea: ? (12a)
Plumbago zeylanica L.
Vesicant: Roots (41a,3)
POLYGALACEAE
Polygala ankaratrensis H.Perr.
Coughs: Roots (41a,3)
Polygala bojeri Chodat
Syphilis: Aerial parts (41a)
Polygala macroptera D.C.
Galactogogue: ? (41a,6)
POLYGONACEAE
Polygonum senegalense Meissn.
Astringent: ? (41a,3)
Chronic rheumatism, Sciatica: ? (41a,21)
Gout: ? (41a,2)
Syphilis, Blennorrhagia: ? (41a)
Rumex abyssinicus Jacq.
Dysentery: Stem leaves (41a)
Scabies: Roots (41a,21)
Syphilitic sores: Leaves (41a,38)
Vermifuge: Entire plant (41a)
POLYPODIACEAE
Pellea viridis Prantl.
Diuretic: Aerial parts (41a)
PORTULACACEAE
Portulaca oleracea L.
Diuretic: Leaves (41a,21)
Emmenagogue: Seeds (41a,21)
Jaundice: ? (41a,1)
POTAMOGETONACEAE
Potamogeton spp.
Eczema: ? (41a,53)
PTAEROXYLACEAE
Cedrelopsis grevei H.Bn.
Anaemia: Bark (41a,21)
Febrifuge: Bark (41a,21)
Headaches: Stem leaves (41a)
Headaches/Fractures/Tonic/Aphrodisiac/Stomach ache: Bark (12a)
Stomach illnesses: Bark (41a,21)
Toothache: ? (41a)
Vermifuge: Bark (41a,21)
PUNICACEAE
Punica granatum L.
Diarrhoea, Dysentery: Fruits, Leaves, Bark (41a,4)
Taenifuge: Bark (41a,3)
RANUNCULACEAE
Clematis ibarensis Bak.
Vesicant: ? (41a,3)
Clematis mauritiana Lamk.
Asthma, Consumption: Leaves (41a,21)
Diuretic: ? (41a,53)
Leprosy: ? (41a,1,38)
Malaria: ? (41a,1)
Paralysis: Entire plant (41a)
Rheumatism: Leaves (41a,21)
Syphilis: ? (41a,21)
Vesicant: ? (41a,3)
Clematis trifida Hook.
Cauterisant: Sap (41a,1)
Ranunculus pinnatus Poir.
Dysentery, Abdominal troubles: Entire plant (41a)
Headaches: Leaves (41a,1,12)
Leprosy: ? (41a,12)
Scabies, Desquamation: Leaves (41a,21)
RHAMNACEAE
Berchemia discolor Klozch [Losy (Mah.)]
Toothache/Anesthetic: Bark (12a)
Ziziphus spina-christi Willd. [Tsinero (Mah.)]
Diarrhoea: ? (12a)

ROSACEAE
Amygdalus persica L.
Stomach troubles: Leaves (41a,1)
Vermifuge: Leaves (41a,1)
Rubus apetalus Poir.
Angina, Stomatitis, Gingivitis: Leaves (41a,21)
Chronic diarrhea: Leaves (41a,21)
Diuretic: ? (41a,3)
Urethritis: Roots (41a,21)
Rubus myrianthus Bak.
Angina, Stomatitis, Gingivitis: Leaves (41a,21)
Chronic diarrhea: Leaves (41a,21)
Rubus pauciflorus Bak.
Angina, Stomatitis, Gingivitis: Leaves (41a,21)
Chronic diarrhea: Leaves (41a,21)
Diuretic: ? (41a,3)
Rubus rosaefolius Sm.
Angina, Stomatitis, Gingivitis: Leaves (41a,21)
Blennorrhagia, Syphilis: Leaves (41a)
Diarrhoea, Dysentery: Stem leaves (41a)
Diuretic: ? (41a,3)
Ear troubles: ? (41a)
RUBIACEAE
Anthospermum emirnense Bak.
Toothache: ? (41a)
Breonia boivini Havil.
Jaundice fever: Bark (41a)
Breonia madagascariensis A.Rich.
Sedative: ? (41a,53)
Cephalanthus spathelliferus Bak.
Malaria: Leaves (41a,1)
Danais fragrans Gaertn.
Febrifuge: Roots (41a,21)
Skin ailments: Bark (41a,21)
Tonic: Entire plant (41a)
Danais gerrardi Bak.
Febrifuge: Roots (41a,21)
Danais sp. [Vahivoraka]
Nerve tonic: Stem leaves (41a)
Treatment for sterility: ? (41a)
Danais verticillata Bak.
Hepatic depurative: Stem leaves (41a)
Malaria: ? (41a,3)
Nephritis: Leaves (41a,21)
Enterospermum sp. [Masaka (Bara)]
Tonic: ? (12a)
Vermifuge: Leaves (12a)
Gaertnera obovata Bak.
Wounds: ? (41a,21)
Gaertnera phanerophlebia Bak.
?: ?
Mussaenda arcuata Poir.
General tonic: ? (41a,21)
Paralysis: ? (41a,21)
Purgative: Roots (41a,21)
Rheumatism: ? (41a,21)
Scurf, Eczema, Psoriasis: Young leaves (41a,21)
Tonic, Stimulant: ? (41a,21)
Oldenlandia lancifolia D.C.
Calms irritability: ? (41a,21)
Scabies: Leaf sap (41a,1)
Wounds: ? (41a,1)
Oldenlandia sp. [Tsinopoka]
Blennorrhagia: Stems, Leaves (41a)
RUBIACEAE
Paederia bojeriana Drake
Blennorrhagia, Syphilis: ? (41a,53)
Depurative: ? (41a,53)
Dermatoses, Ulcers: ? (41a,53)
Diuretic: ? (41a,53)
Payeria excelsa H.Bn.
Febrifuge: Leaves (41a)
Jaundice: Stem leaves (41a)
Randia talangninia DC.
Colds: Resin (41a,21)
Febrifuge: ? (41a,3)
Santalina madagascariensis H.Bn.
Blennorrhagia: ? (41a)
Lumbago, Aching bones: ? (41a,21)

RUBIACEAE (contd.)
Triainolepis emirnensis Breme
Wounds: Wood (41a,21)
Urophyllum lyallii Bak.
Colds: Branches (41a)
RUTACEAE
Citrus medica L.
Diaphoretic: Leaves (41a,53)
Tonic: ? (41a,53)
Citrus spp.
Bronchitis, Head colds: Leaves, Fruits (41a,55)
Teclea punctata Verdoorn
Syphilis: Stems, Leaves (41a)
Teclea sp. [Ampoly]
Powerful vermifuge: Leaves (12a)
Toddalia aculeata Pers.
?: Bark (41a,21)
Abdominal pains: Leaves (41a,21)
Blennorrhagia, Syphilis: ? (41a)
Bronchitis, Pneumonia: Bark (41a,21)
Cardiac tonic: Roots (41a)
Emmenagogue: Leaves, Bark (41a,3)
Febrifuge, Malaria: Leaves, Bark, Roots (41a,3)
Headaches: Stem leaves (41a)
Tonic: Leaves (41a)
Zanthoxylum thouvenotii H.Perr.
Parasites of the scalp: Stem leaves (41a)
SANTALACEAE
Santalum album L.
Wounds: Wood (41a,21)
SAPINDACEAE
Allophylus bieruris Radlk.
Coughs: Tiges feuille (41a,3)
Cardiospermum halicacabum L.
Rickets, Hypertension: ? (41a,2)
Amenorrhea: Leaves, Roots (41a,21)
Blennorrhagia: Roots, Leaves (41a,21,55)
Cholagogue: Flowering tops (41a,3)
Cirrhosis: Flowers, Roots (41a,21)
Diuretic, Nephritis: Roots, Stem leaves (41a,21)
Emetic, Laxative, Haemorrhoids: Roots (41a,21)
Erysipelas: Roots, Leaves (41a,21)
Rheumatism: Roots plus leaves (41a,21)
Vermifuge: Roots, Leaves (41a,21)
Dodonaea viscosa Jacq.
Febrifuge: Leaves (41a,21)
Gout: Stem leaves (41a,2)
Ulcers: ? (41a,3)
Vulnerary: ? (41a)
Litchi sinensis Radlk.
Haematuria: Roots (41a)
Paullinia pinnata L.
Rickets: Stem leaves (41a)
Abcesses: Stem leaves (41a)
Anti-abortifacient: ? (41a)
Lumbago: ? (41a)
Wounds, Haemostatic: Stem leaves (41a)
SARCOLAENACEAE
Leptolaena pauciflora Bak. [Hatsikana (Merina)]
Syphilis: Aerial part (12a)
SCHIZAEACEAE
Lygodium lanceolatum Desv.
Liver ailments: Stem leaves (41a)
Stomach ailments: Stem leaves (41a)
Mohria cafforum Desv.
Malaria: ? (41a,1)
SCROPHULARIACEAE
Rhaphispermum gerardioides Benth.
Syphilis: ? (41a,21)
Scoparia dulcis L.
Gastralgia: ? (41a,21)
SIMAROUBACEAE
Samandura madagascariensis Gaertn.
Burns, Wounds: ? (41a,21)
Dysentery: ? (41a,21)
Febrifuge: ? (41a,21)
Stomachic: Bark (41a,3)

SOLANACEAE
Capsicum annuum L.
Excitant: Fruits (41a,21)
Stomachic: Fruits (41a,21)
Ulcerative angina: Fruits (41a,21)
Capsicum minimum Roxb.
Epithelioma: Fruits (41a,21)
Granular endometritis: Fruits (41a,21)
Neuralgia: Fruits (41a,21)
Scabies: Fruits (41a,21)
Datura stramonium L.
Foot ailments: Leaves (41a,3)
Asthma: Leaves (41a,3)
Narcotic, Sedative, Anti-spasmodic: ? (41a,21,42)
Otitis: Seeds (41a)
Lycopersicum esculentum Mill.
Ophthalmia: Roots (41a,1)
Nicandra physaloides Gaertn.
Asthma, Whooping cough: Stem leaves (41a)
Dermatoses, Affections pediculaires: ? (41a,47)
Gout: Entire plant (41a)
Sedative: ? (41a,3)
Toothache: ? (41a)
Nicotiana tabacum L.
Sedative, Narcotic: ? (41a,53)
Physalis peruviana L.
Diarrhoea: Leaves (41a,42)
Dysuria: ? (41a,21)
Jaundice: Entire plant (41a)
Solanum annuum L.
Antiseptic: Fruits (41a,21)
Solanum asphanathum Bak.
Headaches: Leaves (41a,21)
Solanum auriculatum Ait.
Scabies: ? (41a,21)
Syphilis: Berries (41a,1)
Solanum erythracanthum Boj.
"Eutocique": ? (41a,6)
Boils: Stems, Roots (41a,1)
Haematuria: Roots (41a,21)
Ophthalmia: ? (41a,1)
Toothache: Roots (41a,21)
Tumours: Stems and roots (41a,1)
Solanum indicum L.
Bronchitis, Ague: Leaves (41a,4)
Febrifuge: Entire plant (41a,21)
Neurasthenia, Hypnotic: Leaves, Berries (41a,21)
Stomachic: Leaves (41a,21)
Solanum macrocarpum L.
Febrifuge: Roots, Fruits (41a,21)
Solanum nigrum L.
Asthma, Whooping cough, Coughs, Haemoptysis: Leaves (41a,1,48)
Dysentery: ? (41a,1)
Narcotic, Anti-spasmodic: ? (41a,21)
Rabies: Sap (41a,1)
Scabies, Ulcers: Leaves (41a,21,53)
Vermifuge: Aerial parts (41a)
STERCULIACEAE
Buettneria voulily H.Bn.
Diseases of the fontanelles: Leaves (41a,55)
TACCACEAE
Tacca pinnatifida Forst.
Anaemia, Faiblesse: Roots (41a,58)
TILIACEAE
Grewia barorum [Malimatsa (Sak.)]
Purgative: Leaves (12a)
Grewia triflora Walp.
Epilepsy, Headaches: Leaves (41a,1,55)
Febrifuge: ? (41a,1)
Triumfetta rhomboidea Jacq.
Boils: Roots (41a,21)
Burns: Leaves (41a,38)
Coughs: Roots (41a,3)
Eye ailments: Roots (41a,1)
Tumours: Leaves (41a,38)
TYPHACEAE
Typha angustifolia L.
Epilepsy: Leaves (41a,55)

ULMACEAE
Celtis madagascariensis Boj.
Febrifuge: Bark (41a,21)
Trema orientalis Blume
Anaemia, Cachexie, Debilite: ? (41a,47)
Coughs: Tiges feuille (41a)
Dysentery, Diarrhoea, Stomachic: Bark (41a,21)
Gingivitis, Stomatitis: Bark (41a,4)
Haematuria: Leaves (41a,21)
Malaria, Enlarged spleen: ? (41a,47)
Syphilis: Roots, Shoots (41a,21)
Ulcers: ? (41a,21)
Wounds and sores: Leaves (41a,54)
UMBELLIFERAE
Caucalis sp. [Madinidravina (Merina)]
Constipation: ? (12a)
Centella asiatica Urb. [Korokorona (Merina); Talapetraka (Merina)]
"Tambavy" for children: ? (12a)
Hydrocotyle asiatica L.
Leprosy: ? (41a,18)
Scabies, Ulcers, Adenitis: ? (41a,1)
Secondary syphilis: ? (41a,1)
Tonic: ? (41a,1)
Hydrocotyle superposita Bak.
Diarrhoea, Dysentery: Leaves (41a,21)
Hydrocotyle tussilaginifolia Bak.
?: ?
Phellolophium madagascariense Bak.
Chlorosis: ? (41a,21)
Disinfectant: ? (41a,21)
Facial pimples/Itching/Gonorrhoea/Stomach/Whooping cough: Leaves/ (12a)
Gastralgia: ? (41a,21)
Headaches, Hysteria, Anti-spasmodic: ? (41a,1,21)
Sanicula europaea L.
Haemostatic: ? (41a,21)
Leucorrhea: ? (41a,21)
URTICACEAE
Urera acuminata Gaudich.
Granular endometritis: ? (41a,21)
Urera longifolia Wedd.
Haemostatic: Sap (41a,3)
Urera oligoloba Bak.
?: ?
Pneumonia: Leaves (41a)
Stomach troubles: Leaves (41a)
VERBENACEAE
Clerodendron heterophyllum R.Br.
Dysentery: Leaves plus roots (41a,21)
Febrifuge: ? (41a,21)
Syphilis: Leaves (41a,21)
Vermifuge: Leaves (41a,21)
ZINGIBERACEAE
Aframomum angustifolium K.Schum.
Ophthalmia: Stem sap (41a,21)
Stomachic, Dysentery: ? (41a,42)
Curcuma longa L.
Amenorrhea: ? (41a)
Bronchitis, Coughs, Consumption: Rhizome (41a,21)
Dysentery, Diarrhoea, Dyspepsia, Gastralgia, Stomachic: Rhizomes (41a,47)
Febrifuge: Leaves (41a,21)
Jaundice: ? (41a,47)
Jaundice: Rhizome (12a)
Purulent ophthalmia, Conjunctivitis: Rhizomes (41a,2)
Rabies: ? (41a,47)
Syphilitic ulcers: Rhizomes (41a,21)
Ulcers, Anthrax: Rhizomes (41a,21)
Wounds, Sprains, Antiseptic: Rhizomes (41a,21)
Hedychium coronarium Koen.
Anthrax: Roots (41a,55)
Emmenagogue, Aphrodisiac: Rhizomes (41a,21)
Gout: ? (41a,47)
Haematuria: Rhizomes (41a,21)
Rheumatism, Pleurodynia: ? (41a,53)
Severe constipation, Stomachic: ? (41a,21)
Toothache: Rhizomes (41a,49)

