

THREATENED AND ENDEMIC FLORA AND FAUNA FROM MOUNT AGAD-AGAD, ILIGAN CITY, SOUTHERN PHILIPPINES

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ABSTRACT

The island of Mindanao where the Province of Lanao del Norte is situated is rich in biological diversity. Most plants and animals on this island are endemic—naturally occurring and are found nowhere else in the world. Despite the wealth of biodiversity studies, no known information has yet been formally published on the flora and fauna of Iligan City, a metropolitan area in the province of Lanao del Norte. This study, therefore, presents the endemic as well as the threatened plants and animals that were documented on Mount Agad-Agad in Iligan City. Mount Agad-Agad is an ecologically important massif, and a popular hiking and recreational destination. Floristic and faunistic surveys were conducted using standardized sampling methods. A total of 151 species of threatened and endemic flora (N = 60 species) and fauna (N = 90 species) were found to thrive in this lowland habitat. Although these species are important conservation targets, regional and Mindanao island endemic, the results of the study indicate that the overall species diversity in Mount Agad-Agad is a significant biodiversity hub for this metropolitan area. The protection and conservation of this biologically important mountain are, therefore, highly recommended.

Keywords: *biodiversity, conservation, Lanao del Norte, Mindanao island, local conservation area*



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INTRODUCTION

The Philippine archipelago is remarkably rich in diverse flora and fauna that are found nowhere else in the world. The richness of plants and animals is fundamental in studying the health of an ecosystem and plays a vital role in informing humans about the state of an environment (Kremen, 1992; Dufréne & Legendre, 1997; Carignan & Willard, 2002). Over the years, more than 32,400 species of plants and animals were discovered throughout the country, as vouched by numerous floristic and faunistic studies. Current records note 10,012 species of flora, represented by 1,048 species of ferns and lycophytes (269 species, endemic), 42 species of gymnosperms (16 species, endemic), 8,922 species of flowering plants (4,519 species, endemic) accounted from Co's Digital Flora of the Philippines (Pelser et al., 2011 onwards); and more than 22,440 species of fauna, represented by 1,439 species of vertebrates (775 species, endemic) and 21,000+ invertebrates (approximately 14,000+ species, endemics) based on faunistic accounts of Cabrera (1987), Hämäläinen & Muller (1997), Barrion (2001), Gapud & Lit (2005), Diesmos et al. (2015, 2020), Lucañas & Lit (2015), Gonzalez et al. (2018), Leviton et al. (2018), Allen (2020), ASM (2020), Barley et al. (2020), Avibase (2022), Barley et al. (2021), BCSP (2021), Eliades et al. (2021), and Herr et al. (2021).

Despite this rich biological diversity, numerous endemic plants, and animals in the country are regarded as threatened species, making the Philippines a global biodiversity conservation hotspot (Vesilind, 2002; Venturina et al., 2020). Most of the lowland forest and non-forest environs experience unprecedented levels of habitat degradation (Clements et al., 2016), and severe extraction of natural resources due to the rising demand of increasing population and urban development (Mallari et al., 2001; Ong et al., 2002).

On Mindanao Island, numerous low-lying mountains (>500 meters above sea level) in the nearby metropolis undergo severe biodiversity loss and extirpation due to excessive and unsustainable extraction of natural resources, various anthropogenic activities, and lack of attention to biodiversity awareness, protection, and conservation, especially for Mount Agad-Agad, a lowland mountain ecosystem of ecological importance. Mount Agad-Agad is a low-lying massif that shelters diverse flora (Coritico et al., 2020; Medecilo-Guiang et al., 2021) and fauna (Gabisay et al., 2021; Mohagan et al., 2020; Mohagan et al., 2022; Maglangit et al., 2022). It borders the progressively growing metropolitan area of Iligan City. Its biodiversity has been studied over the years, yet no known information is available on the unique threatened and endemic flora and fauna on this mountain.

