Objective of the Association Vahatra guides to the biodiversity of Madagascar:

Over the course of these past decades, enormous progress has been realized concerning the description and documentation of the flora and fauna of Madagascar, aspects of the ecological communities, and the origin and diversification of the myriads of species that inhabit the island. Lots of information has been presented in a complicated and technical way, in articles and scientific papers which are hardly accessible to many people who have an interest in natural history. Even more, these papers, only available in certain libraries, are expensive and written in English. Considerable efforts have also been made to diffuse this information to students in colleges and universities concerning ecology and conservation of the biodiversity of the island, by the mediation of clubs and journals like Vinsty, organized by WWF-Madagascar. In our opinion, the popularization of science is still not widespread enough, a gap which could be filled and furnished with captivating notions on the extraordinary biodiversity of Madagascar without being too technical. This is the object of this series, where a glossary defining some of the technical terms written in bold in the text is presented at the end of the book.

The Association Vahatra, based in Antananarivo, has begin the publication of a series of guides which cover several subjects concerning the biological diversity of Madagascar. We are truly convinced that informing the Malagasy population about their natural heritage, and contributing to the progression towards a more ecological perception of the use of natural resources and the effective realization of conservation projects, and the availability of more educational materials at a reasonable price, is essential. We introduce in this edition the third book in this series, concerning the endemic birds of Madagascar.

Preface

Despite the accelerated decline of biodiversity on a worldwide level for the past several decades, shown by the rarefaction and disappearance of certain species, Madagascar is one of the rare places which holds an elevated level of endemism of fauna and flora, including families and subfamilies. Scientists and visitors from all over the world remain amazed by the extraordinary diversity and prodigious richness of the Malagasy biota. Is it necessary to say that the ornithological fauna represent one of the fundamental elements of this?

Thanks to much work undertaken by national and international researchers, the knowledge of this Malagasy avifauna has developed extraordinarily. However much remains to be discovered and understood.

Those passionate about birds and conservation can contribute in several ways to the orientation of actions to be taken for the protection of the avian community. The Association Vahatra, for example, is among those who are preoccupied with the balance of keeping research and publications of the rich and relevant resulting information up to date and within the reach of scientists and the public. It has placed at our availability a new work entitled “The Natural
History of Endemic Families and Sub-families of Birds of Madagascar.” This document represents a mine of information which permits researchers, ecotourists, and students to satisfy their thirst for knowledge and therefore to appreciate again the beauty, the richness, and the particularity of Malagasy biodiversity.

Through this work, the authors lead us and familiarize us with the five endemic Malagasy families and two endemic Malagasy subfamilies and tell us of their natural history, their geographic distribution, and their ecological characteristics. They have not omitted speaking of the conservation problems of these species, an important component of the future of the unique avifauna of Madagascar and of the world.

I am sure that this book will contribute to anchoring the idea that progress in ornithological knowledge can be a powerful factor in developing scientific research in Madagascar.

Dr. Lily-Arison Rene de Roland
National Director of the Project
“The Peregrine Fund Madagascar”

Presentation of the book

This book aims for a large audience, and although we try to avoid using too many technical terms, this has been inevitable in certain cases. The words or terms written in bold in the text are defined in the glossary section at the end of the book. Moreover, given that the common vernacular names in Malagasy are very different following the dialects and that they are unknown both to scientists and those passionate for nature, we largely call them by their scientific names. In certain cases, we employ nonscientific generic names to designate different groups of birds. The scientific names written in *italic* when they designate an organism at the level of genus and species. Also, when a genus name is cited several times in the same sentence or paragraph, it may be abbreviated. In the system of zoological classification, a net hierarchy is established to reflect the evolutionary history or phylogeny of organisms, and more specifically, the process of ancestry. This is illustrated in Table 1.

The avifauna of Madagascar is particularly rich, especially in genera and species which are unique on the island and exist nowhere else in the world, and these species are therefore called endemic. While numerous endemic birds are found in Madagascar, many genera are also present in African and the other islands in the western Indian Ocean, or in some cases, in Asia or on other islands in the region. Our objective in this book is to furnish details on the natural history of groups of Malagasy birds endemic at high taxonomic levels. Here, we deal specifically with the level of subfamily and above, as indicated in Table 1.

In the second part of the book under the section “The generalities on different groups of endemic birds” and particularly in “Distribution and habitat,” we don’t present maps for each species, but rather a written description of their area of geographic distribution. We are in the process of preparing maps of distribution which will figure in a future atlas of the biodiversity of Madagascar. While some readers believe it important to know the scientific references used for deciding certain points, others find these cumbersome. In order to find a compromise between these two cases, we use a system of discrete numeration which cites the concerning studies which are then listed in the bibliographic reference part at the end of the book.
Numerous field guides have been published in English and French on the Malagasy birds and those which live on neighboring islands, but these are concise summaries, presenting very few details on the lives of the organisms and on their natural history. Given that these books give us a solid base for identifying regional birds, we concentrate on the birds unique to Madagascar and give information on the way they have evolved, and on their unique character among the splendors of Madagascar and of world natural heritage. While many of these details have been available for scientists and specialists, the non technical summary of several decades of field and laboratory research have not been made available to the public, which is the principal interest of this book, in particular the bird endemic and high taxonomic levels.