ZINGIBERACEAE (contd.)
Zingiber officinale Rose.
Aphrosdisiac, Emmenagogue: Rhizomes (41a)
Headaches: Rhizomes (41a,12)
Stimulant: ? (41a,53)
Zingiber zerumbet Rose.
Pulmonary inflammations: Rhizome (41a,38)
ZYGOPHYLLACEAE
Tribulus terrestris L.
Aphrodisiac: ? (41a)

ETHNOBOTANICAL DATA BASE OF MADAGASCAR

TABLE 2: alphabetically by use

Key: Use
FAMILY Genus, species, Authority. any infraspecific taxa

Abcesses
COMPOS. Senecio faujasioides Bak.
CRASSUL. Kalanchoe prolifera Ham.
CRUCIFERAE Nasturtium barbareaefolium Bak.
LABIATAE Tetradenia fruticosa Benth.
MALVACEAE Malva verticillata L.
MALVACEAE Sida rhombifolia L.
MENISP. Cissampelos pareira L.
MORING. Moringa pterygosperma Gaertn.
SAPIND. Paullinia pinnata L.
Abdominal pains
LEGUM. Piptadenia chrysostachys Benth.
RUTACEAE Toddalia aculeata Pers.
Abdominal troubles
MYRSIN. Ardisia fusco-pilosa Bak.
Embelia concinna Bak.
Embelia madagascariensis DC.
Oncostemon fusco-pilosum Mez.
Oncostemon leprosum Mez.
PITTOS. Pittosporum ochrosiaefolium Boj.
RANUNC. Ranunculus pinnatus Poir.
Abortifacient
BUXACEAE Buxus madagascariensis Baill.
LEGUM. Caesalpinia bonducella Fleming
MELIACEAE Malleastrum sp.
Adenitis
COMPOS. Dichrocephala lyrata DC.
EUPHOR. Croton sp.
Manihot utilissima Pohl.
IRIDACEAE Gladiolus garnieri Klatt.
LOGAN. Buddleia madagascariensis Lamk.
UMBELL. Hydrocotyle asiatica L.
Ague
SOLANAC. Solanum indicum L.
Albuminuria
CELAST. Mystroxylon aethiopicum (Thunb.) Loes.
COMPOS. Helichrysum benthami R.Vig. & H.Humb.
FLACOUR. Aphloia theaeformis Benn.
LABIATAE Ocimum gratissimum L.
MELAST. Antherotoma naudini Hook.f.
Alcoholism
ARACEAE Pothos chapelieri Schott.
Amenorrhoea
COMPOS. Helichrysum gymnocephalum Humb.
HAMAM. Dicoryphe noronhae Tul.
HYPERIC. Haronga madagascariensis Choisy
LABIATAE Leonotis nepetaefolia R.Br.
LEGUM. Caesalpinia sepiaria Roxb.
Tamarindus indica L.
MONIM. Tambourissa spp.
NYMPHA. Nymphaea stellata Willd.
SAPIND. Cardiospermum halicacabum L.
ZINGIB. Curcuma longa L.
Anaemia
AIZOACEAE Mollugo nudicaulis Lamk.
COMPOS. Conyza aegyptiaca Ait. var. lineariloba DC.
Elephantopus scaber L.
DROSER. Drosera madagascariensis D.C.
LEGUM. Cassia occidentalis L.
MORACEAE Ficus pyrifolia Lamk.
PTAEROX. Cedrelopsis grevei H.Bn.
TACCACEAE Tacca pinnatifida Forst.
ULMACEAE Trema orientalis Blume
Anaesthetic
RHAMN. Berchemia discolor Klozch

Angina
COMPOS. Helichrysum gymnocephalum Humb.
EUPHOR. Jatropha curcas L.
Ricinus communis L.
GRAMINEAE Imperata cylindrica (L.) PB
HYPERIC. Haronga madagascariensis Choisy
LABIATAE Hyptis pectinata Poit.
Ocimum gratissimum L.
LEGUM. Albizia lebbek Benth.
Sarcobotrya strigosa (Benth.) R.Vig.
MELIACEAE Turraea sp.
MONIM. Tambourissa boivinii D.C.
Tambourissa purpurea D.C.
MORACEAE Ficus megapoda Bak.
ROSACEAE Rubus apetalus Poir.
Rubus myrianthus Bak.
Rubus pauciflorus Bak.
Rubus rosaefolius Sm.
Anorexia
EQUISET. Equisetum ramosissimum Desf.
EUPHOR. Croton sp.
Anthrax
AMARYLL. Crinum firmifolium Bak.
APOCYN. Echitella lisianthiflora Pich.
ASCLEP. Pentopetia androsaemifolia Decne.
Secamonopsis madagascariensis Jum.
BIGNON. Stereospermum arcuatum H.Perr.
Stereospermum variabile H.Perr.
COMPOS. Senecio sp.
DIOSC. Dioscorea sansibarensis Pax.
IRIDACEAE Gladiolus garnieri Klatt.
MALPIG. Mascarenhasia arborescens D.C.
MUSACEAE Musa paradisiaca L.
ZINGIB. Curcuma longa L.
Hedychium coronarium Koen.
Anti-abortifacient
CACTACEAE Opuntia dillenii Haw.
ERIOCAU. Mesanthemum rutenbergianum Koern.
GRAMINEAE Cynodon dactylon Pers.
SAPIND. Paullinia pinnata L.
Anti-itch
APOCYN. Roupellina boivini (H.Bn.) Pich.
Anti-spasmodic
ACANTH. Rhinacanthus osmospermus Boj.
AIZOACEAE Mollugo nudicaulis Lamk.
CELAST. Mystroxylon aethiopicum (Thunb.) Loes.
COMPOS. Grangea maderaspatana Poir.
Parthenium hysterophorus L.
DROSER. Drosera madagascariensis D.C.
LABIATAE Hyptis pectinata Poit.
Leonotis nepetaefolia R.Br.
Ocimum basilicum L.
Ocimum gratissimum L.
LEGUM. Caesalpinia bonducella Fleming
Indigofera pedunculata Hils. & Boj.
LORANTH. Loranthus sp.
Viscum sp.
MORING. Moringa pterygosperma Gaertn.
PASSIFL. Passiflora incarnata L.
SOLANAC. Datura stramonium L.
Solanum nigrum L.
UMBELL. Phellolophium madagascariense Bak.
Antidote
HYPERIC. Psorospermum androsaemifolium Bak.
Antidote to Cerbera venenifera
COMPOS. Gerbera elliptica H.Humb.

Antiemetic	
LABIATAE	Ocimum canum Sims
	Ocimum gratissimum L.
Anti-fungal	
COMPOS.	Gynura rubens Muscher
Antihelminthic	
LEGUM.	Caesalpinia bonducella Fleming
	Cassia tora L.
Antiseptic	
ACANTH.	Justicia sp.
ANACARD.	Poupartia caffra Perr.
ANNON.	Uvaria catocarpa Diels
BURSER.	Canarium madagascariense Engl.
COMPOS.	Helichrysum gymnocephalum Humb.
	Helichrysum rusillonii Hochr.
	Laggera alata Sch. Bip.
DIOSC.	Dioscorea sansibarensis Pax.
LABIATAE	Tetradenia fruticosa Benth.
LEGUM.	Albizia fastigiata Oliv.
LOGAN.	Anthocleista rhizophoroides Bak.
MALVACEAE	Sida rhombifolia L.
SOLANAC.	Solanum annuum L.
ZINGIB.	Curcuma longa L.
Antitussive	
AIZOACEAE	Mollugo nudicaulis Lamk.
ANNON.	Annona muricata L.
EUPHOR.	Croton sp.
Aphrodisiac	
ACANTH.	Rhinacanthus osmospermus Boj.
APOCYN.	Catharanthus trichophyllus Pich.
COMPOS.	Helichrysum gymnocephalum Humb.
CYPER.	Carex albo-viridis Clarke
	Cyperus esculentus L.
EUPHOR.	Phyllanthus casticum Soy. Will.
LEGUM.	Mucuna pruriens DC.
	Rhynchosia sp.
LYTHR.	Woodfordia fruticosa S.Kurtz
MELIACEAE	Neobeguea mahafalensis Leroy
NYMPHA.	Nymphaea stellata Willd.
ORCHID.	Vanilla madagascariensis Rolfe
PTAEROX.	Cedrelopsis grevei H.Bn.
ZINGIB.	Hedychium coronarium Koen.
	Zingiber officinale Rose.
ZYGOPH.	Tribulus terrestris L.
Articular pains	
LEGUM.	Clitoria ternatea L.
LILIACEAE	Dipcadi cowani H.Perr.
MYRSIN.	Embelia concinna Bak.
PHYTOLAC.	Phytolacca dodecandra L'Her.
Ascaris	
CHENOP.	Chenopodium ambrosioides L.
COMBRET.	Calopyxis phaneropetala H.Perr.
	Calopyxis subumbellata Bak.
LEGUM.	Mucuna pruriens DC.
Asthma	
ASCLEP.	Gomphocarpus fruticosus R.Br.
COMPOS.	Ethulia conyzoides L.
	Senecio erechtitoides Bak.
EUPHOR.	Euphorbia hirta L.
	Phyllanthus distichus Muell. Arg.
	Phyllanthus niruri L.
HYPERIC.	Haronga madagascariensis Choisy
	Harungana madagascariensis Choisy
LEGUM.	Abrus precatorius L.
	Albizia fastigiata Oliv.
	Indigofera tinctoria L.
	Tamarindus indica L.
LOGAN.	Buddleia madagascariensis Lamk.
MORACEAE	Artocarpus integrifolia L.
MORING.	Moringa pterygosperma Gaertn.
MYRTACEAE	Eugenia tapiaka H.Perr.
PIPER.	Piper pachyphyllum Bak.
	Piper pyrifolium Vahl
RANUNC.	Clematis mauritiana Lamk.
SOLANAC.	Datura stramonium L.
	Nicandra physaloides Gaertn.
	Solanum nigrum L.
Astringent	
ANNON.	Uvaria catocarpa Diels
EUPHOR.	Phyllanthus casticum Soy. Will.
Astringent (contd.)	
	Phyllanthus madagascariensis Muell. Arg.
	Phyllanthus niruri L.
FLACOUR.	Aphloia theaeformis Benn.
MYRTACEAE	Eugenia emirensis Bak.
	Psidium guayava Berg.
POLYGON.	Polygonum senegalense Meissn.
Back pains	
CLUSIA.	Ochrocarpos orthcladus H. Perr.
COMPOS.	Vernonia glutinosa DC.
LILIACEAE	Dianella ensifolia (L.) Redoute
Baldness	
EUPHOR.	Jatropha curcas L.
LAURACEAE	Cassytha filiformis L.
PEDAL.	Uncarina stellulifera Humb.
Biliary stones	
COMPOS.	Conyza aegyptiaca Ait. var. linearilobа DC.
Biliousness	
ASCLEP.	Pentopetia androsaemifolia Decne.
CANELL.	Cinnamosma fragrans H.Bn.
FLACOUR.	Aphloia theaeformis Benn.
GENTIAN.	Tachiadenus longifolius Sc. Ell.
LEGUM.	Cassia laevigata Willd.
	Cassia occidentalis L.
	Tamarindus indica L.
Bladder ailments	
NEPENTH.	Nepenthes madagascariensis Poir.
Bladder irritation	
LEGUM.	Clitoria ternatea L.
Bladder stones	
MENISP.	Cissampelos pareira L.
Bleeding, regulates	
COMPOS.	Elephantopus scaber L.
Blennorrhagia	
AMARANTH.	Amaranthus spinosus L.
ANACARD.	Mangifera indica L.
APOCYN.	Cabucala madagascariensis Pich.
ASCLEP.	Gymnema sylvestre R.Br.
	Sarcostemma viminale R.Br.
BALSAM.	Impatiens baroni Bak.
BURSER.	Canarium madagascariense Engl.
CAPPARA.	Physena madagascariensis Steud. & Thou.
COMBRET.	Terminalia catappa L.
COMPOS.	Brachylaena perrieri Humb.
	Brachylaena ramiflora Humb.
	Elephantopus scaber L.
	Helichrysum benthami R.Vig. & H.Humb.
	Siegesbeckia orientalis L.
	Vernonia glutinosa DC.
ERYTHR.	Erythroxylum ferrugineum Cav.
EUPHOR.	Euphorbia bojeri Hook.
	Euphorbia milii Des Moulins
	Macaranga sp.
	Phyllanthus niruri L.
FLACOUR.	Aphloia theaeformis Benn.
GRAMINEAE	Cynodon dactylon Pers.
HYPERIC.	Haronga madagascariensis Choisy
LABIATAE	Ocimum canum Sims
LAURACEAE	Cassytha filiformis L.
LEGUM.	Albizia gummifera C.A.Smith
	Caesalpinia bonducella Fleming
	Caesalpinia sepiaria Roxb.
	Cassia laevigata Willd.
	Cassia occidentalis L.
LILIACEAE	Dianella ensifolia Red.
	Smilax kraussiana Meissn.
MYRSIN.	Embelia concinna Bak.
	Maesa lanceolata Forsk.
PIPER.	Piper pachyphyllum Bak.
	Piper pyrifolium Vahl
PITTOS.	Pittosporum ochrosiaefolium Boj.
POLYGON.	Polygonum senegalense Meissn.
ROSACEAE	Rubus rosaefolius Sm.
RUBIACEAE	Oldenlandia sp.
	Paederia bojeriana Drake
	Santalina madagascariensis H.Bn.
RUTACEAE	Toddalia aculeata Pers.
SAPIND.	Cardiospermum halicacabum L.