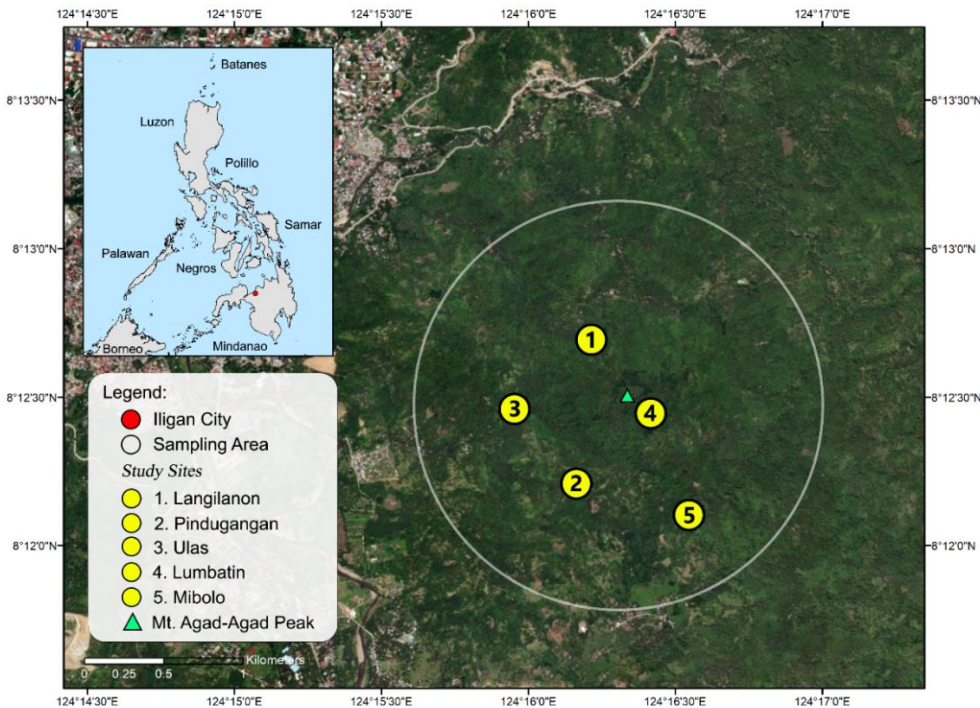
In this study, the researchers aim to provide the first baseline information on the threatened and endemic flora and fauna from Mount Agad-Agad in Iligan City to promote local and national awareness, and practical conservation initiatives, and offer a basis for policy recommendations for the protection of this ecologically important frontier habitat.

METHODOLOGY AND ASSESSMENT TOOLS

Study Area

Mount Agad-Agad (Figure 1) is a lowland massif (8.209128N 124.271433E) located just north of Iligan City. It is one of the remaining biologically important frontier habitats that shelter diverse terrestrial wildlife in this metropolitan area. It approximately covers more than 50 hectares of regenerating secondary forest, a mixed agricultural area, and a human-made forest covering the barangays of Pugaan (Langinlanon), Ubaldo Laya (Ulas), and Tipanoy (Pindugangan and Mibolo) in Iligan City, Lanao del Norte Province. The yellow numbered dots in the figure represent the different study sites surveyed for flora and fauna

Figure 1
Map of Mount Agad-Agad (Iligan City, Lanao del Norte, Mindanao Island) in Relation to the Philippine Islands (inset map)



This mountain is made-up of semi-ultramafic soil, rugged terrain, and simple karstic formation (visible on the southeastern part) with collective limestone outcrops and low-lying mountain ridges creating a spine reaching up to 520 meters high, towering the entire Iligan City. It is popular with the general public; it provides natural aesthetics and venues for recreational activities (e.g., camping and hiking) for local and international tourists.

Study Sites

Floristic and faunistic surveys were conducted in three separate field samplings from 2021-2022, covering five sampling localities (Table 1) and two seasons of the year. The annual mean temperature ranges from 21.7-32.2 °C and the annual mean precipitation is 193.1 mm in this metropolis (Weatherspark, 2020).

Table 1

Sampling Sites on Mount Agad-Agad

Site #	Study Sites	Coordinates	Elevation	Date Surveyed
1	Langinlanon	8°12'52" N 124°16'13" E	45-520	21-29 February 2020
2	Pindugangan	8°11'54" N 124°16'26" E	58-435	25-27 November 2020
3	Ulas	8°12'32" N 124°16'03" E	108-230	28-30 November 2020
4	Lumbatin	8°12'38" N 124°16'24" E	388-426	1-5 December 2020
5	Mibolo	8°11'43" N 124°16'43" E	79-285	26-29 March 2021

Study Site 1 (Barangay Pugaan, Langinlanon: 8°12'52"N 124°16'13"E). Surveyed on 21–29 February 2020, this site is characterized by mixed agroforestry, secondary forest, and human-made forest habitat. Its elevation ranges from 45-520 meters above sea level (masl) with an approximate distance of 2 km. The vegetation is made up mainly of non-endemic trees like *Gmelina arborea* Roxb. ex Sm, *Acacia mangium* Willd, *Cocos nucifera* L., and native fruit-bearing trees such as *Annona muricata* L., *Mangifera indica* L., *Tamarindus indica* L., and *Persea americana* Mill.; for mixed agricultural plantation: *Vitex parviflora* Juss., *Pterocarpus indicus* Willd., and *Cananga odorata* (Lam.) Hook. f. & Thomson; for regrowing secondary forest *Koordersiodenron pinnatum* (Blanco) Merr.; and for human-made plantation:

Sweitenia macrophylla King. The soil is mainly silt and semi-ultramafic. This area is a known recreational site for local tourists and mountaineers.

