

An Integrated Inventory of Terrestrial and Marine Biodiversity in The Extreme South of Madagascar

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Abstract

This study aims to provide an integrated inventory of terrestrial and marine biodiversity in the extreme south of Madagascar by documenting taxonomic diversity, endemism, species distribution, and conservation status across major biological groups. An integrated biodiversity assessment was conducted through a synthesis of published and unpublished literature, institutional records, and field inventories undertaken in representative terrestrial and coastal ecosystems of the Androy region. The study covered marine algae, mollusks, crustaceans, insects, amphibians, reptiles, tortoises, birds, lemurs, and other mammals. The findings revealed that the region supports considerable biological diversity despite its semi-arid environment, with particularly high levels of endemism among marine algae, mollusks, reptiles, birds, and lemurs. Several endemic and threatened species were identified, highlighting the ecological significance of the remaining dry forests, xerophytic thickets, and coastal habitats. However, biodiversity is increasingly threatened by habitat degradation, unsustainable resource use, illegal wildlife exploitation, prolonged drought, and climate change. This study provides one of the first comprehensive syntheses of biodiversity in the Androy region and establishes an important scientific baseline for future ecological research, biodiversity monitoring, conservation planning, and the sustainable management of Madagascar's unique natural heritage.

Keywords: *biodiversity; endemism; marine; terrestrial; Androy.*

Introduction

Biodiversity forms the foundation of ecosystem functioning, supporting ecological processes that sustain human well-being, climate regulation, food security, and economic development (UNEP, 2021; Cardoso et al., 2020). However, accelerating habitat degradation, climate change, invasive species, and unsustainable exploitation of natural resources continue to drive unprecedented losses of biological diversity worldwide. The latest global assessments indicate that biodiversity is declining at an alarming rate, particularly within tropical ecosystems where high levels of endemism coincide with increasing anthropogenic pressures (IPBES, 2019; Mara, 1993; World Resources Institute, 2023). Consequently, comprehensive biodiversity inventories have become essential for documenting species richness, identifying conservation priorities, and providing scientific evidence to guide sustainable environmental management.

Madagascar is internationally recognized as one of the world's most important biodiversity hotspots because of its exceptional levels of endemism and remarkable diversity of terrestrial and marine organisms (Mahatante, 2016; Eric et al., 2025). Owing to more than 80 million years of geographic isolation, the island has evolved a unique flora and fauna, with approximately 90% of terrestrial vertebrates and vascular plants occurring nowhere else

on Earth (Goodman & Benstead, 2021; Madagascar Ministry of Environment and Sustainable Development, 2023). The country harbors extraordinary taxonomic diversity, including globally significant assemblages of lemurs, reptiles, amphibians, birds, insects, and endemic plant species, while its coastal ecosystems support diverse coral reefs, mangroves, seagrass beds, mollusks, crustaceans, algae, and numerous marine fishes. These biological resources provide critical ecosystem services and constitute an important foundation for local livelihoods, fisheries, ecotourism, and climate resilience.

Despite this exceptional natural heritage, Madagascar remains one of the countries experiencing the highest rates of biodiversity loss (Mahazotahy, 2017). Deforestation, agricultural expansion, charcoal production, overexploitation of wildlife, illegal harvesting, habitat fragmentation, recurrent droughts, and climate variability continue to threaten many endemic species and their ecosystems (Vieilledent et al., 2018; IPBES, 2019; IUCN, 2024). These pressures are particularly pronounced in the southern part of the island, where prolonged drought, increasing aridity, and limited freshwater availability have intensified ecosystem degradation and reduced the resilience of both terrestrial and coastal environments. Conservation planning in this region therefore requires updated biological information that accurately reflects the current distribution and conservation status of species across multiple taxonomic groups.

The extreme south of Madagascar, particularly the Androy region, represents one of the island's most distinctive ecological landscapes. It is characterized by xerophytic thickets, dry forests, limestone formations, coastal dunes, mangrove ecosystems, rocky shores, and an extensive continental shelf that supports diverse marine communities (Goodman & Benstead, 2021; Michel et al., 2026). These contrasting habitats sustain numerous endemic species adapted to harsh environmental conditions and contribute substantially to Madagascar's overall biological diversity (Schwitzer et al., 2024; Samsways et al., 2020). Previous biogeographical studies have demonstrated that southern Madagascar constitutes an important center of regional endemism and micro-endemism for several plant and animal groups (Wilmé et al., 2006). Nevertheless, ecological research in this region has remained relatively limited compared with the eastern rainforests and western dry forests, particularly regarding comprehensive assessments that simultaneously examine terrestrial and marine biodiversity.