Blepharitis
MALVACEAE Urena lobata L.
Boils
APOCYN. Pachypodium rosulatum Bak.
COMPOS. Dichrocephala latifolia DC.
Psiadia salviaefolia Bak.
Senecio sp.
DIOSC. Dioscorea bulbifera L.
EUPHOR. Jatropha curcas L.
Manihot utilissima Pohl.
HYDROST. Hydrostachys imbricata A.Juss.
LEMNACEAE Lemna paucicostata Hegelm.
MALVACEAE Kosteletzkya velutina Garcke
Malva verticillata L.
Sida rhombifolia L.
MENISP. Cissampelos pareira L.
ONAGR. Jussiaea repens L.
SOLANAC. Solanum erythracanthum Boj.
TILIACEAE Triumfetta rhomboidea Jacq.
Bones, aching
RUBIACEAE Santalina madagascariensis H.Bn.
Breathlessness
ERYTHR. Erythroxylum sp.
Bronchitis
AMARANTH. Achyranthes aspera L.
EUPHOR. Euphorbia hirta L.
Phyllanthus distichus Muell. Arg.
Phyllanthus niruri L.
LEGUM. Abrus aureus R.Vig.
Abrus precatorius L.
Cassia occidentalis L.
LOGAN. Buddleia madagascariensis Lamk.
MALVACEAE Urena lobata L.
RUTACEAE Citrus spp.
Toddalia aculeata Pers.
SOLANAC. Solanum indicum L.
ZINGIB. Curcuma longa L.
Bruised wounds
CYPER. Cyperus aequalis Vahl
Bruises
COMPOS. Ageratum conyzoides L.
FLACOUR. Aphloia theaeformis Benn.
MORACEAE Ficus pyrifolia Lamk.
Burns
AMARYLL. Crinum firmifolium Bak.
COMPOS. Emilia citrina D.C.
CRASSUL. Kalanchoe prolifera Ham.
EUPHOR. Macaranga sp.
Manihot utilissima Pohl.
MUSACEAE Musa paradisiaca L.
MYRSIN. Embelia concinna Bak.
Embelia madagascariensis DC.
ORCHID. Cynosorchis sp.
SIMAROU. Samandura madagascariensis Gaertn.
TILIACEAE Triumfetta rhomboidea Jacq.
Cachexia
ULMACEAE Trema orientalis Blume
Calmative
RUBIACEAE Oldenlandia lancifolia D.C.
Cardiac edema
GRAMINEAE Zea mays L.
Cardiac tonic
AIZOACEAE Mollugo nudicaulis Lamk.
APOCYN. Cerbera venenifera (Poir.) Steud.
Roupellina boivini (H.Bn.) Pich.
ASCLEP. Cryptostegia madagascariensis Boj.
Gomphocarpus fruticosus R.Br.
Menabea venenata H.Bn.
CHENOP. Chenopodium ambrosioides L.
LEGUM. Cajanus indicus Spreng.
Erythrophleum couminga H.Bn.
RUTACEAE Toddalia aculeata Pers.
Cathartic
CAPPARA. Physena madagascariensis Steud. & Thou.
LILIACEAE Aloe capitata Bak.
Cautery
RANUNC. Clematis trifida Hook.
Chancres
AMARANTH. Amaranthus spinosus L.
COMPOS. Emilia graminea D.C.
Chancres (contd.)
Etulia conyzoides L.
GRAMINEAE Saccharum officinarum L.
LILIACEAE Asparagus vaginellatus Boj.
Chancres, phagedenic
LEGUM. Clitoria lasciva Boj.
Chapped feet
COMPOS. Senecio faujasioides Bak.
Charm
APOCYN. Cerbera venenifera (Poir.) Steud.
Chicken pox
COMPOS. Vernonia appendiculata Less.
MYRSIN. Maesa lanceolata Forsk.
Childbirth
ANACARD. Operculicarya hyphaenoides H.Perr.
ASCLEP. Leptadenia madagascariensis Decne.
COMPOS. Vernonia garnieriana Klatt.
ERIOCAU. Mesanthemum rutenbergianum Koern.
EUPHOR. Phyllanthus sp.
FLACOUR. Calantica sp.
Chlorosis
UMBELL. Phellolophium madagascariense Bak.
Choking
MALVACEAE Sida rhombifolia L.
MYRSIN. Oncostemon leprosum Mez.
Choking ("Etouffements")
MALVACEAE Malva verticillata L.
Cholagogue
PHYTOLAC. Phytolacca dodecandra L'Her.
SAPIND. Cardiospermum halicacabum L.
Cicatrizant
ASCLEP. Asclepias curassavica L.
CLUSIA. Calophyllum inophyllum L.
Calophyllum parviflorum Boj.
COMPOS. Helichrysum faradifani Sc. Ell.
Helichrysum rusillonii Hochr.
EUPHOR. Croton sp.
GRAMINEAE Panicum maximum Jacq.
MYRTACEAE Psidium guayava Berg.
MYRIST. Brochoneura acuminata Warb.
Cicatrizant after circumcision
COMPOS. Helichrysum cordifolium D.C.
Cicatrizant & disinfectant
OPILIAC. Rhopalopilia sp.
Cirrhosis
COMPOS. Ageratum conyzoides L.
SAPIND. Cardiospermum halicacabum L.
Coagulant
COMPOS. Erigeron naudinii E.Bonnet
Coffee substitute
LEGUM. Cassia occidentalis L.
Cassia occidentalis Sond.
Colds
LABIATAE Hyptis pectinata Poit.
Hyptis spicigera Lamk.
LEGUM. Albizia gummifera C.A.Smith
MALVACEAE Abelmoschus esculentus Moench.
RUBIACEAE Randia talangninia DC.
Urophyllum lyallii Bak.
Colic
COMPOS. Helichrysum cordifolium D.C.
MYRTACEAE Psidium cattleyanum Sabine
Condyloma
AMARYLL. Crinum firmifolium Bak.
BIGNON. Phyllarthron madagascariensis K.Schum.
COMPOS. Emilia amplexicaulis Bak.
Emilia citrina D.C.
Emilia humifusa D.C.
Psiadia altissima Benth. & Hook.
Senecio faujasioides Bak.
Senecio myricaefolius DC.
DROSER. Drosera madagascariensis D.C.
Congestion of the breasts
APOCYN. Catharanthus lanceus Pich.
Conjunctivitis
COMPOS. Dichrocephala lyrata DC.
EQUISET. Equisetum ramosissimum Desf.
OLACACEAE Ximenia perrieri Cav. & Ker.
ZINGIB. Curcuma longa L.

Constipation		
	COMPOS.	Brachylaena ramiflora Humb.
	CUNON	Weinmannia sp.
	ICACIN.	Cassinopsis madagascariensis Baill.
	LOGAN.	Anthocleista amplexicaulis Bak.
		Anthocleista madagascariensis Bak.
	MYRSIN.	Embelia concinna Bak.
	UMBELL.	Caucalis sp.
Constipation (severe)		
	ZINGIB.	Hedychium coronarium Koen.
Consumption		
	COMPOS.	Senecio erechtitoides Bak.
		Vernonia diversifolia Boj.
		Vernonia pectoralis Bak.
	LEGUM.	Albizia gummifera C.A.Smith
	RANUNC.	Clematis mauritiana Lamk.
	ZINGIB.	Curcuma longa L.
Contusions		
	CLUSIA.	Symphonia fasciculata Benth. & Hook.
	CRASSUL.	Kalanchoe prolifera Ham.
	DIOSC.	Dioscorea sansibarensis Pax.
	MELAST.	Medinilla sp.
Convulsions		
	CORNACEAE	Kaliphora madagascariensis Hook.
Convulsions (children)		
	LEGUM.	Indigofera tinctoria L.
		Mimosa pudica L.
Convulsions (infants)		
	MYRSIN.	Oncostemon botryoides Bak.
Corrosive		
	ANACARD.	Gluta tourtour March.
Coughs		
	AIZOACEAE	Mollugo nudicaulis Lamk.
	ANNON.	Uvaria catocarpa Diels
	ASCLEP.	Cynanchum aphyllum Schlechtr.
		Gomphocarpus fruticosus R.Br.
		Harpanema acuminatum Decne.
		Pentopetia androsaemifolia Decne.
		Pentopetia sp.
	BIGNON.	Phyllarthron madagascariensis K.Schum.
	CANELL.	Cinnamosma madagascariensis Dang.
	COMPOS.	Ageratum conyzoides L.
		Erigeron naudinii E.Bonnet
		Helichrysum faradifani Sc. Ell.
		Helichrysum sp.
		Inula speciosa (DC) O.Hoffm.
		Vernonia diversifolia Boj.
		Vernonia exserta Bak.
		Vernonia pectoralis Bak.
		Vernonia trichodesma Bak.
		Vernonia trinervis Boj. ex DC.
	CRASSUL.	Kalanchoe prolifera Ham.
	DROSER.	Drosera madagascariensis D.C.
	LABIATAE	Hyptis pectinata Poit.
		Ocimum gratissimum L.
	LAURACEAE	Ravensara sp.
	LEGUM.	Abrus aureus R.Vig.
		Abrus precatorius L.
		Albizia fastigiata Oliv.
		Albizia gummifera C.A.Smith
		Tamarindus indica L.
	LOGAN.	Buddleia madagascariensis Lamk.
	MALVACEAE	Abelmoschus moschatus Medic.
		Hibiscus diversifolia Jacq.
		Sida rhombifolia L.
		Urena lobata L.
	MORACEAE	Ficus megapoda Bak.
		Ficus pyrifolia Lamk.
	MYRTACEAE	Eugenia jambos L.
	OXALID.	Oxalis corniculata L.
	POLYGAL.	Polygala ankaratrensis H.Perr.
	SAPIND.	Allophylus bieruris Radlk.
	SOLANAC.	Solanum nigrum L.
	TILIACEAE	Triumfetta rhomboidea Jacq.
	ULMACEAE	Trema orientalis Blume
	ZINGIB.	Curcuma longa L.
Coughs with blood		
	HYPERIC.	Harungana madagascariensis Choisy
Cystitis		
	EQUISET.	Equisetum ramosissimum Desf.
	GRAMINEAE	Cynodon dactylon Pers.
	LEGUM.	Cassia occidentalis L.
	LYTHR.	Woodfordia fruticosa S.Kurtz
Dandruff		
	CAMPAN.	Dialypetalum floribundum Benth.
	EUPHOR.	Croton sp.
	LILIACEAE	Aloe sp.
	PEDAL.	Uncarina stellulifera Humb.
Debility		
	ULMACEAE	Trema orientalis Blume
Delirium tremens		
	MYRTACEAE	Eugenia emirensis Bak.
Depurative		
	ACANTH.	Justicia gendarussa Burm.
	ANACARD.	Mangifera indica L.
	APOCYN.	Catharanthus roseus G.Don
	AZOLL.	Azolla pinnata L.
	GRAMINEAE	Cymbopogon citratus Stapf.
	LABIATAE	Ocimum gratissimum L.
	LEGUM.	Cassia fistula L.
		Cassia laevigata Willd.
		Cassia occidentalis L.
	LILIACEAE	Smilax kraussiana Meissn.
	LOGAN.	Anthocleista rhizophoroides Bak.
		Buddleia madagascariensis Lamk.
	MALVACEAE	Thespesia populnea Soland.
	RUBIACEAE	Paederia bojeriana Drake
Dermatoses		
	ASCLEP.	Cryptostegia madagascariensis Boj.
	COMPOS.	Eclipta erecta L.
	RUBIACEAE	Paederia bojeriana Drake
	SOLANAC.	Nicandra physaloides Gaertn.
Desquamation		
	RANUNC.	Ranunculus pinnatus Poir.
Detersive		
	EUPHOR.	Dalechampia clematidifolia Boj.
		Jatropha curcas L.
		Phyllanthus casticum Soy. Will.
		Phyllanthus madagascariensis Muell. Arg.
Diabetes		
	ARACEAE	Pothos chapelieri Schott.
	COMPOS.	Brachylaena ramiflora Humb.
		Helichrysum sp.
		Psiadia salviaefolia Bak.
	FLACOUR.	Homalium sp.
	LAURACEAE	Cinnamomum camphora Sieb.
	LEGUM.	Desmodium latifolium D.C.
	MELAST.	Antherotoma naudini Hook.f.
	MUSACEAE	Musa paradisiaca L.
	MYRTACEAE	Eugenia jambolana Lamk.
Diaphoretic		
	COMPOS.	Ageratum conyzoides L.
		Pterocaulon decurrens Moore
	LABIATAE	Hyptis pectinata Poit.
	LEGUM.	Albizia fastigiata Oliv.
	LILIACEAE	Smilax kraussiana Meissn.
	RUTACEAE	Citrus medica L.
Diarrhoea		
	AMARANTH.	Henonia scoparia Moq.
	ANACARD.	Poupartia minor (Boj.) L.Marchand
	ARALIAC.	Cussonia bojeri Seem.
	COMPOS.	Psiadia altissima Benth. & Hook.
		Vernonia sp.
	EUPHOR.	Manihot utilissima Pohl.
		Securinega capuronii J.Leandr.
	FLACOUR.	Aphloia theaeformis Benn.
	GRAMINEAE	Cymbopogon plicatus Stapf.
		Oryza sativa L.
	HYPERIC.	Haronga madagascariensis Choisy
		Psorospermum sp.
	LABIATAE	Coleus sp.
		Tetradenia fruticosa Benth.
	LEGUM.	Albizia fastigiata Oliv.
		Albizia gummifera C.A.Smith
	LILIACEAE	Dracaena reflexa Lamk.
	LOGAN.	Anthocleista amplexicaulis Bak.
	MELAST.	Dichaetanthera oblongifolia Bak.