Knowledge leads to empowerment. We hope that people will take advantage of the biodiversity which makes up our natural heritage, with aspects of protection and conservation becoming more important in their lives. This in turn gives reason for and will incite the remaining natural ecosystems and the constitutive elements, which are species. Madagascar is an excellent example of the necessity of rapidly advancing in this manner and for Malagasy people themselves to always have an active and increasing interest in the unique and irreplaceable forest ecosystems of the island. Therefore, the goal of this book is to pass this message to the intention of those who are interested but who do not have easy access to this type of information.
Table 1
Hierarchical classification of birds with an precise example to the level of subspecies, *Coua cristata pyropyga*. The taxonomic level for which this bird is endemic to Madagascar are shown in bold.

Figure 1
Photo of *Foudia madagascariensis*, called *fody mena* in Malagasy. It is an example of species which is endemic to Madagascar but which has been introduced to the neighboring islands in the western Indian Ocean. Other species in the genus *Foudia* also appear in the region. Therefore, the genus is not uniquely endemic to Madagascar.

Figure 2.
The two principal forest types in Madagascar: the humid evergreen forest of the mountains (above) is a type with a lower canopy compared to the humid forest at low altitude and features many more epiphytes. This photo was taken in the Lakato forest at around 1000 m of altitude and the dry deciduous forest (below) at the forest of Beanka east of Maintirano at the beginning of the dry season.

Figure 3.
The natural forest type of southwest Madagascar is the spiny forest, showing adaptive characteristics for drought.

Figure 4.
Figure composed of members of all the different target groups in this work. They are notably A) *Mesitornis variegata*, endemic family Mesitornithidae, B) *Coua cristata*, endemic subfamily Couinae, C) *Atelornis crossleyi*, endemic family Brachypteraciidae, D) *Leptosomus discolor*, family Leptosomidae endemic to Madagascar and the Comores, E) *Neodrepanis hypoxantha*, endemic subfamily Philepittinae, F) *Crossleia xanthophrys*, endemic family Bernieridae, and G) *Calicalicus madagascariensis*, endemic family Vangidae.

Table 2.
List of species of Malagasy birds which are endemic at the level of family and subfamily which are marked in bold. Code for distribution: E - evergreen forest of the east, O - deciduous forest of the west, S - spiny forest of the south. The conservation statuses are also presented. Code for the statuses: EN - endangered species, EX - extinct species, NT - near-threatened species, LC - species of least concern, VU - vulnerable species.

Table footnotes:
1. It has been proposed that this family should be placed within the Mesitornithiformes, which would in this case be endemic to Madagascar.
2. Some taxonomists place the Couinae in the subfamily Phaenicophaeidae, which includes both species of Cuculidae from the Old World and the New World, which would classify the couas in a subfamily not endemic to the island.
3. Species extinct since the end of the 1800s.
4. Solid evidence has shown that this family does not belong in the Coraciiformes and should be placed in its own order, the Leptosomatiformes.

5. Also found on the islands of the Comores.

Figure 5.

The endemic birds of Madagascar have different ways of getting around in the forest. The two principal ways are being terrestrial (above) as shown in *Coua coquereli* and arboreal (below) as in the case of *C. cristata*.

Figure 6.

The five different species of ground rollers belong to the endemic family Brachypteraciidae comprising (beginning at top left and going clockwise): *Brachypteracias leptosomus*, *Atelornis pittoides*, *Uratelornis chimaera*, *A. crossleyi*, and *Geobiastes squaminger*.

Figure 7.

*Euryceros prevostii* is known for eating large insects and other invertebrates with its large aquiline beak.

Figure 8.

The different species endemic to Madagascar at high taxonomic levels have very different ways of feeding; they play numerous important roles in the maintenance of the ecosystems and in the different ecological functions. For example, *Neodrepanis coruscans* (left), which is probably a young male in this picture, uses its decurved beak to drink the nectar of flowers. Pollen adheres to the beak and the head feathers permitting the dispersal of pollen which in turn favors the fertilization of flowers. The latter subsequently produce fruits and seeds. Other examples are illustrated in the members of the family Vangidae, which are generally predators of invertebrates and vertebrates. They participate in the equilibrium of delicate relationships between predators and prey in the trophic web within the forest ecosystem. Here illustrated is *Calicalicus rufocarpalis* (right) feeding on invertebrates.

Figure 9.

Over the course of the past 150 million years, the position of Madagascar relative to the other continents has radically changed and around 80 million years ago, it was isolated in the western Indian Ocean. The major sequence of events includes: A) the existence of the Supercontinent Gondwana which included South America, Africa, Madagascar, Antarctica, India, and Australia; B) the subsequent rupture of Gondwana and the separation of the terrestrial connections between those formerly united, including Madagascar; C) Madagascar arrives in its current position and the separation of Madagascar from India.

Figure 10.

Time scales of different periods associated with the history of the colonization of birds of Madagascar.
Figure 11.

*Majungasaurus* was a large dinosaur predator which lived in the region of the Mahajanga basin 70 million years ago.

Figure 12.

Excavations of subfossils at the Ampoza site by Errol I. White in 1930. With the aid of local populations, the field team discovered large quantities of bones by digging deeply in the ground of an ancient river bed. Here animals died that had been coming to drink, or the carcasses and bones taken by the river were then buried in the sediments. In the front of the plane of focus you can see a certain number of excavated bones. This is a site where numerous important subfossils of birds have been found.

Table 3.

<table>
<thead>
<tr>
<th>Species of birds found in the subfossil sites in Madagascar. The species preceded by † are currently extinct, those with the signs †? represent forms that are endemic and extinct or forms distributed elsewhere in the world and those preceded by + are introduced to the island, and in some cases, it is not clear if a given species no longer appearing on the island is extinct (given in [see text for reference numbers]). For explanations of the taxonomy of the modern Malagasy birds listed here, see Table 4.</th>
</tr>
</thead>
</table>

Figure 13.