Study Sites 2 (Tipanoy, Pindugangan: 8°11'54"N 124°16'26"E), 3 (Ubaldo Laya, Ulas: 8°12'32" 124°16'03"E) and 4 (Pugaan, Lumbatin: 8°12'38"N 124°16'24"E). These sites were all surveyed from 25 November – 5 December 2020. The habitat includes mixed agricultural areas consisting of *Artocarpus heterophyllus* L., *Chrysophyllum cainito* L., *Cocos nucifera* L., *Mangifera indica* L., and *Sandroricum koetjape* Burm. f.; and secondary forest composed of *Koordersiodendron pinnatum* (Blanco) Merr., *Dasymaschalon clusiflorum* (Merr.) Merr., *Shorea polysperma* (Blanco) Merr., and *Artocarpus blancoi* (Elmer) Merr. The elevation ranges from 58-426 masl and is mainly composed of semi-ultramafic soils with limestone karst aggregates.

Study Site 5 (Tipanoy, Mibolo: 8°11'43"N 124°16'43"E). This site covers the southeastern part of Mount Agad-Agad. It is dominated by *Acalypha amentacea*, *Cananga odorata*, *Xanthosoma sagittifolium*, *Corypha utan*, *Globba campsophylla*, *Colocasia esculenta*, *Cocos nucifera*, and other flowering trees and shrubs on both secondary forest and mixed agroforestry system. Elevation ranges from 79-285 masl.

Floristic Surveys

The floristic surveys were done by documenting ferns, lycophytes, and flowering plants along the established and available trails on Mount Agad-Agad. A combination of visual-encounter surveys, opportunistic sampling, and collection of representative specimens following the standard preservation protocol developed by Amoroso et al. (2016) was used for the sample plants. Voucher specimens were carefully identified by the researcher and plant experts based on their flower, color, odor, and texture. They were further evaluated using the available photographic guides (Madulid, 1995; Amoroso et al., 2015) and digitized plant specimens from Co's Digital Flora of the Philippines (Pelser et al., 2011 onwards). They were photographed, pressed, dried, and deposited at the Central Mindanao University Herbarium (CMUH).

Faunistic Surveys

Faunistic surveys were done using multiple sampling methods. These methods include audio-visual encounter surveys for birds, amphibians, and reptiles; mist netting for bats; and different trapping methods (e.g., sweep netting, light trapping,

malaise trapping, pitfall trapping, and fruit-baiting) and hand-picking for invertebrates. Voucher specimens for vertebrates were properly preserved using the standard preservation protocol, fixed using a 10% buffered formalin, and stored in a 70% ethanol solution. For the invertebrates, the specimens were preserved and submerged in vials and falcon tubes with 95% alcohol. The specimens were all deposited at the Central Mindanao University–Zoological Museum (CMU-ZM).

Conservation Status Assessment

The conservation status of each plant and animal taxa was carefully assessed based on the latest status assessment from the International Union for Conservation of Nature (IUCN) version 2021-3, and Fernando et al. (2022) for plants; and Department of Environment and Natural Resources Administrative Order (DAO) 2019-09 for animals.

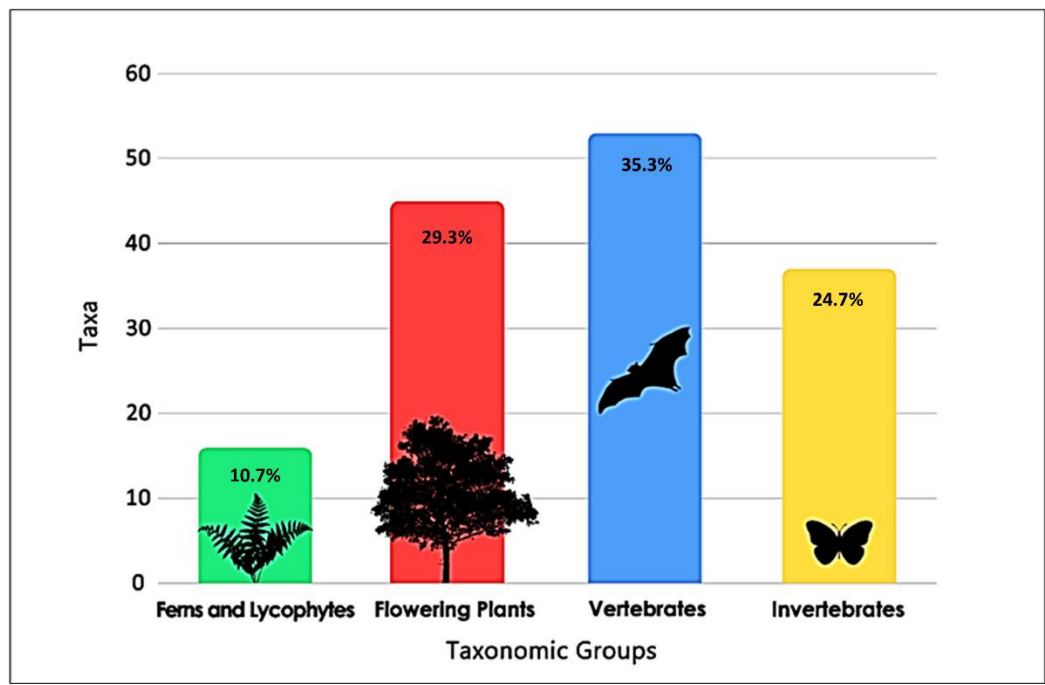
Data Analysis

The analysis of data was performed using R Studio version 3.6.1 which was developed by R Core Team (2019). Datasets of threatened and endemic flora and fauna were analyzed using the *ggplot2* package designed by Wickham et al. (2016) rendering a presentable data visualization.