Diarrhoea (contd.)
MORACEAE Ficus megapoda Bak.
MUSACEAE Musa paradisiaca L.
MYRTACEAE Eugenia jambolana Lamk.
Eugenia parkeri Bak.
Psidium cattleyanum Sabine
Psidium guayava Berg.
OLACACEAE Olax cf. andronensis Bak.
PLUMBAG. Plumbago aphylla Boj.
PUNIC. Punica granatum L.
RHAMN. Ziziphus spina-christi Willd.
ROSACEAE Rubus rosaefolius Sm.
SOLANAC. Physalis peruviana L.
ULMACEAE Trema orientalis Blume
UMBELL. Hydrocotyle superposita Bak.
Hydrocotyle tussilaginifolia Bak.
ZINGIB. Curcuma longa L.
Diarrhoea (chronic)
ROSACEAE Rubus apetalus Poir.
Rubus myrianthus Bak.
Rubus pauciflorus Bak.
Diarrhoea with mucus
LABIATAE Ocimum gratissimum L.
Digestion
ARALIAC. Cussonia bojeri Seem.
Diptheria
CARIC. Carica papaya L.
MELIACEAE Turraea sp.
Disinfectant
LABIATAE Ocimum gratissimum L.
UMBELL. Phellolophium madagascariense Bak.
Dislocations
CONVOLV. Ipomea sp.
Diuretic
AMARANTH. Achyranthes aspera L.
Amaranthus spinosus L.
Henonia scoparia Moq.
APOCYN. Catharanthus lanceus Pich.
BALSAM. Impatiens baroni Bak.
Impatiens emirnensis Bak.
BORAG. Heliotropium indicum L.
CANELL. Cinnamosma fragrans H.Bn.
CELAST. Mystroxylon aethiopicum (Thunb.) Loes.
COMPOS. Conyza aegyptiaca Ait. var.leariloba DC.
Elephantopus scaber L.
Helichrysum emirnense DC.
Helichrysum sp.
Spilanthes acmella Murr.
CRASSUL. Kalanchoe laxiflora Bak.
CUCURB. Cucurbita maxima Duch.
DROSER. Drosera madagascariensis DC.
EQUISET. Equisetum ramosissimum Desf.
ERYTHR. Erythroxylum ferrugineum Cav.
FLACOUR. Aphloia theaeformis Benn.
Flacourtia ramontchi L'Her.
GRAMINEAE Cynodon dactylon Pers.
Saccharum officinarum L.
Zea mays L.
HYPERIC. Psorospermum fanerana Bak.
LAURACEAE Cassytha filiformis L.
LEGUM. Cajanus indicus Spreng.
Cassia occidentalis L.
Clitoria ternatea L.
Mucuna pruriens DC.
LILIACEAE Asparagus greveanus Perr.
Asparagus schumanianus Schlecter
Asparagus simulans Bak.
Asparagus vaginellatus Boj.
Dracaena reflexa Lamk.
Smilax kraussiana Meissn.
LOGAN. Anthocleista rhizophoroides Bak.
Anthocleista sp.
MALVACEAE Gossypium arboreum L.
Sida cordifolia L.
MENISP. Cissampelos pareira L.
MORING. Moringa pterygosperma Gaertn.
MUSACEAE Musa paradisiaca L.
MYRSIN. Oncostemon sp.
MYRTACEAE Eugenia jambolana Lamk.

Diuretic (contd.)
POLYPOD. Pellea viridis Prantl.
PORTUL. Portulaca oleracea L.
RANUNC. Clematis mauritiana Lamk.
ROSACEAE Rubus apetalus Poir.
Rubus pauciflorus Bak.
Rubus rosaefolius Sm.
RUBIACEAE Paederia bojeriana Drake
SAPIND. Cardiospermum halicacabum L.
Dizziness
COMPOS. Laggera alata Sch. Bip.
Dizziness and fainting
EUPHOR. Phyllanthus sp.
Dropsy
AMARANTH. Achyranthes aspera L.
FLACOUR. Aphloia theaeformis Benn.
LILIACEAE Aloe capitata Bak.
Aloe macroclada Bak.
MORING. Moringa pterygosperma Gaertn.
MUSACEAE Musa paradisiaca L.
PHYTOLAC. Phytolacca dodecandra L'Her.
Dysentery
ACANTH. Justicia gendarussa Burm.
ANACARD. Mangifera indica L.
APOCYN. Carissa edulis Vahl
BOMBAC. Adansonia digitata L.
Adansonia madagascariensis H.Bn.
CANELL. Cinnamosma madagascariensis Dang.
COMPOS. Elephantopus scaber L.
EUPHOR. Manihot utilissima Pohl.
Phyllanthus casticum Soy. Will.
Uapaca bojeri H.Bn.
GRAMINEAE Oryza sativa L.
HYPERIC. Haronga madagascariensis Choisy
Hypericum japonicum Thunb.
LABIATAE Tetradenia fruticosa Benth.
LAURACEAE Cassytha filiformis L.
LEGUM. Albizia adianthifolia (Schum.) W.F.Wight
Caesalpinia bonducella Fleming
Crotalaria cytisioides Hilsenb.
Crotalaria uncinella Lamk.
LILIACEAE Dracaena reflexa Lamk.
LOGAN. Anthocleista amplexicaulis Bak.
Buddleia madagascariensis Lamk.
MALVACEAE Gossypium arboreum L.
Sida rhombifolia L.
MELAST. Dichaetanthera oblongifolia Bak.
MENISP. Burasaia madagascariensis D.C.
MORACEAE Ficus cocculifolia Bak.
Ficus megapoda Bak.
Ficus pyrifolia Lamk.
MYRTACEAE Eugenia emirensis Bak.
Eugenia jambolana Lamk.
Eugenia parkeri Bak.
Psidium guayava Berg.
POLYGON. Rumex abyssinicus Jacq.
PUNIC. Punica granatum L.
RANUNC. Ranunculus pinnatus Poir.
ROSACEAE Rubus rosaefolius Sm.
SIMAROU. Samandura madagascariensis Gaertn.
SOLANAC. Solanum nigrum L.
ULMACEAE Trema orientalis Blume
UMBELL. Hydrocotyle superposita Bak.
Hydrocotyle tussilaginifolia Bak.
VERBEN. Clerodendron heterophyllum R.Br.
ZINGIB. Aframomum angustifolium K.Schum.
Curcuma longa L.
Dysentery (chronic)
MALVACEAE Thespesia populnea Soland.
Dysmenorrhoea
COMPOS. Helichrysum gymnocephalum Humb.
EQUISET. Equisetum ramosissimum Desf.
LEGUM. Desmodium barbatum Benth. & Oerst.
Desmodium ramosissimum G.Don
Mimosa pudica L.
LILIACEAE Dracaena reflexa Lamk.
ONAGR. Ludwigia jussiacoides Desr.
Dyspepsia
CARIC. Carica papaya L.
GENTIAN. Tachiadenus longifolius Sc. Ell.

Dyspepsia (contd.)	
GRAMINEAE	Oryza sativa L.
LABIATAE	Ocimum canum Sims
	Ocimum gratissimum L.
ZINGIB.	Curcuma longa L.
Dysuria	
MALVACEAE	Abelmoschus esculentus Moench.
SOLANAC.	Physalis peruviana L.
Ear ailments	
AMARYLL.	Crinum firmifolium Bak.
COMPOS.	Dichrocephala lyrata DC.
LABIATAE	Ocimum canum Sims
ROSACEAE	Rubus rosaefolius Sm.
Ear discharges	
LEGUM.	Voandzeia subterranea Thou.
Ears	
GRAMINEAE	Phragmites communis Tun.
Eczema	
BIGNON.	Ophiocolea floribunda H.Perr.
COMPOS.	Emilia citrina D.C.
	Gynura rubens Muscher
	Psiadia altissima Benth. & Hook.
	Senecio sp.
ERICACEAE	Philippia goudotiana Klotz.
EUPHOR.	Phyllanthus sp.
HYDROST.	Hydrostachys imbricata A.Juss.
HYPERIC.	Haronga madagascariensis Choisy
	Psorospermum androsaemifolium Bak.
LABIATAE	Coleus bojeri Benth.
LEGUM.	Cassia occidentalis L.
LILIACEAE	Smilax kraussiana Meissn.
MYRSIN.	Embelia concinna Bak.
ONAGR.	Jussiaea repens L.
POTAMOG.	Potamogeton spp.
RUBIACEAE	Mussaenda arcuata Poir.
Emetic	
ACANTH.	Justicia gendarussa Burm.
AMARYLL.	Crinum firmifolium Bak.
APOCYN.	Catharanthus lanceus Pich.
	Catharanthus roseus G.Don
	Catharanthus trichophyllus Pich.
ASCLEP.	Gomphocarpus fruticosus R.Br.
EUPHOR.	Jatropha curcas L.
	Ricinus communis L.
FLACOUR.	Aphloia theaeformis Benn.
LABIATAE	Tetradenia fruticosa Benth.
PASSIFL.	Passiflora incarnata L.
PHYTOLAC.	Phytolacca dodecandra L'Her.
SAPIND.	Cardiospermum halicacabum L.
Emmenagogue	
BORAG.	Heliotropium indicum L.
CUCURB.	Momordica charantia L.
HYPERIC.	Haronga madagascariensis Choisy
LABIATAE	Hyptis pectinata Poit.
	Leonotis nepetaefolia R.Br.
LEGUM.	Caesalpinia bonducella Fleming
MENISP.	Cissampelos pareira L.
MONIM.	Tambourissa parvifolia Bak.
	Tambourissa purpurea D.C.
	Tambourissa religiosa DC.
	Tambourissa trichophylla Bak.
PORTUL.	Portulaca oleracea L.
RUTACEAE	Toddalia aculeata Pers.
ZINGIB.	Hedychium coronarium Koen.
	Zingiber officinale Rose.
Enteritis (chronic)	
AIZOACEAE	Mollugo nudicaulis Lamk.
Epilepsy	
BOMBAC.	Adansonia madagascariensis H.Bn.
COMPOS.	Brachylaena ramiflora Humb.
LEGUM.	Indigofera pedunculata Hils. & Boj.
MORING.	Moringa pterygosperma Gaertn.
TILIACEAE	Grewia triflora Walp.
TYPHACEAE	Typha angustifolia L.
Epithelioma	
SOLANAC.	Capsicum minimum Roxb.
Eruptions	
ERICACEAE	Agauria polyphylla Bak.
Erysipelas	
NYMPHA.	Nymphaea stellata Willd.
SAPIND.	Cardiospermum halicacabum L.
"Eutocique"	
BALSAM.	Impatiens baroni Bak.
	Impatiens emirnensis Bak.
	Impatiens madagascariensis Wight & Arn.
LEGUM.	Caesalpinia bonducella Fleming
SOLANAC.	Solanum erythracanthum Boj.
Excitant	
SOLANAC.	Capsicum annuum L.
Expel placenta	
CELAST.	Gymnosporia polyacantha (Sond.) Szyszyl.
Eye ailments	
MUSACEAE	Musa perrieri Clav.
TILIACEAE	Triumfetta rhomboidea Jacq.
Eyes	
LABIATAE	Coleus bojeri Benth.
LEGUM.	Cassia mimosoides L.
Facial pimples	
COMMEL.	Commelina madagascarica Clarke
COMPOS.	Senecio faujasioides Bak.
UMBELL.	Phellolophium madagascariense Bak.
Facial sores of venereal origin	
COMPOS.	Gynura sarcobasis D.C.
Fainting	
CORNACEAE	Kaliphora madagascariensis Hook.
LEGUM.	Dichrostachys sp.
Fainting spells	
MORACEAE	Ficus sp.
Fatigue	
COMPOS.	Vernonia garnieriana Klatt.
Febrifuge	
ANACARD.	Mangifera indica L.
APOCYN.	Catharanthus lanceus Pich.
	Carissa edulis Vahl
ASCLEP.	Pentopetia androsaemifolia Decne.
BIGNON.	Ophiocolea floribunda H.Perr.
	Phyllarthron bernierianum Seeman
BOMBAC.	Adansonia digitata L.
	Adansonia madagascariensis H.Bn.
	Adansonia za H.Bn.
CAPPARA.	Physena madagascariensis Steud. & Thou.
CELAST.	Celastrus madagascariensis Loes.
CHENOP.	Chenopodium ambrosioides L.
COMPOS.	Brachylaena ramiflora Humb.
	Helichrysum faradifani Sc. Ell.
	Vernonia appendiculata Less.
	Brachylaena ramiflora Humb.
	Conyza aegyptiaca Ait. var. linearilloba DC.
	Lactuca welwitschii Sc. Ell.
	Laggera alata Sch. Bip.
	Stenocline inuloides D.C.
	Vernonia appendiculata Less.
CRASSUL.	Kalanchoe crenata Ham.
	Kalanchoe laxiflora Bak.
CYPER.	Kyllingia polyphylla Kunth.
	Kyllingia sp.
DIOSC.	Dioscorea sp.
EBENACEAE	Diospyros humbertiana H.Perr.
ERYTHR.	Erythroxylum sp.
EUPHOR.	Croton sp.
HYPERIC.	Haronga madagascariensis Choisy
LABIATAE	Hyptis pectinata Poit.
	Ocimum canum Sims
LAURACEAE	Cinnamomum camphora Sieb.
	Ravensara aromatica Gmel.
LILIACEAE	Dracaena angustifolia Roxb.
	Dracaena elliptica Thunb.
	Dracaena reflexa Lamk.
LOGAN.	Anthocleista rhizophoroides Bak.
	Gaertneria obovata Bak.
	Gaertneria phanerophlebia Bak.
MALVACEAE	Sida rhombifolia L.
MELIACEAE	Khaya madagascariensis Jum. & Perr.
	Melia azedarach L.
MENISP.	Burasaia congesta Decne.
	Burasaia gracilis Decne.
	Burasaia madagascariensis D.C.

Febrifuge (contd.)

	Cissampelos madagascariensis Miers.
	Cissampelos pareira L.
MORACEAE	Ficus pyrifolia Lamk.
MORING.	Moringa pterygosperma Gaertn.
OXALID.	Biophytum sensitivum (L.) DC.
PIPER.	Piper pachyphyllum Bak.
	Piper pyrifolium Vahl
PITTOS.	Pittosporum ochrosiaefolium Boj.
PTAEROX.	Cedrelopsis grevei H.Bn.
RUBIACEAE	Danais fragrans Gaertn.
	Danais gerrardi Bak.
	Payeria excelsa H.Bn.
	Randia talangninia DC.
RUTACEAE	Toddalia aculeata Pers.
SAPIND.	Dodonaea viscosa Jacq.
SIMAROU.	Samandura madagascariensis Gaertn.
SOLANAC.	Solanum indicum L.
	Solanum macrocarpum L.
TILIACEAE	Grewia triflora Walp.
ULMACEAE	Celtis madagascariensis Boj.
VERBEN.	Clerodendron heterophyllum R.Br.
ZINGIB.	Curcuma longa L.

Fertility, promotion of

LILIACEAE	Smilax kraussiana Meissn.

Flatulence

AMARANTH.	Henonia scoparia Moq.
GRAMINEAE	Oryza sativa L.

Flu

COMPOS.	Laggera alata Sch. Bip.

Fontanelles, diseases of

HYPERIC.	Psorospermum androsaemifolium Bak.
LYTHR.	Pemphis madagascariensis Perr.
MORACEAE	Ficus cocculifolia Bak.
STERCUL.	Buettneria voulily H.Bn.

Fontanelles, swollen

EUPHOR.	Antidesma petiolare Tul.