The three skeletons of birds shown are an ostrich in front, *Aepyornis maximus* in the middle and *Mullerornis* in the back. The two latter species, which are part of a Malagasy radiation of flightless birds (ratites), disappeared approximately several hundred years ago. In the interior part of the photo, the eggs of the ostrich and *Aepyornis maximus* can be seen near the front. This photo was taken in the exhibition room of l’Academie Malgache probably in the 1900s.

Figure 14.

Based on the remains of eggshells of *Aepyornis maximus* found at Cape Saint Marie, the southern point of Madagascar, this species was probably at least semi-colonial, with numerous birds in a relatively restricted area.

Figure 15.

The extinct waterbird *Centrornis majori* had a high stature, with particularly long legs and long wings decorated and armed with a well developed metacarpal spur (bone pictured here at the far left), which could have been used for defense or for combat between males to attract females and obtain sexual partners. Other bones shown here (right) are the central part of the pelvis, the femur, and the coracoid.
Figure 16.

A very large extinct eagle, *Stephanoaetus mahery*, has recently been named in Madagascar based on subfossils recovered from the site of Ampasambazimba, in the central highlands. This species had enormous talons and would have been a formidable predator of a large variety of animals. The claws in the upper part of the photo come from a species living in Africa, *S. coronatus*, and those in the lower part belong to *S. mahery*.

Figure 17.

Reconstruction of the enormous extinct Malagasy raptor *Stephanoaetus mahery* attacking an also extinct subfossil lemur, *Paleopropithicus*. In the subfossil sites, the remains of bones of different disappeared lemurs have been recovered with a distinct round mark in the scapula of the same size as the talons of this disappeared eagle. The existing species in Africa, *S. coronatus*, is known for hunting by planting its claws in the back of its prey and then taking them to be eaten. All these points were considered in creating this reconstruction.

Figure 18.

On the left you can see the leg bone (tarso-metatarsus) of the giant extinct coua, *Coua berthae*, excavated from the subfossil site of Ampasambazimba. This species was quite a bit larger than the largest current coua, *C. gigas*, which is pictured on the left.

Figure 19.

Illustration of an extraordinary example of an adaptive radiation in Madagascar, represented here by the vangas (family Vangidae), which have been shown by molecular genetic studies to be monophyletic. Note the body size and beak shape which permit different species to exploit various food resources. This is notably an adaptation parallel with different types of tools, like pliers (*Calicalicus* spp., *Cyanolanius madagascarinus*, *Leptopterus chabert*, and *Schetba rufa*), tweezers (*Falculea paliata*), forceps (*Hypositta corallirostris* and *Tylas eduardi*), needlenose pliers (*Artamella viridis* and *Vanga curvirostris*) large pliers¹ (*Xenopirostris* spp.), and even larger pliers² (*Euryceros prevostii*). [In the original book, look at who drew the figure!]

Figure 20.

Among the birds endemic at a high level to Madagascar, several species new to science have been recently described. These include notably the tiny *Cryptosylvicola randianasoloi* (left), which is very widespread at high altitudes in humid evergreen forests of the mountains but which remained unknown until a few years ago, at least in part because of its habit of living in the canopy, and *Xanthomixis apperti* (right), which appears in the dry deciduous forest of the southwest.

¹I'm not exactly sure what this tool, pince coulissante, would be in English. I google imaged it and it just looks like particularly robust pliers.

²ditto, although these pliers, pince multiprise, are even thicker and larger maybe
Figure 21.
Although it is not a member of one of the groups endemic at a high level to Madagascar, a remarkable recent discovery of a species to science has been found, *Mentocrex beankaensis*, a large forest rail which was named coming from the forest of Beanka, east of Maintirano.

Table 4.
List of modern avifauna of Madagascar, which includes introduced species and known nesting populations. Codes for status: E - endemic, Er - irregular, Et - extinct or probably extinct, I - introduced, M - migratory, N - breeder. The names in French are presented. The details on the classification at the level of subfamily are not included.
Table footnotes:
1. Recent evidence indicates that this family should be placed in the order Mesitornithiformes
2. The species *O. madagascariensis* is a synonym of *O. rutilus*.
3. The genus designation of this species, we follow a recent revision.
4. This group was previously placed in the endemic family Philepittidae and is currently transferred to the Eurylaimidae.
5. This recently created family endemic to Madagascar represents an adaptive radiation previously ignored.
6. Two members of this genus are only known in Madagascar. The forms *bensoni* and *erythronotus*, while displaying morphological difference, are considered synonyms of *M. sharpei* based on molecular genetic data.
7. Recent molecular studies have revealed numerous surprises in the configuration of this family.

Table 5.
The known names and synonyms of endemic Malagasy birds.

Figure 22.
Illustration of *Coua delalandei*, a species which went extinct over the course of the last 150 years and which was previously uniquely documented on the island of Saint Marie.

Figure 23.
Phylogeny of the Brachypteraciidae, a family endemic to Madagascar, after molecular genetic studies. This figure illustrates the presumed evolution and the process of speciation after colonization of Madagascar by the ancestor of the ground-roller lineage.
Figure 24.
Phylogeny of the Bernieridae, a family endemic to Madagascar, obtained after molecular genetic studies. These studies have clearly shown the importance of molecular tools for distinguishing paraphyletic characters from monophyletic ones. The clade composed of Bernieridae is marked with the letter A. The members of the family previously placed in the genus *Phyllastrephus* of Africa (highlighted in yellow), are indicated with the sign * and include current members of the genera *Bernieria* and *Xanthomixis*. Given the distant positions of these members of three genera in the phylogenetic tree, it is evident that their placement in the former genus *Phyllastrephus* was associated with very convergent external characters.