Most previous investigations conducted in southern Madagascar have focused on individual taxonomic groups, protected areas, or specific ecosystems, including reptiles, tortoises, lemurs, marine invertebrates, vegetation, or fisheries. Although these studies have significantly advanced scientific knowledge, biodiversity information remains fragmented across disciplines, institutions, and unpublished reports. As a result, there is currently no integrated synthesis that consolidates available information across the principal terrestrial and marine taxonomic groups of the extreme south of Madagascar. This fragmentation limits the ability of researchers, conservation practitioners, and policymakers to evaluate regional biodiversity patterns, identify conservation priorities, and establish comprehensive biodiversity baselines for long-term monitoring (Nelson & Horning, 1993; Bouchard & Crumplin, 2010; Emynorane et al., 2026).

The present study addresses this important knowledge gap by integrating biological information derived from historical literature, institutional records, field inventories, and taxonomic surveys conducted in the Androy region. Rather than focusing on a single taxonomic group, this study brings together information on marine algae, mollusks, crustaceans, insects, amphibians, reptiles, tortoises, birds, mammals, and lemurs to provide a comprehensive overview of terrestrial and marine biodiversity in the extreme south of Madagascar. Such an integrated approach offers a more complete understanding of regional species richness, patterns of endemism, habitat distribution, and conservation status than has previously been available.

This study therefore aims to compile and synthesize existing knowledge on the terrestrial and marine biodiversity of the extreme south of Madagascar by documenting taxonomic diversity, identifying endemic species, examining their spatial distribution, and highlighting major conservation concerns across different biological groups. The resulting biodiversity inventory provides an important scientific baseline for future ecological research, biodiversity monitoring, protected area management, and evidence-based conservation planning in one of Madagascar's most environmentally vulnerable regions.

Methodology

This study employed an integrated biodiversity inventory approach to compile and synthesize information on the terrestrial and marine biodiversity of the extreme south of Madagascar, with particular emphasis on the Androy region. The research combined an extensive review of published and unpublished literature with field-based biological surveys. Secondary data were obtained from scientific publications, university theses, institutional reports, historical taxonomic records, and research documents produced by the Regional University Center of Androy and collaborating researchers. These documentary sources were complemented by field inventories conducted across representative terrestrial and coastal ecosystems, including dry forests, xerophytic thickets, limestone formations, wetlands, and nearshore marine habitats. The study focused on major taxonomic groups, including marine algae, mollusks, crustaceans, insects, amphibians, reptiles, tortoises, birds, lemurs, and other mammals, in order to provide a comprehensive assessment of regional biodiversity, endemism, and species distribution. Species identification followed available taxonomic references and previously published classifications, while records from multiple data sources were cross-checked to minimize duplication and improve the reliability of the inventory.

Field sampling protocols were adapted to the ecological characteristics of each taxonomic group following internationally accepted biodiversity survey methods. Direct visual encounter surveys, line transects, opportunistic observations, sweep-netting, butterfly nets, light traps, acoustic detection, and manual searches beneath natural substrates were employed where appropriate. Bird communities were surveyed using standardized transects, whereas amphibians, reptiles, tortoises, lemurs, and mammals were inventoried through visual observations along fixed transects during periods corresponding to peak daily or nocturnal activity. Marine biodiversity assessments included field observations and specimen inventories from selected coastal sites. Data from all biological groups were subsequently synthesized to evaluate taxonomic richness, species composition, levels of endemism, geographic distribution, and conservation status across the study area. This integrated methodological framework enabled the development of a regional biodiversity baseline that supports future ecological research, biodiversity monitoring, and conservation planning in the extreme south of Madagascar.

Results and Discussion

Marine Biodiversity: Algae, Mollusks, and Spiny Lobsters

The marine ecosystems of the extreme south of Madagascar support a remarkable diversity of algae, mollusks, and commercially important crustaceans. The compilation of historical records and recent field investigations confirms that the region constitutes one of Madagascar's most significant centers of marine biodiversity and regional endemism. Owing to the interaction between the Mozambique Channel and the southwestern Indian Ocean, together with the presence of an extensive continental shelf, the coastal waters of the Androy region provide a wide variety of ecological niches that support diverse marine communities.