RESULTS OF THE STUDY

The field sampling resulted in the documentation of 150 species of threatened and endemic flora and fauna on Mount Agad-Agad. In terms of species richness among the four taxonomic groups (Figure 2), the highest is that of the vertebrates (N = 53 species; 35.3%), followed by flowering plants (N = 44 species; 29.3%), invertebrates (N = 37 species; 24.7%), and ferns and lycophytes (N = 16 species; 10.7%).

Figure 2
Species Richness of Threatened, Endemic, and Rare Flora and Fauna on Mount Agad-Agad

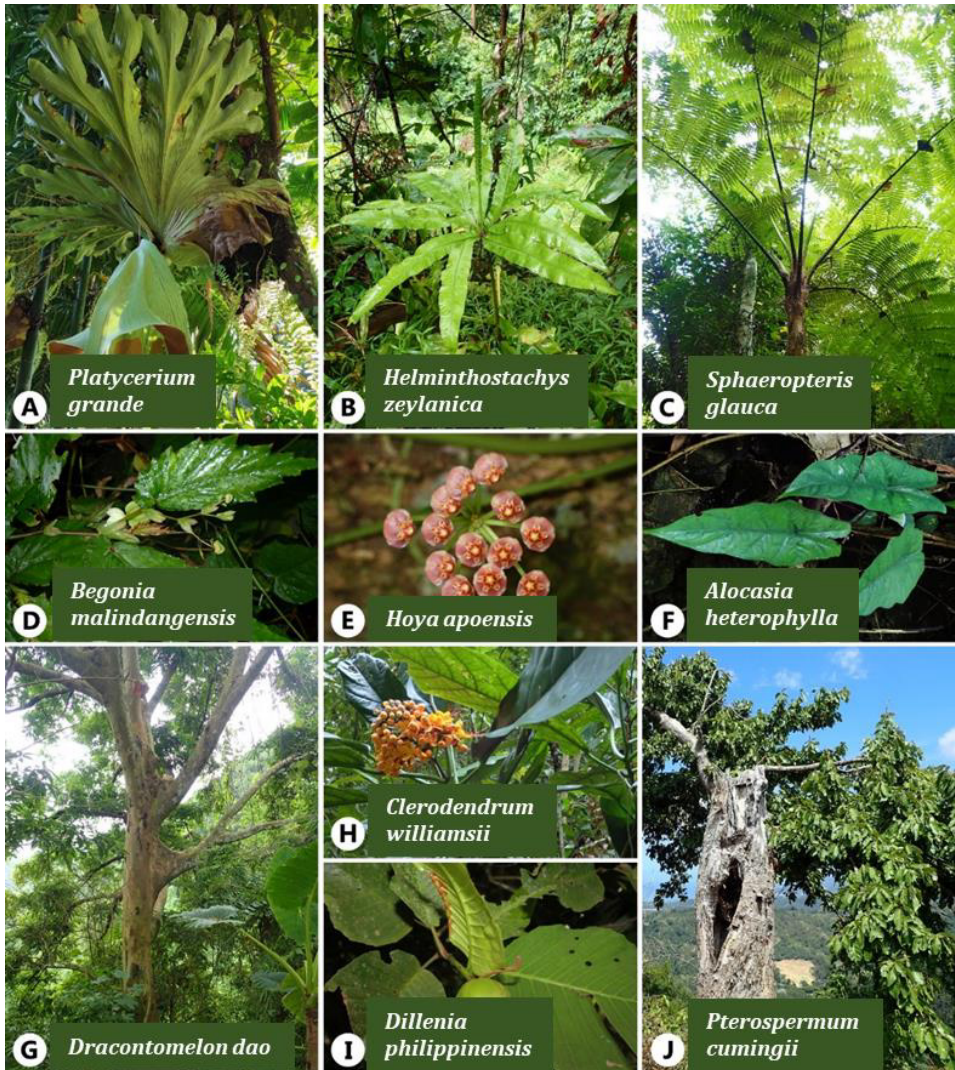


Floristic Records

A total of 63 species of threatened and endemic ferns, lycophytes, and flowering plants were recorded on Mount Agad-Agad (Figure 3).