Figure 25.
Phylogeny of Vangidae, a family endemic to Madagascar and the Comores, obtained after molecular genetic studies. These studies have clearly demonstrated the importance of molecular tools for distinguishing paraphyletic characters from monophyletic ones. The results have suggested the existence of a large local diversification of this family in Madagascar, and that this elevated diversity is not the result of multiple colonizations coming from outside of Madagascar. The extensive morphological and ecological diversity of this family seems to have been reinforced thanks to the utilization and ultimate occupation of vacant niches on the main island.

Figure 26.
*Coua gigas* is the largest of the current couas. This terrestrial species has a large range in the west, south, and southeast of the island.

Figure 27.
The majority of the members of the family Brachypteraciidae are terrestrial. The main exception is the species *Brachypteracias leptosomus*, which, as indicated here, can be found at considerable distance from the ground in the search for prey.

Figure 28.
*Leptosomus discolor* is a masterful flier and its aerial acrobatics associated with piercing cries are immediately perceptible.

Figure 29.
Within the 21 species of the family Vangidae, all are strictly endemic to Madagascar, with the exception of *Cyanolanius madagascarinus*, illustrated here, which exists also on the archipelago of the Comores, specifically on Grande Comore.

Figure 30.
The flowers of the parasitic plant in the genus *Bakerella* (Loranthaceae) are largely visited by nectarivorous birds, including the members of the genus *Neodrepanis*. The beak shape of these birds reflects that of the flower and is presumed to be a case of coevolution.
Figure 31.

*Bernieria madagascariencis* shows sexual dimorphism, with a longer beak in males (left) compared to that of females (right).

Figure 32.

The method used by *Xanthomixis cinereiceps* for finding its food is to hang with its long claws from mosses which cover branches to look for invertebrates.

Figure 33.

The members of the family Vangidae possess particularly remarkable different shapes of beaks, which translate into different mechanisms (tools) in the search for food in varied ways and the ability to live in the same forest: A) thin beak, rather short and pointed, example *Newtonia archiboldi*; B) thin beak, long and pointed, example *Mystacornis crossleyi*; C) long and curved beak, example *Falculea palliata*; D) small beak, pointed and triangular, example *Hypositta corallirostris*; E) strong and thick beak, example *Xenopirostris polleni*; F) strong and pointed beak, example *Vanga curvirostris*.

Figure 34.

*Monias benschi* is a member of the family Mesitornithidae with a very limited distribution in the southwest and a conservation status of “Vulnerable.” Recent estimations indicate that between 100,000 and 150,000 individuals remain.

Figure 35.

In general, the members of the subfamily Couina are sensitive to modifications of natural habitat introduced by man and have been proposed as an excellent group to use as bio-indicators to follow the state of the environment. One of the exceptions is pictured here, *Coua ruficeps*, which tolerates significant degradation of natural forests in some regions of the west. The species is often the only terrestrial coua which persists following a significant anthropogenic change.

Figure 36.

*Uratelornis chimaera*, a member of the family Brachypteraciidae, has a conservation status of “Vulnerable.” This species has a very restricted distribution and lives in the spiny forest of the extreme southwest, in a very sensitive habitat where the ecological conditions are adverse. An eventual disappearance of the forest surface would be nearly irreversible.

Figure 37.

Photo of the summit area of the peak of Andringitra whose highest summit is Pic Boby (2,450 m). The marks running vertically on the upper part of the mountain are areas which were carved by the action of glaciers 12,000 years ago.
Figure 38.
Diagram of the different cycles of movements of belts of vegetation of Madagascar associated with the change of climatic conditions over the course of the Pleistocene. This diagram shows a north-south cut of the Anosyenne chain, near Tolagnaro, to the peak of Tsaratana in the north.

Figure 39.
The Special Reserve of Ambohitantely is an important site for studying the impacts of forest fragmentation on different species of vertebrates. In other times, the area was a continuous block of forest, but the deforestation and various anthropogenic modifications of the natural habitat have reduced it to more than 500 fragments, of size varying from 1,259 hectares to 1 hectare.

Figure 40.
Diagram showing the percentages of fruits consumed by *Philepitta castanea*, by family of plant, in the forest of Ranomafana National Park. The small berries of the families Myrsinaceae and Rubiaceae constitute a large part of their diet.

Figure 41.
Although generally considered a largely insectivorous species, *Cyanolanius madagascarinus* is also known to eat fruits and seeds.

Table 6.
Global distribution by ecological niche of the species belonging to the families and subfamilies endemic to Madagascar.

**Legends**

- **Diet** - G: seeds, I: insects, Veg: fruit or nectar, V: vertebrates.
- **Place of feeding** - T: terrestrial, Ar: arboreal, Ar1: on the lowest branches making up the lowest third of the vertical stratus, Ar2: the middle third, Ar3: in the upper third of the vertical stratus.
- **Place of nesting** - Ar: arboreal, T: terrestrial or burrow.
- **Type of forest** - FE: humid evergreen forest, FO: dense dry deciduous forest in the west, FSSO: dry deciduous forest of the southwest, FSS: spiny forest of the south.
- **Tolerance** - 0: intact forest, 1: relatively intact forest, 2: disturbed forest, 3: degraded forest.
- **Distribution** - E: east, O: west, S: south.

Figure 42.
A certain number of species of endemic birds of Madagascar have very specific ecological niches in which they live. For example, *Geobiastes squaminger* is a secretive terrestrial species of the rather dense undergrowth, which hunts at the ground level and ruffles the rather thick litter to find its prey.