Fontanelles (acclerate hardening of in infants)

LABIATAE	Ocimum canum Sims

Fortifier

EUPHOR.	Croton sp.
LOGAN.	Nuxia capitata Bak.
MYRSIN.	Oncostemon sp.
MYRTACEAE	Eugenia sp.

Fortifier for children

LOGAN.	Nuxia sp.

Fractures

ASCLEP.	Cryptostegia madagascariensis Boj.
CONVOLV.	Ipomea sp.
FLACOUR.	Aphloia theaeformis Benn.
LEGUM.	Albizia fastigiata Oliv.
LILIACEAE	Aloe divaricata Berger.
MALVACEAE	Pavonia urens Lass.
MORACEAE	Ficus pyrifolia Lamk.
PTAEROX.	Cedrelopsis grevei H.Bn.

Galactogogue

AMARANTH.	Alternanthera sessilis R.Br.
APOCYN.	Catharanthus roseus G.Don
ASCLEP.	Secamone ligustrifolia Decne.
COMMEL.	Commelina madagascarica Clarke
COMPOS.	Spilanthes acmella Murr.
EUPHOR.	Ricinus communis L.
POLYGAL.	Polygala macroptera D.C.

Galactorrhoea

COMPOS.	Helichrysum gymnocephalum Humb.

Gangrene

MORING.	Moringa pterygosperma Gaertn.

Gastralgia

GRAMINEAE	Oryza sativa L.
LEGUM.	Clitoria ternatea L.
SCROPHUL.	Scoparia dulcis L.
UMBELL.	Phellolophium madagascariense Bak.
ZINGIB.	Curcuma longa L.

Genital oedema

LEGUM.	Abrus precatorius L.

Gingivitis

ROSACEAE	Rubus apetalus Poir.
	Rubus myrianthus Bak.
	Rubus pauciflorus Bak.
	Rubus rosaefolius Sm.

Gingivitis (contd.)

ULMACEAE	Trema orientalis Blume

Goitre

COMPOS.	Helichrysum gymnocephalum Humb.

Gonorrhoea

ASCLEP.	Secamone obovata Decne.
BIGNON.	Phyllarthron madagascariensis K.Schum.
COMPOS.	Brachylaena ramiflora Humb.
	Helichrysum faradifani Sc. Ell.
	Inula speciosa (DC) O.Hoffm.
	Senecio sp.
	Vernonia sp.
	Vernonia trinervis Boj. ex DC.
CONVOLV.	Ipomaea pescaprae (L.) Sweet
EBENACEAE	Diospyros humbertiana H.Perr.
EUPHOR.	Croton sp.
	Euphorbia laro Drake.
LAURACEAE	Cassytha filiformis L.
LEGUM.	Caesalpinia sepiaria Roxb.
	Cassia occidentalis Sond.
LILIACEAE	Dianella ensifolia (L.) Redoute
LOGAN.	Anthocleista rhizophoroides Bak.
	Nuxia capitata Bak.
UMBELL.	Phellolophium madagascariense Bak.

Gout

APOCYN.	Cabucala madagascariensis Pich.
ASCLEP.	Pentopetia androsaemifolia Decne.
COMPOS.	Conyza aegyptiaca Ait. var. lineariloba DC.
	Helichrysum rusillonii Hochr.
	Siegesbeckia orientalis L.
CONVOLV.	Ipomea wrightii Choisy
CRASSUL.	Kalanchoe prolifera Ham.
GRAMINEAE	Cynodon dactylon Pers.
LEGUM.	Cassia occidentalis L.
LILIACEAE	Asparagus vaginellatus Boj.
	Dipcadi cowani H.Perr.
	Smilax kraussiana Meissn.
LYTHR.	Woodfordia fruticosa S.Kurtz
MORING.	Moringa pterygosperma Gaertn.
MYRSIN.	Embelia concinna Bak.
POLYGON.	Polygonum senegalense Meissn.
SAPIND.	Dodonaea viscosa Jacq.
SOLANAC.	Nicandra physaloides Gaertn.
ZINGIB.	Hedychium coronarium Koen.

Granular endometritis

SOLANAC.	Capsicum minimum Roxb.
URTIC.	Urera acuminata Gaudich.

Growth promoter

BIGNON.	Stereospermum variabile H.Perr.

Gums

MONIM.	Tambourissa religiosa DC.

Haemoglobinuria

CUCURB.	Cucurbita maxima Duch.
FLACOUR.	Aphloia theaeformis Benn.
GENTIAN.	Tachiadenus longifolius Sc. Ell.

Haemoptysis

BOMBAC.	Adansonia digitata L.
COMPOS.	Ethulia conyzoides L.
SOLANAC.	Solanum nigrum L.

Haemorrage

CLUSIA.	Calophyllum inophyllum L.

Haemorrhoids

AZOLL.	Azolla pinnata L.
HYPERIC.	Haronga madagascariensis Choisy
LEGUM.	Mucuna pruriens DC.
MALVACEAE	Malva verticillata L.
NYMPHA.	Nymphaea stellata Willd.
SAPIND.	Cardiospermum halicacabum L.

Haemostatic

ANACARD.	Operculicarya monstruosa H.Perr.
APOCYN.	Catharanthus lanceus Pich.
	Catharanthus roseus G.Don
	Catharanthus trichophyllus Pich.
ARACEAE	Colocasia esculenta Schott
ASCLEP.	Pentopetia androsaemifolia Decne.
BIGNON.	Stereospermum euphorioides D.C.
COMPOS.	Conyza aegyptiaca Ait. var. lineariloba DC.
	Elephantopus scaber L.

Haemostatic (contd.)	
COMPOSITE	Emilia citrina D.C.
	Helichrysum mutisiaefolium H.Humb.
	Helichrysum sp.
	Siegesbeckia orientalis L.
	Vernonia secundifolia Boj. ex DC.
EUPHOR.	Jatropha mahafalensis Jum. & Perr.
HYPERIC.	Hypericum japonicum Thunb.
LILIACEAE	Dracaena reflexa Lamk.
MALVACEAE	Gossypium arboreum L.
MELAST.	Clidemia hirta D.Don
SAPIND.	Paullinia pinnata L.
UMBELL.	Sanicula europaea L.
URTIC.	Urera longifolia Wedd.
	Urera oligoloba Bak.
Haematuria	
ASCLEP.	Pentopetia androsaemifolia Decne.
FLACOUR.	Aphloia theaeformis Benn.
MALVACEAE	Gossypium arboreum L.
	Sida cordifolia L.
MUSACEAE	Musa paradisiaca L.
PALMAE	Cocos nucifera L.
PIPER.	Piper pachyphyllum Bak.
SAPIND.	Litchi sinensis Radlk.
SOLANAC.	Solanum erythracanthum Boj.
ULMACEAE	Trema orientalis Blume
ZINGIB.	Hedychium coronarium Koen.
Head colds	
BIGNON.	Colea fusca H.Perr.
COMPOS.	Laggera alata Sch. Bip.
RUTACEAE	Citrus spp.
Head problems	
COMPOS.	Vernonia trinervis Boj. ex DC.
LABIATAE	Plectranthus sp.
Headaches	
CAPPARA.	Capparis chrysomeia Boj.
CELAST.	Evonymopsis longipes H.Perr.
COMPOS.	Helichrysum gymnocephalum Humb.
	Laggera alata Sch. Bip.
CORNACEAE	Kaliphora madagascariensis Hook.
CUNON	Weinmannia rutenbergii Engl.
EUPHOR.	Croton sp.
HERNAN.	Hernandia voyroni Jum.
LABIATAE	Ocimum gratissimum L.
LEGUM.	Indigofera lyallii Bak.
	Smithia chamaecrista Benth.
PTAEROX.	Cedrelopsis grevei H.Bn.
RANUNC.	Ranunculus pinnatus Poir.
RUTACEAE	Toddalia aculeata Pers.
SOLANAC.	Solanum asphanathum Bak.
TILIACEAE	Grewia triflora Walp.
UMBELL.	Phellolophium madagascariense Bak.
ZINGIB.	Zingiber officinale Rose.
Headaches (children)	
AMARANTH.	Henonia scoparia Moq.
Headaches & nosebleed	
CAPPARID.	Maerva filiformis Drake
Heart	
GRAMINEAE	Phragmites communis Tun.
MENISP.	Cissampelos sp.
Heart troubles	
APOCYN.	Voacanga thouarsii Roem. & Schult.
Hemiplegia	
LEGUM.	Mucuna pruriens DC.
Hepatic colic	
MORACEAE	Artocarpus integrifolia L.
Hepatic depurative	
RUBIACEAE	Danais verticillata Bak.
Hepatic fever	
COMPOS.	Conyza garnieri Klatt.
Hepatitis	
LOGAN.	Anthocleista rhizophoroides Bak.
Herpes	
ACANTH.	Rhinacanthus osmospermus Boj.
COMPOS.	Helichrysum gymnocephalum Humb.
EUPHOR.	Jatropha curcas L.
Hiccups	
COMBRET.	Calopyxis subumbellata Bak.
Hoarseness	
MALVACEAE	Abelmoschus esculentus Moench.
Hookworm	
CHENOP.	Chenopodium ambrosioides L.
COMBRET.	Calopyxis subumbellata Bak.
Hypertension	
CELAST.	Mystroxylon aethiopicum (Thunb.) Loes.
LEGUM.	Cassia alata L.
	Cassia occidentalis Sond.
LORANTH.	Loranthus sp.
	Viscum sp.
SAPIND.	Cardiospermum halicacabum L.
Hypnotic	
OXALID.	Biophytum sensitivum (L.) DC.
SOLANAC.	Solanum indicum L.
Hypoglycaemia	
ASCLEP.	Gymnema sylvestre R.Br.
Hysteria	
BIGNON.	Rhodocolea telfairiae Perr.
LEGUM.	Cassia occidentalis L.
	Cassia tora L.
MORING.	Moringa pterygosperma Gaertn.
UMBELL.	Phellolophium madagascariense Bak.
Impetigo	
ACANTH.	Rhinacanthus aspera L.
LEGUM.	Cassia alata L.
	Cassia tora L.
Infant cholera	
LEGUM.	Mimosa latispinosa Lamk.
Infant maladies	
LEGUM.	Mundulea scoparia R.Viguier
Inflamation	
AMARYLL.	Crinum firmifolium Bak.
Insomnia	
MYRTACEAE	Eugenia sp.
PASSIFL.	Passiflora caerula L.
Intellectual stimulant	
HYPERIC.	Haronga madagascariensis Choisy
Intestinal debility	
HYPERIC.	Haronga madagascariensis Choisy
Intestinal pains	
EUPHOR.	Hura crepitans L.
Intestinal troubles	
EUPHOR.	Croton sp.
MORACEAE	Ficus soroceoides Bak.
Intestinal worms	
LEGUM.	Mucuna pruriens DC.
Irritant	
EBENACEAE	Diospyros graceilipes Hiern.
Itching	
AMARANTH.	Alternanthera sessilis R.Br.
ERICACEAE	Agauria polyphylla Bak.
UMBELL.	Phellolophium madagascariense Bak.
Jaundice	
ACANTH.	Justicia gendarussa Burm.
ASCLEP.	Pentopetia androsaemifolia Decne.
COMPOS.	Helichrysum fulvescens D.C.
CUCURB.	Cucurbita maxima Duch.
EUPHOR.	Phyllanthus casticum Soy. Will.
FLACOUR.	Aphloia theaeformis Benn.
GENTIAN.	Tachiadenus longifolius Sc. Ell.
GRAMINEAE	Cymbopogon plicatus Stapf.
HERNAN.	Hernandia voyroni Jum.
LEGUM.	Cassia occidentalis Sond.
MORACEAE	Ficus sp.
OPILIAC.	Rhopalopilia cf. umbellulavo Engl.
PORTUL.	Portulaca oleracea L.
RUBIACEAE	Payeria excelsa H.Bn.
SOLANAC.	Physalis peruviana L.
ZINGIB.	Curcuma longa L.
Jaundice fever	
EUPHOR.	Jatropha curcas L.
RUBIACEAE	Breonia boivini Havil.
Kidney ailments	
COMPOS.	Conyza aegyptiaca Ait. var. linearilоba DC.
	Gynura rubens Muscher
Kidney colic	
ERYTHR.	Erythroxylum ferrugineum Cav.
FLACOUR.	Flacourtia ramontchi L'Her.
Kidney pain	
FLACOUR.	Homalium sp.