Figure 3

Some Threatened and Endemic Ferns and Flowering Plants on Mount Agad-Agad



Ferns such as *Platycerium grande* were recorded at the research site. This species of fern is critically endangered because of over-collection in the wild due to its ornamental value. *Helminthostachys zeylanica* is another endangered species of ferns, which is found under shaded areas. This species of fern not only has ornamental value but is known for its many medicinal uses. *H. zeylanica* is a unique plant that has a solitary frond with a fertile spike arising from the frond. As regards the threatened flowering plants, some species are trees such as *Dracontomelon dao* and *Pterospermum cumingii*, which are hardwoods. The rest of the threatened angiosperms are herbs or shrubs with ornamental values.

Table 2 lists 17 species from 63 species of plants belonging to the fern and lycophyte group, represented by 13 genera belonging to 10 families (Cyatheaceae, Davalliaceae, Lycopodiaceae, Marattiaceae, Ophioglossaceae, Polypodiaceae, Pteridaceae, Selaginellaceae, Tectariaceae, Thelypteridaceae). Of the 10 families recorded, the Polypodiaceae (N = 5 species; 29.4%) is the most abundant.

Table 2
Floristic Accounts of Threatened and Endemic Plants on Mount. Agad-Agad, Iligan City Summarized by Family, and Conservation Status

Taxa	IUCN (2021-3) Status	Fernando et al. (2022)
FERNS AND LYCOPHYTES (N=17)		
Cyatheaceae (N=1)		
<i>Sphaeropteris glauca</i> (Blume) R.M.Tryon Scaly Tree Fern	LC	EN
Davalliaceae (N=1)		
<i>Davallia solida</i> (G.Forst.) Sw. Hare’s Foot Fern	NA	OTS
Lycopodiaceae (N=1)		
<i>Phlegmariurus carinatus</i> (Desv. ex Poir.) Ching Keeled Tassel-fern	NA	EN
Marattiaceae (N=1)		
<i>Angiopteris evecta</i> (G.Forst.) Hoffm * Giant Fern	NA	OTS
Ophioglossaceae (N=1)		
<i>Helminthostachys zeylanica</i> (L.) Hook Fishtail Fern	NA	CR
Polypodiaceae (N=5)		
<i>Aglaomorpha heraclea</i> (Kunze) Copel. Oakleaf Fern	NA	VU
<i>Aglaomorpha splendens</i> (J.Sm.) Copel. Oakleaf Fern	NA	VU
<i>Microsorium samarense</i> (J.Sm.) Bosman * Polypody Fern	NA	OWS
<i>Platycterium grande</i> (A.Cunn. ex Fée) J.Sm Giant Staghorn Fern	NA	CR

Table 2 (continuation)

Taxa	IUCN (2021-3) Status	Fernando et al. (2022)
Pteridaceae (N=2)		
<i>Pteris opaca</i> (C.Presl) J.Sm. Brake Fern	NA	VU
<i>Pteris oppositipinnata</i> Fée * Brake Fern	NA	OWS
Selaginellaceae (N=1)		
<i>Selaginella ramossi</i> Hieron. * Spike moss	NA	OWS
Tectariaceae (N=1)		
<i>Tectaria athyriosora</i> M.G.Price * Halberd Fern	NA	OWS
Thelypteridaceae (N=3)		
<i>Pronephrium xiphioides</i> (Christ) Holttum * Marsh Fern	NA	OWS
<i>Reholtumia laevis</i> (Mett.) S.E.Fawc. & A.R.Sm. * Gully Fern	NA	OWS
<i>Reholtumia nitidula</i> (C.Presl) S.E.Fawc. & A.R.Sm. * Gully Fern	NA	OWS
FLOWERING PLANTS (N=44)		
Actinidiaceae (N=1)		
<i>Saurauia clementis</i> Merr. * Saurauia Tree	NA	OWS
Anacardiaceae (N=2)		
<i>Dracontomelon dao</i> (Blanco) Merr. & Rolfe Argus Pheasant Tree	LC	VU
<i>Koordersiodendron pinnatum</i> (Blanco) Merr. Amugis Tree	NA	OTS
Annonaceae (N=1)		
<i>Dasymaschalon clusiflorum</i> (Merr.) Merr. * Amugis Tree	LC	OWS
Apocynaceae (N=1)		
<i>Hoya apoensis</i> Kloppenb. & Siar. * Hoya	NA	OWS

Table 2 (continuation)