Table 7.
Niches of each species of Madagascar endemic family or subfamily. This list concerns subfossil (†) or current species, and presents their principal ecological aspects.
Legends

**Diet** - G: seeds, I: insects, Veg: fruit or nectar, V: vertebrates. **Place of feeding** - T: terrestrial, Ar: arboreal, Ar1: on the lowest branches making up the lowest third of the vertical stratus, Ar2: the middle third, Ar3: in the upper third of the vertical stratus. **Place of nesting** - Ar: arboreal, T: terrestrial or burrow. **Type of forest** - FE: humid evergreen forest, FM: mixed forest, FSO: dense dry deciduous forest in the west, FSSO: dry deciduous forest of the southwest, FSS: spiny forest of the south. **Tolerance** - 0: intact forest, 1: relatively intact forest, 2: disturbed forest, 3: degraded forest. **Distribution** - e: east, o: west, s: south, c: central, sa: Sambirano, hm: high mountains.

Figure 43.
For several species of Malagasy birds, few details are available on their nest or young. For example, these photos of the plumage of chicks of *Calicalicus rufocarpalis* (left) and *Euryceros prevostii* (left) are the first to be published.

Figure 44.
The nest of *Philepitta schlegeli* has recently been described. The nest pictured here was found in the forest of Beanka, hooked in the fork of branches situated 3 to 4 m above the ground, within a dry deciduous forest on a calcium substrate or *tsingy*.

Figure 45.
The nests of two species in the genus *Xanthomixis* are illustrated here, *X. zosterops* (left) and *X. cinereiceps* (right), with the adults brooding.

Figure 46.
For some species of birds, the males and females have the same coloration, while for others they are different and show sexual dimorphism. An example of this latter is *Philepitta schlegeli*, in which the plumage of females (left) is rather dull and forms a kind of camouflage, while the males (right), in particular during the breeding season, have caruncles of bright colors, which make them more visible to diurnal predators.

Figure 47.
During the nuptial dance of the male *Philepitta castanea* (left), one of the steps used by adult males with velvety plumage of a brilliant black, is to elongate their narrow caruncles to expose a very bright blue-green color. Often black enough males are surrounded by a certain number of females and males with female plumage, but capable of producing sperm. The bird pictured here (right) is mostly in female plumage, but the black feathers on the wing coverts indicates that he is molting into the plumage of the masculine sex.

Figure 48.
The nuptial dance of *Philepitta castanea* is remarkably complex and interesting. It is composed of at least five different steps: A) erect posture, B) wing flapping, C) horizontal position, D) beak open, and E) acrobatics and beak open.
Figure 49.
Vocal communication is important during social interactions of a pair or a group of individuals in the mesites. A pair of *Mesitornis variegata* singing a sort of duet is shown here.

Figure 50.
During the night, groups of birds in the same species can be observed closely huddled on branches, sleeping together. The example pictured here is represented by *Xanthomixis zosterops*.

Figure 51.
Recent research in the field has revealed different aspects concerning the reproduction of the species of Vangidae. In the case of *Leptopterus chabert* (left), presented here resting on its nest, a system of cooperative reproduction is used, with three or four birds feeding the chicks. For certain species, like *Xenopirostris pollen* (right), also represented on its nest, the current evidence indicates that they use a monogamous system.

Figure 52.
Several species of birds are known for taking sun baths which can be observed among the different species of couas. These photos show a *Coua reynaudii* (left) perched on a branch in an open area of the forest with its wings out and open to absorb the solar energy and a *C. cristata* in a similar position with the back feathers ruffled to expose the darker parts under the feathers.

Figure 53.
The recent massive exploitation of large trees, principally precious wood like rose wood in the forests of the northeast of Madagascar, pose major problems for the maintenance and survival of locally endemic species. A good example is the case of *Oriola bernieri*, a species showing a notable sexual dimorphism where the male has an entirely black plumage (left) and the female reddish brown (right).

Figure 54.
Over the course of the past few decades, remarkable progress has been made in the study of the natural history of birds endemic to Madagascar. The extraordinary information collected concerning *Philepitta castanea* testifies to this. The male, after the reproductive season (in the photo), shows a reduced caruncle and a plumage which wear gives yellow tips. One of the fundamental questions which preoccupies us is to know, until the destruction of the remaining forested habitat in Madagascar and the progressive loss of Malagasy biodiversity, will they go and how much time remains for the unique jewels that ornament our main island?
Glossary
Terms are in original French, definitions are translated.

A

Adaptation
State of a species which makes reproduction or existence more favorable under the conditions of its environment.

ADN
Deoxyribonucleic acid, forms the carrier molecule for hereditary genetic information.

Allogène
Stranger, non-native and [term is] often used for introduced species.

Allopatrique (allopatrie)
Having an own area of distribution, different from those of neighboring species.

Anatomique
Related to the structure of the body.

Ancêtre
Any organism, population or species giving rise to other organisms, populations, or species, born through reproduction.

Ancien Monde
Denomination for a group of regions, composed of Europe, Asia, and Africa.

Angiosperms
Plants with flowers, and therefore plants that produce fruit.

Anthropogénique (anthropique)
Effects, processes or materials generated by the activity of man.

Aphylles
Does not have leaves.

Arboricole
Lives in the trees.

Arbre phylogénétique
Schematic figure which shows the relationships between taxa or clades supposed to have a common ancestor.
**Archipel**
Group of islands or a set of islands close to one another amid the ocean, most often born from the same geologic formation.