Marine algae represent one of the most distinctive components of the regional flora. Results from the *Atimo Vatae* expedition and complementary inventories documented

numerous algal species, including several taxa newly reported from southern Madagascar. Approximately 10% of the recorded algal flora consists of regional endemic species, highlighting the conservation importance of the coastal ecosystems. Among the most noteworthy taxa are *Ptilophora aureolusa*, recorded at *Cap Malainmpioka*, and *Pterocladia hamelii*, identified from *Lavanono*. These findings emphasize the floristic uniqueness of the southern coastline and suggest that the current knowledge of marine macroalgae remains incomplete, with additional undescribed or previously unrecorded species likely to occur in poorly explored coastal habitats.

The high diversity of marine algae observed in this study is consistent with previous investigations demonstrating that Madagascar's southwestern coastline forms part of the Western Indian Ocean marine biodiversity hotspot, where oceanographic processes, habitat heterogeneity, and long-term geographic isolation have promoted high levels of species diversification (Obura et al., 2017; UNEP, 2021). Marine macroalgae perform fundamental ecological functions by contributing substantially to primary productivity, nutrient cycling, habitat formation, and coastal food webs. Consequently, the preservation of these habitats is essential not only for maintaining biodiversity but also for supporting fisheries and enhancing coastal resilience under changing climatic conditions.

Mollusks constitute another exceptionally diverse marine group within the study area. The available inventory indicates an estimated regional endemism rate of approximately 25%, making mollusks among the most endemic marine organisms documented in the extreme south of Madagascar. Several endemic species, including *Cerithiopsidella caterinae*, *Clathropsis abelai*, *Clathropsis ornata*, *Specula widmeriana*, *Clathropsis atimovatae*, *Clathropsis corbariae*, *Clathropsis fuzzii*, *Horologica lavanonoensis*, *Joculator flavicans*, and *Joculator meanii*, were recorded primarily from *Cap Malainmpioka* and *Lavanono*. These localities therefore represent important centers of marine micro-endemism and significantly contribute to the regional conservation value of the Androy coastline.

The concentration of endemic mollusks within relatively restricted coastal areas reflects the evolutionary isolation that characterizes many marine taxa in the southwestern Indian Ocean. Similar patterns have been reported for marine gastropods and other benthic invertebrates inhabiting environmentally stable rocky reefs and coral-associated habitats, where localized speciation and limited larval dispersal promote high levels of endemism (Bouchet et al., 2019; Obura et al., 2017). Beyond their scientific importance, mollusks also contribute substantially to tourism, shell collecting, artisanal fisheries, and coastal ecosystem functioning, reinforcing the need for integrated conservation strategies that balance biodiversity protection with sustainable resource use.

Spiny lobsters represent one of the most valuable fisheries resources along the Malagasy coast. The present synthesis confirms the occurrence of four commercially important species belonging to the genus *Panulirus*, namely *Panulirus homarus*, *P. japonicus*, *P. penicillatus*, and *P. ornatus*. These species constitute the principal lobster resources harvested in the region and have long supported local livelihoods and export fisheries.

The ecological and economic importance of these lobster populations extends beyond their commercial value. Spiny lobsters are key benthic predators that contribute to maintaining the ecological balance of reef-associated ecosystems. However, increasing fishing pressure, habitat degradation, and climate-induced changes in coastal environments have raised growing concerns regarding the long-term sustainability of lobster stocks throughout the Western Indian Ocean (FAO, 2024). Sustainable fisheries management strengthened monitoring programs, and protection of critical nursery habitats will therefore be essential to ensure the persistence of these economically important species while maintaining ecosystem integrity.

Overall, the marine biodiversity documented in the extreme south of Madagascar demonstrates exceptionally high conservation value, particularly with respect to regional endemism among algae and mollusks and the ecological significance of commercially

exploited crustaceans. The synthesis presented in this study provides one of the most comprehensive overviews currently available for the marine biodiversity of the Androy region and establishes an important scientific baseline for future taxonomic research, ecological monitoring, and marine conservation planning.