Taxa	IUCN (2021-3) Status	Fernando et al. (2022)
Araceae (N=2)		
<i>Alocasia heterophylla</i> (C.Presl) Merr. *	NA	OWS
<i>Alocasia</i>		
<i>Pothos dolichophyllus</i> Merr. *	NA	OWS
Begoniaceae (N=1)		
<i>Begonia malindangensis</i> Merr. *	NA	OWS
Angel-wing Begonia		
Brownlowiaceae (N=1)		
<i>Diplodiscus paniculatus</i> Turcz. *	LC	OWS
Burseraceae (N=1)		
<i>Canarium ovatum</i> Engl. *	LC	OTS
Pili nut		
Dilleniaceae (N=1)		
<i>Dillenia philippinensis</i> Rolfe *	NT	OWS
Philippine Simpoh		
Dipterocarpaceae (N=1)		
<i>Shorea polysperma</i> (Blanco) Merr. *	LC	VU
Tanguile		
Dombeyaceae (N=1)		
<i>Pterospermum cumingii</i> Merr. & Rolfe *	EN	OWS
Maple-leaf Tree		
Ebenaceae (N=2)		
<i>Diospyros discolor</i> Willd.	VU	OWS
Velvet Apple		
<i>Diospyros philippinensis</i> A.DC.	NT	VU
Mabolo Tree		
Euphorbiaceae (N=1)		
<i>Macaranga grandifolia</i> (Blanco) Merr.	VU	OWS
Parasol Leaf Tree		
Fabaceae (N=1)		
<i>Pterocarpus indicus</i> Willd.	EN	VU
Red Sandalwood		

Table 2 (continuation)

Taxa	IUCN (2021-3) Status	Fernando et al. (2022)
Lamiaceae (N=2)		
<i>Clerodendrum williamsii</i> Elmer *	VU	OWS
Glorybower		
<i>Vitex parviflora</i> Juss.	LC	EN
Molave Tree		
Lauraceae (N=3)		
<i>Cinnamomum mercadoi</i> S.Vidal *	LC	OTS
Kalingag Tree		
<i>Cinnamomum utile</i> Kosterm. *	NA	OWS
Philippine Cinnamon		
<i>Litsea philippinensis</i> Merr. *	NT	OTS
Philippine Bollywood		
Loranthaceae (N=3)		
<i>Amyema haenkeana</i> (C.Presl ex Schult.f.) Danser *	NA	OWS
Mistletoe		
<i>Amyema luzonensis</i> (Schult.f.) Danser *	NA	OWS
Philippine Mistletoe		
<i>Decaisnina ovatifolia</i> (Merr.) Barlow *	NA	OWS
Mistletoe		
Moraceae (N=5)		
<i>Artocarpus blancoi</i> (Elmer) Merr. *	LC	OWS
Antipolo		
<i>Ficus balete</i> Merr. *	LC	OWS
Balete Tree		
<i>Ficus gigantifolia</i> Merr. *	NT	OWS
Giant Fig Tree		
<i>Ficus odorata</i> (Blanco) Merr. *	LC	OWS
<i>Ficus pseudopalma</i> Blanco *	NA	OWS
Philippine Fig		
Myrtaceae (N=1)		
<i>Syzygium toppingii</i> (Elmer) Merr. *	EN	OWS
Plum		

Table 2 (continuation)

Taxa	IUCN (2021-3) Status	Fernando et al. (2022)
Phyllanthaceae (N=1)		
<i>Glochidion cauliflorum</i> Merr. * Pin Flower Tree	NA	OWS
Piperaceae (N=1)		
<i>Piper caninum</i> Blume Piper	NA	OTS
Primulaceae (N=1)		
<i>Ardisia mindanaensis</i> Mez * Coralberry	NA	OWS
Rubiaceae (N=1)		
<i>Neonauclea bartlingii</i> (DC.) Merr. *	LC	OWS
Rutaceae (N=2)		
<i>Clausena anisum-olens</i> (Blanco) Merr. *	NA	OWS
<i>Micromelum compressum</i> (Blanco) Merr. *	NA	OWS
Sapindaceae (N=1)		
<i>Allophylus leptocladus</i> Radlk. ★	EN	OWS
Sapotaceae (N=1)		
<i>Palaquium mindanaense</i> Merr. ★	CR	VU
Urticaceae (N=1)		
<i>Elatostematoides sublaxa</i> Elmer *	NA	OWS
Zingiberaceae (N=4)		
<i>Alpinia haenkei</i> C.Presl *	LC	OWS
<i>Globba campsophylla</i> K.Schum. * Ginger Lilly	NA	OWS
<i>Hornstedtia conoidea</i> Ridl. *	NA	OWS
<i>Zingiber matutumense</i> Mood & Theilade ★ Mindanao Island Ginger	NA	OWS

Legend: NA = Not Assessed, LC = Least Concern, OWS = Other Wildlife Species, NT = Near Threatened, OTS = Other Threatened Species, VU = Vulnerable, EN = Endangered, CR = Critically Endangered based on IUCN (2021-3) and Fernando et al. (2022) for plants. Asterisk (*) represents Philippine endemic species and star symbol (★) denotes Mindanao biogeographic region endemics

Forty-four (44) species of flowering plants were represented by 40 genera from 28 families (Actinidiaceae, Anacardiaceae, Annonaceae, Apocynaceae, Araceae, Begoniaceae, Brownlowiaceae, Burseraceae, Dilleniaceae, Dipterocarpaceae, Dombeyaceae, Ebenaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Lauraceae, Loranthaceae, Moraceae, Myrtaceae, Phyllanthaceae, Piperaceae, Primulaceae, Rubiaceae, Rutaceae, Sapindaceae, Sapotaceae, Urticaceae, Zingiberaceae). Of these families, the Moraceae had the greatest number of species, represented by five endemic species (N=5 species; 11.1%).