Kidney stones	
CELAST.	Maytenus fasciculata Loes.
Labor pains	
MORACEAE	Ficus pyrifolia Lamk.
Lactation	
ASCLEP.	Secamone ligustrifolia Decne.
EUPHOR.	Croton sp.
Laxative	
ANNON.	Uvaria catocarpa Diels
ASCLEP.	Leptadenia madagascariensis Decne.
EUPHOR.	Croton sp.
GENTIAN.	Tachiadenus longifolius Sc. Ell.
LEGUM.	Caesalpinia bonducella Fleming
	Cajanus indicus Spreng.
	Cassia fistula L.
	Cassia laevigata Willd.
	Cassia occidentalis L.
	Tamarindus indica L.
LOGAN.	Anthocleista rhizophoroides Bak.
MALVACEAE	Malva verticillata L.
MYRSIN.	Oncostemon sp.
PALMAE	Raphia ruffia Mart.
PASSIFL.	Passiflora incarnata L.
SAPIND.	Cardiospermum halicacabum L.
Leprosy	
AMARYLL.	Crinum firmifolium Bak.
CLUSIA.	Symphonia fasciculata Benth. & Hook.
COMPOS.	Ageratum conyzoides L.
	Crassocephalum sarcobasis (DC) Moore
	Pterocaulon decurrens Moore
EUPHOR.	Givotia madagascariensis H.Bn.
HAMAM.	Dicoryphe retusa Bak.
PHYTOLAC.	Phytolacca dodecandra L'Her.
RANUNC.	Clematis mauritiana Lamk.
	Ranunculus pinnatus Poir.
UMBELL.	Hydrocotyle asiatica L.
Leucorrhoea	
EQUISET.	Equisetum ramosissimum Desf.
MYRTACEAE	Eugenia jambolana Lamk.
UMBELL.	Sanicula europaea L.
Lice	
EUPHOR.	Jatropha mahafalensis Jum. & Perr.
MYRIST.	Brochoneura acuminata Warb.
SOLANAC.	Datura stramonium L.
	Nicandra physaloides Gaertn.
Lips	
LYCOP.	Lycopodium clavatum L.
Liver ailments	
AMARANTH.	Cyathula uncinulata (Schrad) Schinz
ARALIAC.	Cussonia bojeri Seem.
	Cussonia sp.
	Polyscias sp.
ASCLEP.	Menabea venenata H.Bn.
CELAST.	Mystroxylon aethiopicum (Thunb.) Loes.
COMPOS.	Inula speciosa (DC) O.Hoffm.
	Psiadia salviaefolia Bak.
	Senecio cochlearifolius Boj.
MENISP.	Cissampelos sp.
MYRSIN.	Oncostemon leprosum Mez.
SCHIZAC.	Lygodium lanceolatum Desv.
Liver congestion	
ANACARD.	Mangifera indica L.
APOCYN.	Catharanthus roseus G.Don
EQUISET.	Equisetum ramosissimum Desf.
Liver flukes	
MORACEAE	Ficus soroceoides Bak.
Loss of voice	
MONIM.	Tambourissa boivinii D.C.
	Tambourissa purpurea D.C.
Low blood pressure	
COMPOS.	Brachylaena ramiflora Humb.
Lumbago	
EUPHOR.	Euphorbia erythroxyloides Bak.
RUBIACEAE	Santalina madagascariensis H.Bn.
SAPIND.	Paullinia pinnata L.
Madness	
FLACOUR.	Flacourtia ramontchi L'Her.
Malaria	
ANACARD.	Rhus taratana (Bak.) H.Perr.
ARISTOL.	Aristolochia acuminata Lamk.
Malaria (contd.)	
COMMEL.	Commelina benghalensis L.
COMPOS.	Brachylaena ramiflora Humb.
	Conyza aegyptiaca Ait. var. lineariloba DC.
	Parthenium hysterophorus L.
	Stenocline inuloides D.C.
	Vernonia pectoralis Bak.
	Vernonia trichodesma Bak.
Malaria	
EUPHOR.	Fluggea microcarpa Blume
	Jatropha curcas L.
	Manihot utilissima Pohl.
GRAMINEAE	Phragmites mauritianus Kunth.
ICACIN.	Cassinopsis madagascariensis Baill.
LABIATAE	Hyptis pectinata Poit.
LAURACEAE	Cinnamomum camphora Sieb.
LEGUM.	Abrus precatorius L.
	Caesalpinia bonducella Fleming
	Cassia occidentalis L.
	Cassia occidentalis Sond.
	Crotalaria spinosa Hochst.
LOGAN.	Anthocleista amplexicaulis Bak.
	Anthocleista rhizophoroides Bak.
MENISP.	Cissampelos pareira L.
RANUNC.	Clematis mauritiana Lamk.
RUBIACEAE	Cephalanthus spathelliferus Bak.
	Danais verticillata Bak.
RUTACEAE	Toddalia aculeata Pers.
SCHIZAC.	Mohria cafforum Desv.
ULMACEAE	Trema orientalis Blume
Measles	
CHENOP.	Chenopodium ambrosioides L.
COMPOS.	Senecio erechtitoides Bak.
	Vernonia appendiculata Less.
MYRSIN.	Maesa lanceolata Forsk.
Mental	
IRIDACEAE	Gladiolus garnieri Klatt.
MONIM.	Tambourissa religiosa DC.
Migraines	
LABIATAE	Ocimum canum Sims
Miscarriage	
HYPERIC.	Psorospermum ferrovestitum Bak.
Mouth	
MONIM.	Tambourissa religiosa DC.
Narcotic	
CANNAB.	Cannabis sativa L.
LABIATAE	Leonotis nepetaefolia R.Br.
PHYTOLAC.	Phytolacca dodecandra L'Her.
SOLANAC.	Datura stramonium L.
	Nicotiana tabacum L.
	Solanum nigrum L.
Nephritis	
EQUISET.	Equisetum ramosissimum Desf.
LABIATAE	Ocimum canum Sims
RUBIACEAE	Danais verticillata Bak.
SAPIND.	Cardiospermum halicacabum L.
Nerve diseases	
COMPOS.	Laggera alata Sch. Bip.
	Vernonia eriophylla Drake
LEGUM.	Albizia gummifera C.A.Smith
Nerve disorders	
GENTIAN.	Tachiadenus carinatus Griseb.
Nerve sedative	
BIGNON.	Phyllarthron bernierianum Seeman
Nerve tonic	
CONNAR.	Agelaea lamarckii Planch.
RUBIACEAE	Danais sp.
Nervous children	
EUPHOR.	Croton sp.
Nervous system stimulant	
LILIACEAE	Dianella ensifolia (L.) Redoute
Nervousness	
COMPOS.	Vernonia appendiculata Less.
CORNACEAE	Kaliphora madagascariensis Hook.
LOGAN.	Anthocleista amplexicaulis Bak.
	Anthocleista madagascariensis Bak.
MYRSIN.	Oncostemon sp.
Nettle rashes	
ERICACEAE	Philippia goudotiana Klotz.

Neuralgia	
ACANTH.	Justicia sp.
APOCYN.	Catharanthus lanceus Pich.
ARALIAC.	Cussonia bojeri Seem.
ASCLEP.	Gomphocarpus fruticosus R.Br.
BIGNON.	Ophiocolea floribunda H.Perr.
	Ophiocolea sp.
CELAST.	Hippocratea sp.
	Mystroxylon aethiopicum (Thunb.) Loes.
COMPOS.	Senecio sp.
	Vernonia glutinosa DC.
	Vernonia trinervis Boj. ex DC.
CUCURB.	Raphidiocystis brachypoda Bak.
EBENACEAE	Diospyros sp.
ERICACEAE	Agauria salicifolia Hook.
EUPHOR.	Euphorbia milii Des Moulins
	Phyllanthus sp.
GRAMINEAE	Cymbopogon citratus Stapf.
	Imperata cylindrica (L.) PB
HYPERIC.	Psorospermum androsaemifolium Bak.
LABIATAE	Pycnostachys coerulea Hook.
LEGUM.	Albizia fastigiata Oliv.
	Calliandra alternans Benth.
LILIACEAE	Asparagus simulans Bak.
	Smilax kraussiana Meissn.
LOGAN.	Nuxia capitata Bak.
LYCOP.	Lycopodium cernuum L.
MELAST.	Dichaetanthera crassinodis Bak.
	Tristemma virusanum Comm.
MELIACEAE	Turraea sp.
MONIM.	Tambourissa religiosa DC.
MORACEAE	Ficus sp.
MYRSIN.	Embelia concinna Bak.
	Embelia madagascariensis DC.
	Oncostemon sp.
MYRTACEAE	Eugenia jambolana Lamk.
	Eugenia sp.
PIPER.	Piper pachyphyllum Bak.
	Piper pyrifolium Vahl
SOLANAC.	Capsicum minimum Roxb.
Neurasthenia	
SOLANAC.	Solanum indicum L.
Neuritis	
MYRSIN.	Embelia concinna Bak.
	Embelia madagascariensis DC.
Neuroses	
LABIATAE	Ocimum canum Sims
MORACEAE	Ficus pyrifolia Lamk.
Obesity in children	
COMPOS.	Senecio sp.
Ocytocic agent	
APOCYN.	Catharanthus lanceus Pich.
BUXACEAE	Buxus madagascariensis Baill.
COMPOS.	Brachylaena ramiflora Humb.
	Epallage dentata D.C.
	Helichrysum sp.
FLACOUR.	Casearia sp.
LEGUM.	Caesalpinia bonducella Fleming
LILIACEAE	Aloe divaricata Berger.
Ophthalmia	
AMARANTH.	Achyranthes aspera L.
CLUSIA.	Calophyllum inophyllum L.
COMPOS.	Ageratum conyzoides L.
CRASSUL.	Kalanchoe laxiflora Bak.
FLACOUR.	Calantica grandiflora Jaub.
SOLANAC.	Lycopersicum esculentum Mill.
	Solanum erythracanthum Boj.
ZINGIB.	Aframomum angustifolium K.Schum.
Oral antiseptic	
CELAST.	Hippocratea urceolus Tul.
Orchitis	
CLUSIA.	Calophyllum inophyllum L.
"Osmeomalacie"	
FLACOUR.	Aphloia theaeformis Benn.
Otitis	
ASCLEP.	Gomphocarpus fruticosus R.Br.
FLAGELL.	Flagellaria indica L.
GRAMINEAE	Phragmites mauritianus Kunth.
MORING.	Moringa pterygosperma Gaertn.
SOLANAC.	Datura stramonium L.
Pain	
ASCLEP.	Pentopetia sp.
	Secamone sp.
COMPOS.	Vernonia polygalaefolia Less.
EUPHOR.	Croton cf. noronhae Baill.
MALPIG.	Tristellateia sp.
Pain and stiffness	
ARALIAC.	Cussonia sp.
Pains	
ANACARD.	Poupartia caffra Perr.
Palpitations	
APOCYN.	Cerbera venenifera (Poir.) Steud.
Paralysis	
APOCYN.	Cerbera venenifera (Poir.) Steud.
BORAG.	Heliotropium indicum L.
LABIATAE	Ocimum canum Sims
LEGUM.	Caesalpinia bonducella Fleming
MORING.	Moringa pterygosperma Gaertn.
RANUNC.	Clematis mauritiana Lamk.
RUBIACEAE	Mussaenda arcuata Poir.
Periostitis	
CRASSUL.	Kalanchoe prolifera Ham.
Pleurodynia	
ZINGIB.	Hedychium coronarium Koen.
Pneumonia	
COMPOS.	Conyza aegyptiaca Ait. var. lineariloba DC.
	Psiadia sp.
EQUISET.	Equisetum ramosissimum Desf.
EUPHOR.	Manihot utilissima Pohl.
	Phyllanthus sp.
LABIATAE	Ocimum gratissimum L.
LEGUM.	Desmodium ramosissimum G.Don
MORACEAE	Ficus pyrifolia Lamk.
RUTACEAE	Toddalia aculeata Pers.
URTIC.	Urera oligoloba Bak.
Poison	
APOCYN.	Roupellina boivini (H.Bn.) Pich.
CLUSIA.	Calophyllum inophyllum L.
Poison antidote	
APOCYN.	Cerbera venenifera (Poir.) Steud.
ARACEAE	Pothos chapelieri Schott.
Post-partum stomach pains	
EUPHOR.	Croton sp.
Postpartum disinfectant	
LEGUM.	Mundulea pungens R.Viguier
Postpartum reconstituent	
LEGUM.	Indigofera depauperata Drake
Pregnant women	
LYCOP.	Lycopodium clavatum L.
Prostate	
LEGUM.	Cassia occidentalis Sond.
Psoriasis	
RUBIACEAE	Mussaenda arcuata Poir.
Puerperal ailments	
AMARANTH.	Achyranthes aspera L.
Pulmonary inflammations	
ZINGIB.	Zingiber zerumbet Rose.
Purgative	
ANNON.	Uvaria catocarpa Diels
APOCYN.	Catharanthus lanceus Pich.
	Catharanthus roseus G.Don
	Catharanthus trichophyllus Pich.
ASCLEP.	Gomphocarpus cornutus Decne.
	Menabea venenata H.Bn.
BUXACEAE	Buxus madagascariensis Baill.
EUPHOR.	Euphorbia trichophylla Bak.
	Jatropha curcas L.
	Ricinus communis L.
GENTIAN.	Tachiadenus carinatus Griseb.
IRIDACEAE	Gladiolus garnieri Klatt.
LABIATAE	Leonotis nepetaefolia R.Br.
LEGUM.	Clitoria ternatea L.
LILIACEAE	Aloe capitata Bak.
	Aloe divaricata Berger.
	Aloe macroclada Bak.
	Rhodocodon madagascariensis Bak.
LOGAN.	Anthocleista sp.
MALVACEAE	Pavonia bojeri Bak.
NYCTAG.	Mirabilis jalapa L.