Insect Diversity

Insects constituted one of the most species-rich terrestrial groups recorded during this study, although their overall diversity is likely underestimated due to limited taxonomic knowledge and the scarcity of reference collections for the region. The inventories conducted in the Androy region revealed considerable variation in insect assemblages among sampling sites. At Angavo, a total of 558 individuals representing 20 orders, 43 families, and 50 species were recorded. Similarly, the Andranohazonaily forest supported 388 individuals belonging to 17 orders, 37 families, and 43 species. These findings demonstrate that the remaining dry forest fragments of the extreme south of Madagascar continue to harbor diverse insect communities despite the region's harsh climatic conditions. However, because many collected specimens could only be identified to the family or genus level, the level of species endemism could not be accurately estimated, emphasizing the need for further taxonomic investigations and molecular identification of the collected material.

The composition of insect communities was dominated by the orders Hymenoptera, Diptera, and Isoptera, which were consistently the most abundant groups in the dry forest ecosystems. Their predominance reflects their broad ecological adaptability and the availability of suitable nesting, feeding, and decomposing substrates within *xerophytic* habitats. Hymenopterans perform essential ecological functions through pollination, biological control, and nutrient cycling, while dipterans contribute to decomposition and pollination. Likewise, termites (*Isoptera*) play a fundamental role in soil formation, organic matter decomposition, and nutrient recycling, particularly in dry tropical ecosystems where decomposition processes are constrained by limited moisture. The dominance of these insect groups therefore indicates that, despite prolonged drought and habitat fragmentation, important ecological processes remain functional within the remnant forests of southern Madagascar.

Although insect diversity was relatively high, the present inventory almost certainly underestimates the actual richness of the region. The surveys were constrained by the limited availability of professional trapping equipment, incomplete taxonomic reference collections, and the seasonal timing of fieldwork. Many insect species exhibits pronounced seasonal activity, with abundance and detectability increasing substantially during the rainy season when food resources and breeding habitats become more favorable. Consequently, the use of additional sampling techniques—including Malaise traps, pitfall traps, baited traps, canopy sampling, and long-term light trapping across different seasons—would undoubtedly increase the number of recorded taxa and improve estimates of regional species richness. These findings are consistent with previous studies demonstrating that insect diversity in Madagascar's dry forests remains considerably underestimated owing to insufficient sampling intensity and a shortage of taxonomic specialists (Goodman & Benstead, 2021; Bickford et al., 2018).

Several endemic taxa of conservation significance were documented or confirmed through historical records associated with the study area. The stick insect order Phasmatodea has previously been recognized as endemic to Madagascar and remains characteristic of the southern dry forests. Likewise, the butterfly *Gideona lucasi*, an endemic species restricted to southern Madagascar, was repeatedly observed during the surveys. Other noteworthy taxa include *Belohina inexpectata*, a highly distinctive orthopteran belonging to the endemic family *Belohinidae*, which was encountered only once along National Road 10 between Beloha and Tsihombe. This species has rarely been recorded since its original description by Paulian in 1959 and remains one of the least understood insects in Madagascar. Conversely, several

endemic southern Malagasy insects previously reported from the region, including *Enaria androyensis*, *E. tulearensis*, *E. betiokensis*, *Hoplochelus piliger*, *Mahafalyanus clementi*, *Prinus perrieri*, *Papilio dardanus*, and *Belenois helcida*, were not detected during the present inventories. Their apparent absence may reflect seasonal variation, naturally low population densities, restricted distributions, or insufficient sampling effort rather than true local extinction.

The conservation significance of the insect fauna extends beyond species richness alone. Insects represent fundamental components of terrestrial ecosystems by supporting pollination, decomposition, nutrient cycling, seed dispersal, and food-web dynamics. The persistence of diverse insect communities therefore reflects the ecological integrity of the remaining dry forest habitats. Nevertheless, ongoing habitat degradation caused by agricultural expansion, charcoal production, overgrazing, recurrent drought, and climate change continues to threaten these specialized communities. Because many Malagasy insects possess highly restricted geographic distributions and narrow habitat requirements, the loss or fragmentation of xerophytic forests could result in the disappearance of numerous undescribed endemic species before they are scientifically documented. Continued biodiversity surveys integrating morphological and molecular taxonomy, together with long-term ecological monitoring, are therefore essential for improving knowledge of the insect fauna of southern Madagascar and for informing effective conservation strategies.