**Arène**
Space where males of certain birds gather to compete or display in front of females in order to mate.

**Aridification**
Reduction of the moisture content of the ground provoking an extreme drought.

**Arthropode**
Segmented animal, having an exoskeleton and jointed appendices, belonging to the phylum Arthropoda. Insects, spiders, scorpions, millipedes, crayfish, crabs, trilobites, and numerous other groups are all arthropods.

**Atmosphère**
Gas layer which contains oxygen and envelopes our planet. Without our atmosphere, we could not live on Earth.

**Autochtone**
Species which can be found naturally in a place.

**Avifaune**
Set of species of birds in a given place.

**B**

**Biodiversité**
Refers to the variety or the variability of the living organisms and the complex environments in which these organisms are found.

**Bio-indicateur (indicateur biologique)**
Qualifies an organism or set of organisms which permit the characterization of the state of an ecosystem and also places in evidence early on their modifications, natural or provoked.

**Biomasse**
Total mass of organisms living in a given habitat at a given time.

**Biome**
Vast biogeographic entity defined by its climatic characteristics and its animal and plant populations.
**Biote**
Set of living beings (fauna and flora) of a region or a geological period.

**Biotope**
Set of elements characterizing a uniform and determined physiochemical which accommodates plant and animal populations.

**Bipède**
Animal which walks on two legs.

**“Bird-watchers”**
Amateur ornithologist.

**Caducifolée (caduque)**
The *deciduous* forests are made up of plants which lose the majority of their leaves over the course of the dry season

**Camouflage**
Something which blends in the environment.

**Canopée**
Highest level of vegetation compared to the ground level, generally made of branches and epiphytes. In tropical forests, the *canopy* can be more than 30 m above the ground.

**Carnivora**
Order of the class of mammals which possess, in general, large pointed teeth, powerful jaws and which hunt other animals.

**Carnivore**
Animal which eats meat.

**Caruncle (barbillons)**
Small fleshy protuberance, brightly colored, situated near the beak, adorning the front, the throat or the eyebrows.

**Chaîne trophique**
A suite of living beings in which each eats the one that precedes it.

**Clade**
Group of species which shares inherited characteristics with a common ancestor.
Classification
Act of attributing classes or categories to elements of the same type.

Cline
Gradient of morphological or physiological change in a group of organisms generally along a line of environmental or geographic transition.

Coévolution
Simultaneous evolution of two species of animals or plants.

Colonisation
Conquering of a given region by one or more species.

Coloniser
To establish a population or colony. In the context of Madagascar, the original colonization of birds is associated with crossings of the Mozambique Canal or Indian Ocean.

Communauté
Interaction of organisms sharing a common environment.

Compétition
Rivalry between living species for access to resources of a place.

Comportement
Means the actions of a living being, like the ensemble of reactions (movements, physiological modifications, vocal expressions, etc.) of an individual in a given situation. [Behavior]

Convergent
Said of the similarities found independently in two or more organisms which do not have a close common ancestor.

Coureur
Means an animal which is skilled at running.

Crépusculaire
Means an organism which is active during the periods at the end of the afternoon and in early morning.

Cryptique
Said of a group of species which satisfy certain definitions of species (biological or phylogenetic definitions) indicating an ancient divergence, but which are not distinguishable from the point of view of morphology.
Cycle annuel
Set of biological phases of an organism over the course of a year.

Cycle biologique
Set of phases in the life of an organism: from seed to seed for a plant, or from egg to egg for an animal.

D

Dégradation
Deterioration of vegetation cover in a determined forest. The causes can be of natural origin, like cyclones, or human origin like deforestation, slash-and-burn agriculture, or the overexploitation of agricultural fields.

Dépendent
Depends on something, like certain ecological factors.

Dessiccation
Action of drying out, often associated with climatic change.

Dialecte
Language particular to a region.

Différenciation génétique
Diversity on the level of genes.

Dimorphisme sexuel
Case of a species where the male and the female have different appearance (shape, size, color.)

Dinosaurs
Reptile of different sizes which lived in the secondary era or Cenozoic.

Dispersion
Dissemination of individuals of a species, often following a major event of reproduction. The organisms can disperse as seeds, eggs, larvae, or as adults.

Dissémination
The act of scattering or diffusing something all around.

Diurnes
Said of an organism active during the day.
Divergence
Different evolution between two populations of the same species.

Diversification
Act of diversifying, in the context of a species.

Diversité
Term used to designate the number of given taxa.

Domestique
Relating to an animal which has been made the object of constant and continuous selective pressure, normally in the context of raising it in captivity, that is to say, which has been made an object of domestication.

E

Ecologie (écologique)
Science of the relations of organisms with the environment.

Ecosystème
All the organisms found in a particular region and the environment in which they live. The elements of an ecosystem interact in a certain way, which makes each dependent on the others directly or indirectly.

Ectoparasites
External parasite living on the body surface of a living being.

Endémique
Organism native to a particular region and unknown elsewhere.

Epineuse (bush épineux)
Habitat in the south generally made up of deciduous brush and spiny thickets.

Epiphyte
Plant which is fixed to others to behave as a parasite.

Etymologie
The origin of a word.

Evolution
Course of events implicated in the evolutionary development of a species of a taxonomic group of organisms.
Exotiques (introduite)
Said of a species not originating in a region.

Extinction
Total disappearance of a species.

F

Fécondation
Stage of sexual reproduction consisting in a fusion of male and female gametes to a single cell called a zygote.

Flux génétique
Exchange of genes by sexual reproduction or movement of genes between populations.

Fonctions écologiques
Principal processes implicated in functioning and ecological production of ecosystems.

Forêt littoral
Forest growing on a sandy bank above or below the high tide line, and it is therefore influenced by the tides.