Purgative (contd.)		
	RUBIACEAE	Mussaenda arcuata Poir.
	TILIACEAE	Grewia barorum
Purgative (strong)		
	EUPHOR.	Hura crepitans L.
Purulent ophthalmia		
	ZINGIB.	Curcuma longa L.
Pyrosis		
	AMARANTH.	Achyranthes aspera L.
	GENTIAN.	Tachiadenus longifolius Sc. Ell.
Rabies		
	CONNAR.	Cnestis polyphylla Lamk.
	PHYTOLAC.	Phytolacca dodecandra L'Her.
	SOLANAC.	Solanum nigrum L.
	ZINGIB.	Curcuma longa L.
Reconstituent		
	EUPHOR.	Jatropha mahafalensis Jum. & Perr.
Rectal prolapsis		
	MALVACEAE	Malva verticillata L.
Relaxant		
	COMPOS.	Helichrysum faradifani Sc. Ell.
Resolutive		
	AMARYLL.	Crinum firmifolium Bak.
		Crinum modestum Bak.
	APOCYN.	Pachypodium rosulatum Bak.
Retention of urine		
	EQUISET.	Equisetum ramosissimum Desf.
	MORACEAE	Pachytrophe dimepate Bur.
	ONAGR.	Jussiaea suffruticosa L.
Revulsive		
	MORING.	Moringa pterygosperma Gaertn.
Rheumatic pains		
	ANNON.	Uvaria manjensis Cav. & Ker.
	MELIACEAE	Neobeguea mahafalensis Leroy
Rheumatism		
	AMARANTH.	Achyranthes aspera L.
	APOCYN.	Cabucala madagascariensis Pich.
	ASCLEP.	Pentopetia androsaemifolia Decne.
	BIGNON.	Kigelia pinnata D.C.
	BURSER.	Canarium madagascariense Engl.
	CELAST.	Gymnosporia polyacantha (Sond.) Szyszyl.
	CLUSIA.	Calophyllum inophyllum L.
		Symphonia fasciculata Benth. & Hook.
	COMPOS.	Helichrysum rusillonii Hochr.
	CRASSUL.	Kalanchoe prolifera Ham.
	ERICACEAE	Agauria polyphylla Bak.
	EUPHOR.	Aleurites triloba Forst.
		Ricinus communis L.
	FLACOUR.	Aphloia theaeformis Benn.
		Scolopia sp.
	GENTIAN.	Tachiadenus longifolius Sc. Ell.
	GRAMINEAE	Cynodon dactylon Pers.
	LABIATAE	Ocimum canum Sims
	LEGUM.	Cassia occidentalis Sond.
	MYRIST.	Brochoneura acuminata Warb.
	RANUNC.	Clematis mauritiana Lamk.
	RUBIACEAE	Mussaenda arcuata Poir.
	SAPIND.	Cardiospermum halicacabum L.
	ZINGIB.	Hedychium coronarium Koen.
Rheumatism (chronic)		
	ACANTH.	Justicia gendarussa Burm.
	POLYGON.	Polygonum senegalense Meissn.
Rickets		
	ASCLEP.	Folotsia sarcostemmoides Const. & Bois.
	COMPOS.	Helichrysum gymnocephalum Humb.
	LAURACEAE	Cassytha filiformis L.
	SAPIND.	Cardiospermum halicacabum L.
		Paullinia pinnata L.
Scabies		
	AMARYLL.	Crinum firmifolium Bak.
	ANACARD.	Mangifera indica L.
	ASCLEP.	Cryptostegia madagascariensis Boj.
	BIXACEAE	Bixa orellana L.
	CLUSIA.	Calophyllum inophyllum L.
		Symphonia fasciculata Benth. & Hook.
	COMPOS.	Emilia citrina D.C.
		Emilia graminea D.C.
		Ethulia conyzoides L.
		Gynura rubens Muscher
		Laggera alata Sch. Bip.
Scabies (contd.)		
	COMPOS.	Psiadia altissima Benth. & Hook.
		Senecio adscendens Boj.
	CUCURB.	Adenopus breviflorus Benth.
	CYPER.	Cyperus rotundus L.
	ERICACEAE	Philippia goudotiana Klotz.
	GERAN.	Geranium simense Hochst.
	HYPERIC.	Haronga madagascariensis Choisy
		Psorospermum androsaemifolium Bak.
	LABIATAE	Tetradenia fruticosa Benth.
	LEGUM.	Cassia occidentalis L.
		Cassia tora L.
		Crotalaria fulva Roxb.
	LILIACEAE	Smilax kraussiana Meissn.
	LOGAN.	Strychnos madagascariensis Poir.
		Strychnos spinosa Lamk.
	MALVACEAE	Gossypium arboreum L.
	MONIM.	Tambourissa boivinii D.C.
		Tambourissa parvifolia Bak.
		Tambourissa purpurea D.C.
		Tambourissa religiosa DC.
		Tambourissa trichophylla Bak.
	MYRIST.	Brochoneura acuminata Warb.
	POLYGON.	Rumex abyssinicus Jacq.
	RANUNC.	Ranunculus pinnatus Poir.
	RUBIACEAE	Oldenlandia lancifolia D.C.
	SOLANAC.	Capsicum minimum Roxb.
		Solanum auriculatum Ait.
		Solanum nigrum L.
	UMBELL.	Hydrocotyle asiatica L.
Scalp ailments		
	HYPERIC.	Haronga madagascariensis Choisy
	LAURACEAE	Cassytha filiformis L.
Scalp parasites		
	RUTACEAE	Zanthoxylum thouvenotii H.Perr.
Scalp ringworm		
	GENTIAN.	Tachiadenus carinatus Griseb.
Sciatica		
	LEGUM.	Cassia occidentalis L.
	POLYGON.	Polygonum senegalense Meissn.
Scurf		
	(LICHEN)	Parmelia perforata Ach.
	APOCYN.	Catharanthus lanceus Pich.
		Catharanthus roseus G.Don
		Catharanthus trichophyllus Pich.
	HYPERIC.	Haronga madagascariensis Choisy
	LEGUM.	Calliandra alternans Benth.
		Cassia occidentalis L.
		Cassia tora L.
	RUBIACEAE	Mussaenda arcuata Poir.
Sedative		
	EUPHOR.	Croton sp.
	FLACOUR.	Casearia sp.
	LABIATAE	Pycnostachys coerulea Hook.
	LECYTH.	Barringtonia speciosa L.
	LEGUM.	Tamarindus indica L.
	OXALID.	Biophytum sensitivum (L.) DC.
	RUBIACEAE	Breonia madagascariensis A.Rich.
	SOLANAC.	Datura stramonium L.
		Nicandra physaloides Gaertn.
		Nicotiana tabacum L.
Sickness in children		
	MONIM.	Tambourissa trichophylla Bak.
Skin ailments		
	AMARANTH.	Achyranthes aspera L.
	AQUIFOL.	Ilex mitis Radlk.
	GENTIAN.	Tachiadenus carinatus Griseb.
	HYPERIC.	Haronga madagascariensis Choisy
	LABIATAE	Leonotis nepetaefolia R.Br.
	LEGUM.	Cassia alata L.
	MALVACEAE	Thespesia populnea Soland.
	MONIM.	Tambourissa boivinii D.C.
		Tambourissa parvifolia Bak.
		Tambourissa purpurea D.C.
		Tambourissa religiosa DC.
		Tambourissa trichophylla Bak.
	MYRIST.	Brochoneura acuminata Warb.
	RUBIACEAE	Danais fragrans Gaertn.
Skin diseases (parasitic)		
	EUPHOR.	Phyllanthus niruri L.

Smallpox
CHENOP. Chenopodium ambrosioides L.
EBENACEAE Diospyros megasepala Bak.
Sneezing
MORACEAE Ficus megapoda Bak.
Sore throat
ANACARD. Mangifera indica L.
MALVACEAE Malva verticillata L.
MELIACEAE Turraea sp.
Sores
ASCLEP. Secamonopsis madagascariensis Jum.
CELAST. Hippocratea sp.
COMBRET. Terminalia catappa L.
COMPOS. Bidens pilosa L.
Psiadia altissima Benth. & Hook.
Senecio faujasioides Bak.
Senecio longiscapus Boj. ex DC.
Stenocline aricoides DC.
DIOSC. Dioscorea bulbifera L.
EUPHOR. Gelonium sp.
LEGUM. Albizia fastigiata Oliv.
Tetrapterocarpon geayi H.Humb.
MORACEAE Ficus baroni Bak.
Ficus megapoda Bak.
Ficus pyrifolia Lamk.
MYRSIN. Oncostemon sp.
ULMACEAE Trema orientalis Blume
Spinal marrow, diseases of
APOCYN. Cabucala madagascariensis Pich.
COMPOS. Helichrysum benthami R.Vig. & H.Humb.
MYRSIN. Embelia concinna Bak.
Spleen, enlargement of
APOCYN. Plectaneia elastica Jum. & Perr.
CHENOP. Chenopodium ambrosioides L.
COMPOS. Tagetes patula L.
MORING. Moringa pterygosperma Gaertn.
ULMACEAE Trema orientalis Blume
Sprains
COMMEL. Commelina benghalensis L.
FLACOUR. Aphloia theaeformis Benn.
GRAMINEAE Cynodon dactylon Pers.
Eleusine indica Gaertn.
LABIATAE Ocimum gratissimum L.
MALVACEAE Malva verticillata L.
MORACEAE Ficus sp.
MYRTACEAE Eugenia jambolana Lamk.
ZINGIB. Curcuma longa L.
Sprains and swellings
EUPHOR. Phyllanthus sp.
Stiffness
ASCLEP. Gomphocarpus fruticosus R.Br.
BIGNON. Phyllarthron madagascariensis K.Schum.
OLEACEAE Jasminum kitchingii Bak.
Stimulant
BIXACEAE Bixa orellana L.
CANNAB. Cannabis sativa L.
CARYOPH. Drymaria cordata (L.) Willd. ex Roem. & Schult.
COMPOS. Helichrysum bracteiferum Humb.
Helichrysum gymnocephalum Humb.
Siegesbeckia orientalis L.
HERNAN. Hernandia voyroni Jum.
LAURACEAE Ravensara aromatica Gmel.
LEGUM. Mucuna pruriens DC.
MALVACEAE Sida rhombifolia L.
MORACEAE Ficus pyrifolia Lamk.
MYRTACEAE Eugenia aromatica H.Bn.
ORCHID. Vanilla planifolia Andrews
RUBIACEAE Mussaenda arcuata Poir.
ZINGIB. Zingiber officinale Rose.
Stinging rash
MYRSIN. Maesa lanceolata Forsk.
Stomach
AMARANTH. Cyathula uncinulata (Schrad) Schinz
ANACARD. Rhus taratana (Bak.) H.Perr.
APOCYN. Cabucala madagascariensis Pich.
ARACEAE Pothos chapelieri Schott.
ARALIAC. Cussonia bojeri Seem.
ASCLEP. Secamone sp.
Menabea venenata H.Bn.

Stomach (contd.)
BIGNON. Ophiocolea sp.
CANELL. Cinnamosma fragrans H.Bn.
CELAST. Celastrus madagascariensis Loes.
Mystroxylon aethiopicum (Thunb.) Loes.
COMPOS. Ageratum conyzoides L.
Brachylaena ramiflora Humb.
Elephantopus scaber L.
Gerbera elliptica H.Humb.
Helichrysum faradifani Sc. Ell.
Senecio sp.
Vernonia sp.
CRASSUL. Kalanchoe sp.
EUPHOR. Croton sp.
Euphorbia sp.
GENTIAN. Tachiadenus carinatus Griseb.
Tachiadenus longifolius Sc. Ell.
GRAMINEAE Eleusine indica Gaertn.
HYPERIC. Hypericum japonicum Thunb.
IRIDACEAE Geissorhiza bojeri Bak.
LABIATAE Hyptis sp.
Hyptis pectinata Poit.
LEGUM. Cassia tora L.
Neobaronia phylanthoides Bak.
Tamarindus indica L.
LILIACEAE Asparagus simulans Bak.
Dianella ensifolia (L.) Redoute
Smilax kraussiana Meissn.
LOGAN. Nuxia capitata Bak.
MELAST. Tristemma virusanum Comm.
MYRSIN. Embelia sp.
Oncostemon sp.
OXALID. Biophytum sensitivum (L.) DC.
PIPER. Piper pachyphyllum Bak.
Piper pyrifolium Vahl
PTAEROX. Cedrelopsis grevei H.Bn.
ROSACEAE Amygdalus persica L.
SCHIZAC. Lygodium lanceolatum Desv.
SIMAROU. Samandura madagascariensis Gaertn.
SOLANAC. Capsicum annuum L.
Solanum indicum L.
ULMACEAE Trema orientalis Blume
UMBELL. Phellolophium madagascariense Bak.
URTIC. Urera oligoloba Bak.
ZINGIB. Aframomum angustifolium K.Schum.
Curcuma longa L.
Hedychium coronarium Koen.
Stomach (baby)
LEGUM. Cassia occidentalis Sond.
Stomach ache
ADIANT. Acrostichum aureum Willd.
EUPHOR. Ricinus communis L.
PTAEROX. Cedrelopsis grevei H.Bn.
Stomach ache (children)
ASCLEP. Cynanchum aphyllum Schlechtr.
Stomach cramps
AIZOACEAE Mollugo nudicaulis Lamk.
GRAMINEAE Oryza sativa L.
Stomach, swollen
COMPOS. Vernonia moquinoides Bak.
Stomatitis
ROSACEAE Rubus apetalus Poir.
Rubus myrianthus Bak.
Rubus pauciflorus Bak.
Rubus rosaefolius Sm.
ULMACEAE Trema orientalis Blume
Strengthen newborns
BIGNON. Stereospermum variabile H.Perr.
Strengthener
EBENACEAE Diospyros sp.
Suppurating sores
APOCYN. Hazunta modesta (Bak.) Pich. subvar methuenii Mgf.
Swelling
ASCLEP. Gomphocarpus fruticosus R.Br.
DIOSC. Dioscorea bulbifera L.
EUPHOR. Croton sp.
MORACEAE Ficus sp.
MYRSIN. Embelia concinna Bak.
MYRTACEAE Eugenia jambolana Lamk.

Syphilis
AMARANTH. Achyranthes aspera L.
APOCYN. Craspidospermum verticillatum Boj.
ARALIAC. Cussonia bojeri Seem.
ASCLEP. Cynanchum sp.
Pentopetia androsaemifolia Decne.
Secamone ligustrifolia Decne.
CANELL. Cinnamosma fragrans H.Bn.
CELAST. Hippocratea bojeri Tul.
Hippocratea sp.
CHENOP. Chenopodium ambrosioides L.
CLUSIA. Ochrocarpos orthcladus H. Perr.
COMPOS. Bojeria speciosa D.C.
Crassocephalum bojeri (DC) Robyns
Elephantopus scaber L.
Emilia citrina D.C.
Emilia graminea D.C.
Epallage dentata D.C.
Etulia conyzoides L.
Helichrysum benthami R.Vig. & H.Humb.
Helichrysum sp.
Psiadia altissima Benth. & Hook.
Senecio adscendens Boj.
Senecio canaliculatus Boj. ex. DC.
Senecio erechtitoides Bak.
Senecio faujasioides Bak.
Senecio longiscapus Boj. ex DC.
Senecio myricaefolius DC.
Senecio resectus Boj. ex. DC.
Senecio sp.
Siegesbeckia orientalis L.
Vernonia glutinosa DC.
DROSER. Drosera madagascariensis D.C.
ERICACEAE Agauria polyphylla Bak.
Agauria salicifolia Hook.
Philippia sp.
EUPHOR. Acalypha radula Bak.
Acalypha spachiana H.Bn.
Bridelia pervilleana H.Bn.
Croton jennyanum Gris.
Phyllanthus sp.
GRAMINEAE Cynodon dactylon Pers.
ICACIN. Cassinopsis madagascariensis Baill.
IRIDACEAE Geissorhiza bojeri Bak.
LABIATAE Coleus bojeri Benth.
Plectranthus cymosus Bak.
Pycnostachys coerulea Hook.
Tetradenia fruticosa Benth.
LAURACEAE Cassytha filiformis L.
LEGUM. Albizia fastigiata Oliv.
Caesalpinia sepiaria Roxb.
Calliandra sp.
Cassia laevigata Willd.
Cassia occidentalis L.
Dolichos biflorus L.
LILIACEAE Smilax kraussiana Meissn.
MALVACEAE Abelmoschus esculentus Moench.
Gossypium arboreum L.
Urena lobata L.
MORACEAE Ficus sp.
MYRSIN. Embelia concinna Bak.
Maesa lanceolata Forsk.
POLYGAL. Polygala bojeri Chodat
POLYGON. Polygonum senegalense Meissn.
RANUNC. Clematis mauritiana Lamk.
ROSACEAE Rubus rosaefolius Sm.
RUBIACEAE Paederia bojeriana Drake
RUTACEAE Teclea punctata Verdoorn
Toddalia aculeata Pers.
SARCOL. Leptolaena pauciflora Bak.
SCROPHUL. Rhaphispermum gerardioides Benth.
SOLANAC. Solanum auriculatum Ait.
ULMACEAE Trema orientalis Blume
VERBEN. Clerodendron heterophyllum R.Br.
Syphilis (secondary)
UMBELL. Hydrocotyle asiatica L.
Syphilitic chancres
(LICHEN) Parmelia perforata Ach.
MALVACEAE Kosteletzkya velutina Garcke
Syphilitic eruptions
LEMNACEAE Lemna paucicostata Hegelm.
Syphilitic sores
BIGNON. Phyllarthron madagascariensis K.Schum.
POLYGON. Rumex abyssinicus Jacq.
Syphilitic stigmates
LABIATAE Pycnostachys coerulea Hook.
MONIM. Tambourissa religiosa DC.
Syphilitic tumors
LEGUM. Albizia lebbek Benth.
Syphilitic ulcers
ZINGIB. Curcuma longa L.
Taenifuge
CANELL. Cinnamosma fragrans H.Bn.
CHENOP. Chenopodium ambrosioides L.
COMBRET. Calopyxis subumbellata Bak.
CUCURB. Citrulus vulgaris Schrad.
Cucurbita maxima Duch.
EBENACEAE Diospyros megasepala Bak.
PUNIC. Punica granatum L.
"Tambavy"
COMPOS. Helichrysum mutisiaefolium H.Humb.
Senecio canaliculatus Boj. ex. DC.
Senecio longiscapus Boj. ex DC.
Vernonia exserta Bak.
Vernonia glutinosa DC.
Vernonia polygalaefolia Less.
ERYTHR. Erythroxylum sp.
FLACOUR. Homalium sp.
LABIATAE Hyptis sp.
LILIACEAE Smilax kraussiana Meissn.
MONIM. Tambourissa religiosa DC.
"Tambavy" for children
LEGUM. Cassia laevigata Willd.
UMBELL. Centella asiatica Urb.
Teeth
ASCLEP. Gomphocarpus fruticosus R.Br.
MYRIC. Myrica spathulata Mirb.
Throat
ASCLEP. Secamone sp.
Tobacco substitute
ARACEAE Pothos chapelieri Schott.
Tonic
AIZOACEAE Mollugo nudicaulis Lamk.
ANACARD. Operculicarya hyphaenoides H.Perr.
ANNON. Uvaria catocarpa Diels
APOCYN. Cabucala madagascariensis Pich.
Carissa edulis Vahl
Catharanthus lanceus Pich.
Catharanthus roseus G.Don
Hazunta modesta (Bak.) Pich. subvar methuenii Mgf.
Voacanga thouarsii Roem. & Schult.
CELAST. Mystroxylon aethiopicum (Thunb.) Loes.
COMPOS. Conyza aegyptiaca Ait. var. leariloba DC.
Spilanthes acmella Murr.
Vernonia pectoralis Bak.
CONNAR. Agelaea lamarckii Planch.
Cnestis polyphylla Lamk.
GENTIAN. Tachiadenus longifolius Sc. Ell.
LABIATAE Hyptis pectinata Poit.
LEGUM. Caesalpinia bonducella Fleming
Cassia occidentalis L.
Phylloxylon sp.
LOGAN. Strychnos madagascariensis Poir.
MORACEAE Chlorophora greveana (Baill.) Leandri
Ficus pyrifolia Lamk.
OLACACEAE Anacolosa pervilleana H.Bn.
PHYTOLAC. Phytolacca dodecandra L'Her.
PTAEROX. Cedrelopsis grevei H.Bn.
RUBIACEAE Danais fragrans Gaertn.
Enterospermum sp.
Mussaenda arcuata Poir.
RUTACEAE Citrus medica L.
Toddalia aculeata Pers.
TACCACEAE Tacca pinnatifida Forst
UMBELL. Hydrocotyle asiatica L.
Tooth cavities
EUPHOR. Croton sp.