Amphibians, Reptiles, and Tortoises

The herpetofauna of the extreme south of Madagascar reflects the ecological characteristics of the region's semi-arid climate and xerophytic vegetation. Although species richness is lower than that reported for Madagascar's humid eastern forests, the Androy region supports several endemic taxa that are highly adapted to dry environments and therefore represent an important component of the island's biodiversity. The present inventory confirms the ecological significance of these habitats for the conservation of amphibians, reptiles, and tortoises, many of which exhibit restricted geographic distributions and specialized habitat requirements.

A total of six amphibian species representing six *genera* and six families were recorded during this study, namely *Laliostoma labrosum*, *Scaphiophryne brevis*, *Heterixalus boettgeri*, *Boophis* sp., *Ptychadena mascareniensis*, and one unidentified species. Among these, four species are endemic to Madagascar, one is shared with neighboring islands, and one specimen could not be identified to species level. *Laliostoma labrosum* was the most widely distributed amphibian, occurring across several sampling sites, whereas *Scaphiophryne brevis* was restricted to a limited number of localities. Both species were associated with temporary wetlands, roadside depressions, and seasonal pools formed during the rainy season, demonstrating their remarkable adaptation to the highly seasonal hydrological conditions that characterize southern Madagascar.

The relatively low amphibian diversity observed in the Androy region is consistent with the ecological constraints imposed by the semi-arid environment. Amphibians depend strongly on the availability of freshwater habitats for reproduction, and the scarcity of permanent wetlands, combined with prolonged drought and irregular rainfall, substantially limits species richness. This finding agrees with previous studies indicating that amphibian diversity in Madagascar is highest within humid rainforest ecosystems and decreases markedly toward the island's southern xeric regions (Glaw & Vences, 2007; Goodman & Benstead, 2021). Nevertheless, the occurrence of predominantly endemic amphibians demonstrates that even species-poor communities may possess considerable conservation value because of their evolutionary uniqueness.

Reptiles were considerably more diverse than amphibians and included numerous species characteristic of Madagascar's southern dry forests. Three chameleon species were recorded, all of which are specialists of xerophytic habitats. Among them, *Furcifer lateralis*

and *Furcifer oustaleti* were more abundant than *Furcifer verrucosus*. The study also documented four individuals of *Leioheterodon madagascariensis* at Ambatosarotse in the Tsihombe District, together with several lizard species including *Zonosaurus quadrilineatus*, *Z. trilineatus*, and *Z. laticaudatus*, the latter occurring within the Angavo and Tsideho-Andranohazonaily forest massifs. In addition, *Oplurus quadrimaculatus* and *Chalarodon madagascariensis* were commonly encountered throughout the study area, indicating that rocky outcrops and dry forest habitats provide favorable ecological conditions for these heliophilous reptiles.

The reptile assemblage observed in this study highlights the exceptional ecological adaptations of Madagascar's dry-forest reptiles. Most recorded species are endemic to the island and exhibit physiological and behavioral traits that enable survival under high temperatures and prolonged seasonal drought. The occurrence of *Zonosaurus laticaudatus* within the Angavo and Tsideho-Andranohazonaily massifs is particularly noteworthy because this species has generally been associated with eastern and western dry forests, suggesting that these forest remnants function as important ecological refugia. Likewise, the fossorial skink *Madascincus cf. igneocaudatus*, found beneath decomposing cactus litter in Ambovombe, may represent one of the few reptile taxa with a particularly restricted distribution within the Androy region.

Tortoises constitute one of the most emblematic vertebrate groups of southern Madagascar and are of exceptional global conservation importance. The present study confirmed the occurrence of two endemic species, the radiated tortoise (*Astrochelys radiata*) and the spider tortoise (*Pyxis arachnoides* var. *oblonga*). *Astrochelys radiata* was consistently more abundant than *Pyxis arachnoides*, reaching an estimated density of approximately 40 individuals per hectare at Evany, compared with an average density of 27.72 individuals per hectare previously reported from the Cap Sainte-Marie Special Reserve. In contrast, *Pyxis arachnoides* exhibited a much narrower distribution, occurring only between the Menarandra River and the Taranty River, with estimated densities ranging from two to four individuals per hectare at Andranohazonaily and Evany.