Forêt secondaire
Forest which has regrown after being destroyed (for example by slash and burn agriculture) or exploitation by man.

Fossile
Mineralized remains of an animal or plant having existed in a past geological time.

Fossilisation
Transformation of a body, particularly the bones, into the fossil state.

Fragmentation
Destruction or alteration of habitats by man, which are the major causes of disturbance of species and decline of biodiversity.

Frugivore
Said of an animal whose diet is based on fruits.

G

Géologiste (géologue)
Specialist in geology or the science of the earth.
Généraliste
Said of an animal which is not specialized vis-a-vis its diet or other aspect of its natural history.

Génétique
Discipline of biology which involves the science of heredity and the variation of living organisms. In more simple terms, the science of heredity.

Génétique moléculaire
Research which concerns the structure and the activity of genetic material at the molecular level.

Germination
Development of a seed, transformation of the seed into a plant.

Glaciation
Period during which the quantity of ice stored on the surface of the globe is higher than normal.

Glacier
Mass of ice formed by the accumulation of snow during glaciation, a geological entity resulting from the accumulation of ice in the valley.

Gondwana
Supercontinent which existed from the Cambrian until the Jurassic composed primarily of South America, Africa, Madagascar, India, Antarctica, and Australia.

Granivore
Said of an animal whose diet is based on seeds.

Grégaire
Said of an animal which lives in a group, but without social structure.

Grimpeur
Relating to a bird apt to climb on trees.

Groupe soeur (“sister group”)
Monophyletic group more tightly linked to the group in question, compared to other groups.

H

Habitat
Place and conditions in which an organism lives.

Hétérogène
Made up of elements of different natures, like the structure of a forest or genetic variation.
**Hiérarchie**
Subordination of ranks.

**Histoire évolutive**
On the scale of geological time, evolution of species driven by changes in morphology, anatomy, physiology, and behavior. The history of species can therefore be written and represented in the form of a phylogenetic tree.

**Histoire naturelle**
Natural science which concerns observations and studies in nature, on animals, plants, and minerals.

**Holotype**
Reference specimen attached to a scientific named, from which a taxon or a species is described.

**Hybridation**
Mix of two distinct forms or species.

**Hypothèses**
Supposition from which one constructs a reasoning.

**I**

**Insectivore**
Organism which principally consumes insects.

**Interspécifique**
Designates everything to do with relations between different species.

**Intraspécifique**
Designates everything to do with relations between individuals of the same species.

**Introduit**
Organism not original to a given place but brought to another, exotic.

**Invertébré**
Animal without a vertebral column, like the insects.

**K**

**Kératine**
Protein used numerous living beings as an element of structure, like hair or feathers.
**L**

*Lavaka*
Malagasy word which literally means “large hole” and which is used to describe the deep ravines with very steep walls, carved into a cellar (following lateritic soil), and associated with erosion.

*Leks*
Parade area, where males of certain species gather in a competition of seduction, in order to determine the prerogatives for mating with the females in the same place.

*Lignée*
Branch, descendance, or parentage.

*Lisière*
Transition zone between a forested place and an open place.

*Locomotion*
Action, the ability to move from one place to another.

**M**

*Métapopulation*
Group of populations of individuals of the same species, separated spatially or temporally.

*Microendémique*
Organism native to a particular area with a very limited geographic area.

*Microscopique*
Very small, minuscule or imperceptible, and visible only with a microscope.

*Migrateur*
Qualifies an organism which makes a migration. For example, nesting European species which spend the boreal winter in Africa and migrate to Madagascar in the summer.\(^3\)

*Minéralisation*
Transformation of an organic substance (bone) to mineral substance (fossil).

*Monogame*
An individual having a single sexual partner.

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\(^3\) Malagsy summer = European winter!
**Monophylétique**
Term applied to a group of organisms made up of the most recent common ancestor of all the members and the descendants. A monophyletic group is also called a clade.

**Monospécifique (monotypique)**
What we call a genus represented by only one species.

**Morphologie**
Appearance and structure which generally concerns the shapes, elements, and the arrangement of characteristics of living and fossil organisms.

**Muséologique**
Something preserved in a museum or in places which hold reference collections.

**Mutualisme**
Enduring relationship between two species or populations, advantageous for both.

**N**

**Nectarivore**
Animal which feeds primarily on nectar and pollen of flowers.

**Niche écologique**
Place and specialization of a species within a population, or set of conditions of existence of an animal species (habitat, food, reproductive behavior, relationship with other species.)

**Nidification**
Construction of a nest by birds.

**Niveau supérieur**
Taxonomic classification which generally concerns a level above genus.

**Nocturne**
Said of an organism active during the night.

**Non-passeraux**
Bird belonging to an order other than the Passeriformes.

**Nouveau Monde**
Title for the Americas (North, Central and South).
**O**

**Omnivore**
Feeds on a variety of food of animal and plant origin.

**Origine**
Principle of where a thing comes from.

**Ornementation**
Used as a signaling device, such as special feathers, wattles, or caruncles; action of creating a dominance hierarchy among males, generally without excessive injuries or fatality.

**Ornithologiste (ornithologue)**
Specialist in ornithology or the science of birds.

**Orographique**
Related to orography, part of geography which deals with landforms, which is related to terrestrial relief.

**P**

**Paléontologiste**
Specialist in paleontology or the science of fossils.

**Paraphyletique**
Term applies to a group of organisms made up of the most recent common ancestor of all the members, and a part but not all of the descendants of the most recent common ancestor.