Toothache	
ANNON.	Uvaria catocarpa Diels
APOCYN.	Catharanthus lanceus Pich.
	Catharanthus roseus G.Don
	Catharanthus trichophyllus Pich.
ASCLEP.	Cryptostegia madagascariensis Boj.
	Gomphocarpus fruticosus R.Br.
	Pentopetia androsaemifolia Decne.
BURSER.	Canarium madagascariense Engl.
COMPOS.	Conyza aegyptiaca Ait. var.
	garnieri Klatt.
	leariloba DC.
	Spilanthes acmella Murr.
LEGUM.	Tetrapterocarpon geayi H.Humb.
PALMAE	Raphia ruffia Mart.
PTAEROX.	Cedrelopsis grevei H.Bn.
RHAMN.	Berchemia discolor Klozch
RUBIACEAE	Anthospermum emirnense Bak.
SOLANAC.	Nicandra physaloides Gaertn.
	Solanum erythracanthum Boj.
ZINGIB.	Hedychium coronarium Koen.
Treatment for sterility	
RUBIACEAE	Danais sp.
Trembling	
APOCYN.	Cerbera venenifera (Poir.) Steud.
Tuberculosis	
HYPERIC.	Haronga madagascariensis Choisy
"Tumeurs blanches"	
LEGUM.	Crotalaria fulva Roxb.
Tumours	
BURSER.	Canarium madagascariense Engl.
IRIDACEAE	Gladiolus garnieri Klatt.
MALVACEAE	Sida rhombifolia L.
SOLANAC.	Solanum erythracanthum Boj.
TILIACEAE	Triumfetta rhomboidea Jacq.
Ulcerative angina	
SOLANAC.	Capsicum annuum L.
Ulcerous sores	
COMPOS.	Brachylaena ramiflora Humb.
	Emilia citrina D.C.
ERICACEAE	Agauria salicifolia Hook.
EUPHOR.	Euphorbia sp.
Ulcers	
ASCLEP.	Cryptostegia madagascariensis Boj.
CLUSIA.	Calophyllum inophyllum L.
	Calophyllum parviflorum Boj.
	Symphonia fasciculata Benth. & Hook.
COMPOS.	Helichrysum gymnocephalum Humb.
	Psiadia altissima Benth. & Hook.
CRASSUL.	Kalanchoe laxiflora Bak.
EBENACEAE	Diospyros megasepala Bak.
ERICACEAE	Agauria polyphylla Bak.
	Philippia goudotiana Klotz.
EUPHOR.	Euphorbia hirta L.
	Manihot utilissima Pohl.
FLACOUR.	Aphloia theaeformis Benn.
HYPERIC.	Psorospermum androsaemifolium Bak.
IRIDACEAE	Geissorhiza bojeri Bak.
LABIATAE	Tetradenia fruticosa Benth.
LEGUM.	Erythrophleum couminga H.Bn.
LILIACEAE	Smilax kraussiana Meissn.
MORACEAE	Ficus baroni Bak.
	Ficus megapoda Bak.
MORING.	Moringa pterygosperma Gaertn.
MUSACEAE	Musa paradisiaca L.
MYRSIN.	Embelia concinna Bak.
	Embelia madagascariensis DC.
RUBIACEAE	Paederia bojeriana Drake
SAPIND.	Dodonaea viscosa Jacq.
SOLANAC.	Solanum nigrum L.
ULMACEAE	Trema orientalis Blume
UMBELL.	Hydrocotyle asiatica L.
ZINGIB.	Curcuma longa L.
Ulcers	
MUSACEAE	Musa paradisiaca L.
Urethritis	
COMPOS.	Vernonia glutinosa DC.
GENTIAN.	Tachiadenus carinatus Griseb.
LABIATAE	Coleus sp.
LEGUM.	Clitoria ternatea L.
Urethritis (contd.)	
LYTHR.	Woodfordia fruticosa S.Kurtz
ROSACEAE	Rubus apetalus Poir.
Urinary ailments	
LEGUM.	Tamarindus indica L.
Urinary incontinence	
APOCYN.	Cerbera venenifera (Poir.) Steud.
Urine inconsistency	
COMPOS.	Brachylaena ramiflora Humb.
	Helichrysum sp.
DROSER.	Drosera madagascariensis DC.
Urogenital ailments	
BOMBAC.	Adansonia digitata L.
Uterine colic	
LABIATAE	Ocimum gratissimum L.
Uterine hemorrhage	
MALVACEAE	Gossypium arboreum L.
MONIM.	Tambourissa parvifolia Bak.
Venereal ailments	
AMARANTH.	Cyathula prostrata Blume
EUPHOR.	Phyllanthus casticum Soy. Will.
Vermifuge	
AIZOACEAE	Mollugo nudicaulis Lamk.
ANACARD.	Mangifera indica L.
	Rhus taratana (Bak.) H.Perr.
ANNON.	Uvaria catocarpa Diels
APOCYN.	Cabucala madagascariensis Pich.
	Catharanthus lanceus Pich.
	Catharanthus roseus G.Don
	Catharanthus trichophyllus Pich.
BROMEL.	Ananas sativus Schult.
CARYOPH.	Stellaria emirensis P.Danguy
COMBRET.	Calopyxis grandidieri H.Perr.
	Calopyxis phaneropetala H.Perr.
	Calopyxis villosa Tul.
	Poivrea coccinea D.C.
	Poivrea sp.
COMPOS.	Brachylaena ramiflora Humb.
	Elephantopus scaber L.
	Gerbera elliptica H.Humb.
	Vernonia exserta Bak.
CRASSUL.	Kalanchoe crenata Ham.
CUCURB.	Benincasa cerifera Savi
	Citrulus vulgaris Schrad.
	Cucumis sativus L.
	Momordica charantia L.
ERYTHR.	Erythroxylum retusum Baill. ex
	O.E.Schulz.
EUPHOR.	Euphorbia hirta L.
LABIATAE	Hyptis pectinata Poit.
LECYTH.	Barringtonia racemosa Roxb.
LEGUM.	Mimosa pudica L.
	Sarcobotrya strigosa (Benth.) R.Vig.
	Tamarindus indica L.
LILIACEAE	Dianella ensifolia (L.) Redoute
MELAST.	Medinilla sp.
MELIACEAE	Melia azedarach L.
MORACEAE	Chlorophora greveana (Baill.) Leandri
	Ficus soroceoides Bak.
MORING.	Moringa pterygosperma Gaertn.
MYRSIN.	Embelia concinna Bak.
	Embelia madagascariensis DC.
	Embelia sp.
	Maesa lanceolata Forsk.
OXALID.	Biophytum sensitivum (L.) DC.
	Oxalis corniculata L.
PITTOS.	Pittosporum ochrosiaefolium Boj.
POLYGON.	Rumex abyssinicus Jacq.
PTAEROX.	Cedrelopsis grevei H.Bn.
ROSACEAE	Amygdalus persica L.
RUBIACEAE	Enterospermum sp.
RUTACEAE	Teclea sp.
SAPIND.	Cardiospermum halicacabum L.
SOLANAC.	Solanum nigrum L.
VERBEN.	Clerodendron heterophyllum R.Br.
Vesicant	
ANACARD.	Gluta tourtour March.
EUPHOR.	Euphorbia milii Des Moulins
PLUMBAG.	Plumbago zeylanica L.
RANUNC.	Clematis ibarensis Bak.

Vesicant (contd.)
- RANUNC. Clematis mauritiana Lamk.

Vomiting
- MYROTHAM Myrothamnus meschaius Baill.

Vomitive
- PHYTOLAC. Phytolacca dodecandra L'Her.

Vomitive property
- CAMPAN. Dialypetalum floribundum Benth.

Vomitory
- APOCYN. Cerbera venenifera (Poir.) Steud.

Vulnerary
- CLUSIA. Calophyllum inophyllum L.
- COMPOS. Siegesbeckia orientalis L.
- SAPIND. Dodonaea viscosa Jacq.

Vulnerary for ulcerated sores
- BURSER. Commiphora pterocarpa H.Perr.

Weakness
- MYRSIN. Embelia concinna Bak.

Whitlow
- AMARYLL. Crinum firmifolium Bak.

Whooping cough
- AIZOACEAE Mollugo nudicaulis Lamk.
- ANNON. Uvaria catocarpa Diels
- ASCLEP. Harpanema acuminatum Decne.
- CANELL. Cinnamosma fragrans H.Bn.
- COMPOS. Conyza aegyptiaca Ait. var. lineariloba DC.
- CRASSUL. Kalanchoe prolifera Ham.
- LABIATAE Hyptis pectinata Poit.
  - Ocimum gratissimum L.
- LEGUM. Abrus precatorius L.
  - Aeschynomene laxiflora Boj.
  - Cadia sp.
  - Cassia occidentalis L.
  - Rhynchosia caribaea D.C.
- SOLANAC. Nicandra physaloides Gaertn.
  - Solanum nigrum L.
- UMBELL. Phellolophium madagascariense Bak.

Witchcraft
- BIGNON. Ophiocolea floribunda H.Perr.
- COMPOS. Helichrysum cordifolium D.C.
- LAURACEAE Cassytha filiformis L.
- MYROTHAM Myrothamnus meschaius Baill.

Witchcraft antidote
- ANACARD. Rhus taratana (Bak.) H.Perr.

Wood
- EUPHOR. Jatropha curcas L.

Wounds
- APOCYN. Cerbera venenifera (Poir.) Steud.
  - Hazunta modesta (Bak.) Pich. subvar methuenii Mgf.
- CLUSIA. Calophyllum inophyllum L.
  - Calophyllum parviflorum Boj.
- COMPOS. Dichrosephala lyrata DC.
  - Melanthera madagascariensis Bak.
  - Senecio faujasioides Bak.
  - Vernonia appendiculata Less.
  - Vernonia diversifolia Boj.
- DIOSC. Dioscorea bulbifera L.
  - Dioscorea sansibarensis Pax.
- ERICACEAE Agauria polyphylla Bak.
  - Philippia goudotiana Klotz.
- EUPHOR. Dalechampia clematidifolia Boj.
  - Jatropha curcas L.
  - Manihot utilissima Pohl.
  - Phyllanthus casticum Soy. Will.
  - Phyllanthus madagascariensis Muell. Arg.
- FLACOUR. Aphloia theaeformis Benn.
- HYPERIC. Haronga madagascariensis Choisy
  - Psorospermum androsaemifolium Bak.
- IRIDACEAE Geissorhiza bojeri Bak.
- LABIATAE Coleus sp.
- LEGUM. Albizia fastigiata Oliv.
  - Crotalaria striata D.C.
  - Desmodium latifolium D.C.
  - Erythrophleum couminga H.Bn.
  - Glycine lyallii Benth.
  - Tamarindus indica L.
  - Tephrosia linearis Pers.
- LILIACEAE Smilax kraussiana Meissn.

Wounds (contd.)
- MORACEAE Ficus pyrifolia Lamk.
  - Ficus trichopoda Bak.
- MYRSIN. Maesa lanceolata Forsk.
- PIPER. Piper umbellatum L.
- RUBIACEAE Gaertnera obovata Bak.
  - Gaertnera phanerophlebia Bak.
  - Oldenlandia lancifolia D.C.
  - Triainolepis emirnensis Breme
- SANTAL. Santalum album L.
- SAPIND. Paullinia pinnata L.
- SIMAROU. Samandura madagascariensis Gaertn.
- ULMACEAE Trema orientalis Blume
- ZINGIB. Curcuma longa L.

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