The distribution patterns of both tortoise species correspond closely to the xerophytic vegetation zone of southern Madagascar. *Astrochelys radiata* remains largely confined to intact spiny forests and protected areas, where habitat quality remains relatively high, whereas *Pyxis arachnoides* occupies an even more restricted range and therefore faces greater conservation vulnerability. Habitat destruction caused by slash-and-burn agriculture, charcoal production, and forest degradation, together with illegal wildlife trafficking, continues to threaten both species despite ongoing conservation efforts. These findings are consistent with recent IUCN assessments recognizing both tortoises among the world's most threatened *Chelonian* species and emphasizing the urgent need to strengthen habitat protection, law enforcement, and community-based conservation initiatives (IUCN, 2024; Turtle Conservation Fund, 2023).

In one word, the herpetofauna documented in the extreme south of Madagascar illustrates the remarkable ecological specialization of vertebrate communities inhabiting one of the island's most climatically challenging environments. Although amphibian diversity remains relatively low because of hydrological limitations, reptiles and tortoises contribute substantially to regional endemism and conservation value. The persistence of these species depends on the effective protection of remaining dry forests, xerophytic thickets, and associated seasonal wetlands, all of which are increasingly threatened by climate change and human disturbance.

Bird Diversity

Bird surveys conducted across the Androy region recorded a total of 67 species belonging to 22 families and 26 genera, demonstrating that the remaining dry forests and xerophytic habitats continue to support a relatively diverse *avifauna* despite the harsh

climatic conditions of southern Madagascar. Although species richness is lower than that reported from Madagascar's humid forests, the region supports a remarkably high proportion of endemic birds, emphasizing its importance for national biodiversity conservation.

The predominance of endemic species reflects the long evolutionary isolation of Madagascar and the ecological specialization of birds inhabiting the southern dry forests. According to the findings of this study, approximately 90% of the recorded bird species are endemic to Madagascar, highlighting the exceptional conservation value of the Androy region. This level of endemism is consistent with previous studies identifying southern Madagascar as an important center of avian diversification, where habitat heterogeneity and geographic isolation have promoted the evolution of species with restricted distributions (Goodman & Benstead, 2021). The relatively low number of bird families and genera compared with other bioclimatic regions of Madagascar is likely associated with limited water availability, reduced structural complexity of vegetation, and the predominance of xerophytic habitats, all of which influence food availability and nesting opportunities.

Several species recorded during this study provide important insights into habitat connectivity and the historical biogeography of southern Madagascar. *Coua verreauxi*, a species generally associated with coastal forests, was observed at Ivany and Vohidefo at elevations reaching approximately 200 m above sea level. Its occurrence within xerophytic thickets suggests ecological affinities between the coastal vegetation and the spiny forest ecosystems of the extreme south. Likewise, *Coua gigas*, which is typically associated with the western dry deciduous forests, was also documented within the study area, indicating that remnant forest patches of the Androy region retain ecological characteristics capable of supporting species usually associated with western Madagascar. The presence of *Thamnornis chloropetoides* in Malaipioke, Cap Sainte-Marie, and Beanike further emphasizes the ecological significance of the southern coastal habitats, where this species remains largely restricted to the littoral forests of southern Madagascar.

The occurrence of these endemic birds highlights the role of the Androy region as an important refuge for species adapted to dry forest ecosystems. Habitat fragmentation, recurrent drought, agricultural expansion, charcoal production, and the degradation of native vegetation continue to reduce the availability of suitable breeding and foraging habitats. Some endemic birds, particularly species of the genus *Coua*, are also exposed to hunting and illegal capture for sale along major transportation routes, further increasing conservation concerns. These pressures, combined with projected climate change impacts in southern Madagascar, may accelerate group declines if effective habitat protection and community-based conservation measures are not strengthened.

The findings demonstrate that the avifauna of the extreme south of Madagascar is characterized less by high species richness than by exceptional endemism and ecological specialization. The persistence of these bird communities depends on maintaining the integrity of dry forests, coastal thickets, and associated habitats that sustain endemic species with limited geographic distributions. Continued monitoring of bird populations will provide valuable indicators of ecosystem health and contribute to the long-term conservation planning of one of Madagascar's most distinctive ecological regions.