Faunistic Records

There are 93 species of threatened and endemic terrestrial vertebrates and invertebrates recorded on Mount Agad-Agad (Figure 5). A total of 53 species representing four vertebrate groups consisting of mammals (N = 6 species; 11.3%), birds (N = 27 species; 51.0%), reptiles (N = 14 species; 26.4%), and amphibians (N = 6 species; 11.3%). Among the four taxonomic groups of flora and fauna, animal vertebrates were found to be rich and taxonomically diverse.

Figure 4

Some Threatened and Endemic Animals (Vertebrates and Invertebrates) on Mount Agad-Agad



Table 3 lists 53 species of vertebrates represented by 47 genera belonging to 32 families. These include family *Accipitridae*, *Agamidae*, *Alcedinidae*, *Apodidae*, *Bucerotidae*, *Caprimulgidae*, *Cercopithecidae*, *Cisticolidae*, *Colubridae*, *Columbidae*, *Cuculidae*, *Dicaeidae*, *Dicroglossidae*, *Elapidae*, *Gekkonidae*, *Geomydidae*, *Lamprophiidae*, *Megophryidae*, *Microhylidae*, *Muridae*, *Muscicapidae*, *Nectariniidae*, *Paridae*, *Picidae*, *Psittacidae*, *Pteropodidae*, *Pycnonotidae*, *Ranidae*, *Rhipiduridae*, *Scincidae*, *Strigidae*, and *Varanidae*. Of the 32 families, Pteropodidae (fruit bats) had the highest number of endemic species recorded (N = 4 species; 7.5%).

Table 3

Faunistic Accounts of Threatened and Endemic Animals on Mount Agad-Agad, Iligan City Summarized by Family and Conservation Status

Taxa	IUCN (2021-3) Status	DAO 2019-09
VERTEBRATES (N=53)		
MAMMALIA (MONKEY)		
Cercopithecidae (N=1)		
<i>Macaca fascicularis philippensis</i> (I. Geoffroy, 1843) * Philippine Long-tailed Macaque	NT	OWS
MAMMALIA (BATS)		
Pteropodidae (N=4)		
<i>Haplonycteris fischeri</i> Lawrence, 1939 * Philippine Pygmy Fruit Bat	LC	OWS
<i>Megaerops wetmorei</i> Taylor, 1934 White-collared Fruit Bat	VU	OWS
<i>Ptenochirus jagori</i> (Peters, 1861) * Greater Musky Fruit Bat	LC	OWS
<i>Ptenochirus minor</i> Yoshiyuki, 1979 * Lesser Musky Fruit Bat	LC	OWS
MAMMALIA (RATS)		
Muridae (N=1)		
<i>Rattus everetti</i> (Günther, 1879) * Philippine Forest Rat	LC	OWS

Table 3 (continuation)

Taxa	IUCN (2021-3) Status	DAO 2019-09
AVIFAUNA (BIRDS)		
Columbidae (N=3)		
<i>Macropygia tenuirostris</i> Bonaparte, 1854 * Philippine Cuckoo Dove	LC	OWS
<i>Phapitreron brevirostris</i> Tweeddale, 1877 * Short-billed Brown Dove	LC	OWS
<i>Phapitreron amethystinus</i> Bonaparte, 1855 * Amethyst Brown Dove	LC	CR
Cuculidae (N=1)		
<i>Centropus viridis</i> (Scopoli, 1786) * Philippine Coucal	LC	OWS
Caprimulgidae (N=1)		
<i>Caprimulgus manillensis</i> Walden, 1875 * Philippine Nightjar	LC	OWS
Apodidae (N=3)		
<i>Collocalia troglodytes</i> Gray, 1845 * Pygmy Swiftlet	LC	OWS
<i>Collocalia isonota</i> Oberholser, 1906 * Ridgetop Swiftlet	NA	OWS
<i>Aerodramus mearnsi</i> (Oberholser, 1912) * Philippine Swiftlet	LC	OWS
Accipitridae (N=1)		
<i>Spilornis holospilus</i> (Vigors, 1831) * Philippine Serpent Eagle	LC	OWS
Strigidae (N=1)		
<i>Bubo philippensis</i> (Kaup, 1851) * Philippine Eagle-owl	VU	EN
Bucerotidae (N=1)		
<i>Penelopides affinis</i> Tweeddale, 1877 * Mindanao Hornbill	LC	EN
Alcedinidae (N=1)		
<i>Ceyx mindanensis</i> Steere, 1890 * Southern Philippine Dwarf Kingfisher	VU	VU

Table 3 (continuation)