**Parasite**
Animal or plant which lives or grows on another organism’s body at its expense.

**Passereau (passereaux)**
Member of the order Passeriformes.

**Patrimoine naturel**
Natural monuments made up of physical and biological formations or by groups of such formations which have exceptional national and universal value from an aesthetic or scientific point of view.

**Perturbation**
Event or series of events which upset the structure of an ecosystem, community, or population and alter the physical environment.
Phénotypique
Said of an observable state or character (anatomical or morphological) of a living organism.

Phylogénétique
Study of the evolutionary relationship within different groups of organisms, like species or populations.

Phylogénie
Relationships within organisms, particularly the aspects of branching of lineages caused by a verifiable evolutionary history.

Physiology
Role, function, and mechanical, physical, and biochemical organization of living organisms, and their component organs, tissues, etc and the study of interactions between a living organism and its environment.

Plurispecifique (“multi-species flocks”)
Formed by several individuals belonging to different species.

Pollinisateur
Animal which brings pollen of one flowering plant to another and which contributes to the reproduction of the plant.

Pollinisation
Transport of pollen grains (male element) to the pistil (female element) of the flower to bring about fertilization. This transport is effected by the wind, insects, or other animals.

Polyandrie coopérative
Highly mixed brood raised by a female and several males.

Polygynandrie
The male and female each have several sexual partners.

Polygame
Relates to a system of reproduction in which a single male fertilizes several females.

Population
Organisms belonging to the same specie and found in a particular place at a given time.

Précipitation
Varies forms under which water contained in the atmosphere falls to the surface of the globe (rain, snow, hail).
Prédateur (prédation)
Living organism which kills prey to eat them or to feed its young.

Processus évolutif
Various steps of evolution.

Proie
Organism hunted and eaten by a predator.

R

Rabougri
Qualifies a plant that has not come to its perfection and its proper grandeur [=stunted].

Radiation adaptive
Designated the adaptive divergences can be observed within the same monophyletic group of living beings as a function of the type of ecological niche they occupy.

Radiocarbone
The most currently used method of absolute dating used in archaeology and in paleontology of the Holocene. This method is based on the half life of one of the carbon 14 isotopes.

Rapace
All birds which hunt other animals.

Ratite
Bird of Gondwanan origin with robust legs and rudimentary wings, incapable of flying.

Refuge
Isolated place where organisms are exempt from natural pressures or those caused by man.

Régénération
Capacity of a forested place to be reconstituted by natural processes, like seed dispersal by birds.

Régime alimentaire
Food consumed by an organism.

Reproduction communautaire (coopérative)
Social system where other individuals than the natural parents give cared to the young.

Résilience
Capacity of a species for growing or living in and reconstructing after the impacts of different environmental, degree of resistance of a species subjected to impacts on the environment.
Sédentaire
A way of life characterized by movements of small distance.

Sélection de parentèle (“kin selection)
Theory allowing the explanation of the appearance, over the course of evolution, of altruistic behavior among organisms vis-a-vis other organisms. It says that in general altruistic instincts increase with relatedness under the affects of natural selection.

Sélection naturelle
Survival of the species of animals best adapted and those successful in surviving and proliferating, and the characteristics which cause the success being transmissible by genetic inheritance.

Sempervirente (humide)
Forest type where the foliage remains present and green throughout the year.

Sous-bois
Space under the trees of a forest.

Spécialiste
Related to an organism which as adopted a specific style of life under a set of particular conditions.

Spéciation
Evolutionary process by which a new biological species appears.

Spéciation naissante
First steps in a process of evolution.

Spécimen
Individual, normally a museum sample, representative of its species.

Subfossil
Bone remains not yet mineralized as they would be in a true fossil, formed in recent geological past.

Suboscine
Suborder in the order Passeriformes characterized by a simple syrinx and other aspects of anatomy and behavior.
Subsistance
Action or fact of maintaining at a minimum level.

Sylvicole
Inhabits forests.

Sympatrique (sympatie)
Qualifies two or more organisms which coexist in the same place without hybridizing.

Syrinx
Organ at the bottom of the trachea of birds, which permits them to emit vocalizations.

Systématique
Science which studies the classification of living or dead organisms.

Taxon
Taxonomic unit or category of organisms: subspecies, species, genus, etc (plural: taxa or taxons).  

Taxonomie
Science with the object of designating and classifying organisms.

Tectonique
Study of geological structures at a grand scale, like the movements of plates and the mechanisms responsible for them.

Temps géologique
Periods during which occurred different events in the history of Earth,

Terrestre
Belonging to the ground, like terrestrial animals.

Territoire
Space which belongs to an individual, a pair, or a small group of a given species in order to assure the exclusivity of usage of local available resources.

Trophique
Related to the nutrition the body of animals, particularly the tissues.

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4 In English the plural is only “taxa”
U

**Ultraviolet**
Said of invisible radiations along the smallest wave at the limit of visibility and placed at the extremity of the violet of the spectrum.

V

**Végétation érhoide**
Shrubby vegetation formation formed primarily by plants in the genus *Erica* in Madagascar.

**Vernaculaire**
Qualifies a common proper noun of a region or ethnic group.

**Vertébré**
Animal overall possessing an internal bony or cartilaginous skeleton, which includes in particular a vertebral column composed of vertebrae.

**Viande de brousse (gibier)**
Wild animals that people hunt for consuming or for selling their meat.

**Vicariantes**
Said of tightly related taxa which each exist in a separated geographic area. They are supposed to come from a single population which dispersed because of geological events.

Z

**Zones de refuge**
Places where organisms are exempt from natural or human caused pressures.

**Zoochorie**
Dispersal of seeds by animals.