Lemur and Mammal Diversity

The mammalian fauna of the extreme south of Madagascar is characterized by relatively low species richness but considerable conservation importance owing to the presence of several endemic lemur species and mammals adapted to the region's arid ecosystems. The present inventory recorded four lemur species, comprising two diurnal species (*Propithecus verreauxi verreauxi* and *Lemur catta*) and two nocturnal species (*Lepilemur leucopus* and *Microcebus griseorufus*). During field surveys, a total of 122 individuals of *Propithecus verreauxi verreauxi* were documented, including 101 adults and 21 juveniles. In

contrast, only four adult individuals of *Microcebus griseorufus* and four individuals of *Lepilemur leucopus* (two pairs) were observed at Malaintsatroke. Group size of *P. verreauxi verreauxi* ranged from one to ten individuals, with a mean size group of 4.14 individuals. Groups were recorded across several forest massifs, including Andranohazonaily, Ambovo Evany, Angavo, Ampamolora Basin, Ankarahake Forest, Vohidefo, Ampihamy, and Ankotsobe-Ambatosarotse, indicating that these fragmented dry forests continue to provide important habitat for endemic primates.

The distribution of lemurs observed during this study reflects the ecological importance of the remaining spiny forests and gallery forests in southern Madagascar. *Propithecus verreauxi* was the dominant primate species throughout the study area, whereas the nocturnal lemurs occurred at considerably lower densities. The absence of *Lemur catta* at Malaintsatroke during surveys conducted in March 2021 contrasts with observations made in October 2020, when a group of approximately ten individuals was recorded in the northern part of the same forest. This seasonal difference suggests that ring-tailed lemurs may undertake local movements in response to fluctuations in water availability and food resources, particularly during prolonged dry periods. Local ecological knowledge further indicated that these populations frequently move toward the gallery forest of the Menarandra River during periods of severe drought, illustrating the importance of habitat connectivity for maintaining viable populations under increasingly variable climatic conditions.

The persistence of lemur populations in the Androy region is closely associated with the ecological integrity of the remaining dry forests. Although habitat fragmentation and prolonged drought represent significant threats, local cultural taboos (*fady*) that prohibit the consumption of lemurs appear to provide an important form of traditional protection in many communities. These customary practices may partially explain the continued presence of viable groups of *Propithecus verreauxi verreauxi* and other endemic lemurs despite increasing anthropogenic pressures. Integrating traditional ecological knowledge with formal conservation strategies could therefore strengthen long-term biodiversity management while promoting greater community participation in species conservation. Similar interactions between cultural values and wildlife conservation have been documented elsewhere in Madagascar, where customary institutions continue to influence the protection of endemic fauna (Jones et al., 2021; Goodman & Benstead, 2021).

The survey also documented several non-primate mammal species that contribute to the ecological diversity of the region. Two individuals of *Echinops telfairi* were recorded during nocturnal searches, while *Potamochoerus larvatus* was found to be relatively abundant in the Angavo forest. Conversely, *Tenrec ecaudatus* appeared to have become extremely rare throughout the Androy region. Roosting colonies of the fruit bat *Eidolon helvum* were observed within caves at Andreampanihy-Marolinta and inside hollow baobab trees at Bemamba Tsarapioke in southern Antanimora, demonstrating the importance of these natural structures as refuges for volant mammals.

Historical observations and field evidence also indicate that the *fossa* (*Cryptoprocta ferox*), Madagascar's largest native carnivore, remains present within the region but has become increasingly restricted to the forest massifs of Vohidefo and Angavo. Local communities reported that this predator is frequently persecuted because of livestock predation, particularly involving goats and sheep, forcing populations into more remote forest habitats where rocky caves provide suitable refuges. The contraction of suitable habitat, combined with human-wildlife conflict, may reduce the long-term viability of *fossa* groups if unmanaged. Similarly, uncertainty regarding the biogeographical origin of *Potamochoerus larvatus* remains unresolved, although the species is now widely distributed across Madagascar. The continuing decline of *Tenrec ecaudatus* appears to be associated with prolonged drought and increasing hunting pressure, while the abundance of the introduced

wild cat (*Felis silvestris*) within the *Karimbola* limestone formations suggests that invasive predators may represent an additional pressure on native vertebrate communities.

The mammalian assemblage documented during this study demonstrates that the dry forests of the Androy region remain essential refuges for several endemic vertebrates despite increasing environmental stress. The maintenance of habitat connectivity, protection of remaining forest fragments, mitigation of human-wildlife conflict, and recognition of local conservation practices will be fundamental for ensuring the long-term persistence of Madagascar's endemic mammals under continuing climate change and land-use pressures.

Patterns of Endemism and Conservation Implications

The integrated inventory of terrestrial and marine biodiversity demonstrates that the extreme south of Madagascar constitutes an important center of biological diversity despite its relatively harsh environmental conditions. Although the region generally supports lower species richness than Madagascar's humid eastern forests, it contains exceptionally high levels of endemism across several taxonomic groups. Marine algae and mollusks exhibited the greatest proportion of regional endemic species, while reptiles, tortoises, birds, lemurs, and numerous insects contributed substantially to the island's unique terrestrial biodiversity. The coexistence of endemic species from both terrestrial and marine ecosystems highlights the ecological uniqueness of the Androy region and reinforces its importance as a national conservation priority.

The distribution of species observed in this study reflects the strong influence of environmental heterogeneity across the landscape. *Xerophytic* forests, limestone massifs, gallery forests, coastal dunes, rocky shores, and the extensive continental shelf create a mosaic of habitats that support taxonomic groups with contrasting ecological requirements. Habitat specialization was particularly evident among reptiles, tortoises, lemurs, and several marine invertebrates whose distributions were closely associated with specific vegetation types or coastal environments. Such ecological specialization contributes to high levels of endemism but also increases vulnerability to habitat disturbance because many species occupy relatively narrow geographic ranges. Similar relationships between habitat heterogeneity and endemism have been documented throughout Madagascar, where long-term geographic isolation and environmental variation have driven extensive evolutionary diversification (Wilmé et al., 2006; Goodman & Benstead, 2021).

The findings further demonstrate that biodiversity conservation in the extreme south of Madagascar faces multiple interacting threats. Habitat degradation resulting from slash-and-burn agriculture, charcoal production, illegal wildlife exploitation, overharvesting of marine resources, prolonged drought, and increasing climate variability continues to reduce the extent and quality of natural ecosystems. These pressures affect both terrestrial and coastal habitats, threatening species with restricted distributions and reducing ecological connectivity between remnant forest patches. Climate change is expected to intensify these challenges by increasing the frequency and severity of droughts in southern Madagascar, thereby affecting freshwater availability, vegetation structure, and ecosystem productivity (IPCC, 2023). Species with limited dispersal capacity, particularly amphibians, tortoises, and habitat-specialist insects, are likely to be among the most vulnerable to these environmental changes.

This inventory also highlights important knowledge gaps that warrant further investigation. Several insect specimens remain unidentified, additional marine algae and mollusk species are likely to occur in poorly explored coastal habitats, and long-term monitoring is needed to clarify group trends for many endemic vertebrates. Future study integrating molecular taxonomy, ecological monitoring, remote sensing, and spatial conservation planning would substantially improve understanding of biodiversity patterns across the Androy region. Expanding systematic surveys into underexplored habitats and strengthening collaborations among universities, research institutions, conservation

organizations, and local communities will facilitate more comprehensive biodiversity assessments and improve the scientific basis for conservation decision-making.

The biodiversity documented in this study provides one of the most comprehensive syntheses currently available for the extreme south of Madagascar. By integrating information across multiple taxonomic groups and ecosystems, the study establishes an important baseline for future biodiversity monitoring, protected area management, and evidence-based conservation planning. The findings further demonstrate that conserving the remaining dry forests and coastal ecosystems of the Androy region is essential not only for safeguarding Madagascar's exceptional endemic biodiversity but also for maintaining the ecological processes and ecosystem services that support local livelihoods and regional environmental resilience.

Conclusion

This study provides one of the first integrated syntheses of terrestrial and marine biodiversity in the extreme south of Madagascar by compiling and evaluating information across major taxonomic groups, including marine algae, mollusks, crustaceans, insects, amphibians, reptiles, tortoises, birds, lemurs, and other mammals. The findings demonstrate that, despite its semi-arid environment and relatively lower species richness than other regions of Madagascar, the Androy region supports exceptionally high levels of endemism and contains habitats of considerable ecological and conservation significance. The persistence of this unique biodiversity is increasingly threatened by habitat degradation, unsustainable resource use, wildlife exploitation, prolonged drought, and climate change, emphasizing the urgency of strengthening conservation actions and long-term biodiversity monitoring. This inventory establishes an important scientific baseline for future taxonomic and ecological research while providing valuable evidence to support protected area management, biodiversity conservation planning, and the sustainable management of Madagascar's unique natural heritage.

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