Taxa	IUCN (2021-3) Status	DAO 2019-09
Picidae (N=1)		
<i>Dendrocopos maculatus</i> (Scopoli, 1786) * Philippine Pygmy Woodpecker	LC	OWS
Psittacidae (N=2)		
<i>Bolbopsittacus lunulatus</i> (Scopoli, 1786) * Guaibero	LC	OWS
<i>Loriculus philippensis</i> (Müller, 1776) * Philippine Hanging Parrot	LC	CR
Rhipiduridae (N=1)		
<i>Rhipidura nigritorquis</i> Vigors, 1831 * Philippine Pied Fantail	LC	OWS
Paridae (N=1)		
<i>Pardaliparus elegans</i> (Lesson, 1831) * Elegant Tit	LC	OWS
Cisticolidae (N=1)		
<i>Orthotomus cinereiceps</i> Sharpe, 1877 * White-eared Tailorbird	LC	OWS
Pycnonotidae (N=3)		
<i>Brachypodius urostictus</i> (Salvadori, 1870) * Yellow-wattled Bulbul	LC	OWS
<i>Hypsipetes philippinus</i> (Foster, 1795) * Philippine Bulbul	LC	OWS
<i>Macronus striaticeps</i> Sharpe, 1877 * Brown Tit-babbler	LC	OWS
Muscicapidae (N=1)		
<i>Copsychus mindanensis</i> (Boddaert, 1783) * Philippine Magpie-robin	LC	OWS
Dicaeidae (N=2)		
<i>Dicaeum australe</i> (Hermann, 1783) * Red-keeled Flowerpecker	LC	OWS
<i>Dicaeum pygmaeum</i> (Kittlitz, 1833) * Pygmy Flowerpecker	LC	OWS

Table 3 (continuation)

Taxa	IUCN (2021-3) Status	DAO 2019-09
Nectariniidae (N=3)		
<i>Aethopyga pulcherrima</i> Sharpe, 1876 * Metallic-winged Sunbird	LC	OWS
<i>Arachnothera flammifera</i> Tweeddale, 1878 * Orange-tufted Spiderhunter	LC	OWS
<i>Arachnothera clarae</i> Blasius, 1890 * Naked-faced Spiderhunter	LC	OWS
REPTILES (LIZARDS)		
Agamidae (N=2)		
<i>Draco bimaculatus</i> (Günther, 1864) * Two-spotted Flying Lizard	LC	OWS
<i>Hydrosaurus pustulatus</i> Escholtz, 1829 * Philippine Sailfin Lizard	VU	OTS
Gekkonidae (N=1)		
<i>Cyrtodactylus annulatus</i> (Taylor, 1915) * Annulated Bow-fingered Gecko	LC	OWS
Scincidae (N=3)		
<i>Eutropis caraga</i> Barley et al. 2020 * Caraga Sun Skink	NA	OWS
<i>Lamprolepis smaragdina philippinica</i> (Mertens, 1928) * Green Tree Skink	LC	OWS
<i>Tropidophorus misaminius</i> Stejneger, 1910 * Misamis Waterside Skink	LC	OWS
Varanidae (N=1)		
<i>Varanus cumingi</i> Martin, 1839 * Mindanao Monitor Lizard	LC	OWS

Table 3 (continuation)

Taxa	IUCN (2021-3) Status	DAO 2019-09
REPTILES (SNAKES)		
Colubridae (N=3)		
<i>Ahaetula prasina preocularis</i> (Taylor, 1922) * Philippine Vine Snake	LC	OWS
<i>Chrysopelea paradisi variabilis</i> Mertens, 1968 * Paradise Tree Snake	LC	OWS
<i>Cyclocorus nuchalis taylori</i> Leviton, 1967 * Southern Triangle-spotted Snake	LC	OWS
Elapidae (N=2)		
<i>Calliophis philippina</i> Günther, 1864 * Philippine Striped Coral Snake	LC	OWS
<i>Naja samarensis</i> Peters, 1861 * Southern Philippine Cobra	LC	OTS
Lamprophiidae (N=1)		
<i>Oxyrhabdium modestum</i> (Duméril, Bibron & Duméril, 1854) * Non-banded Philippine Burrowing Snake	LC	OWS
REPTILE (TURTLE)		
Geomydidae (N=1)		
<i>Cuora amboinensis</i> (Riche in Daudin, 1802) Southeast Asian Box Turtle	EN	OTS
AMPHIBIANS (FROGS)		
Dicroglossidae (N=3)		
<i>Fejervarya vittigera</i> (Wiegmann, 1824) * Philippine Grass Frog	LC	OWS
<i>Limnonectes leytensis</i> (Boetger, 1893) * Philippine Swamp Frog	LC	OWS
<i>Limnonectes magnus</i> (Stejneger, 1910) * Philippine Fanged Frog	NT	OWS
Megophryidae (N=1)		
<i>Pelobatrachus stejnegeri</i> (Taylor 1920) * Mindanao Horned Frog	LC	OWS
Microhylidae (N=1)		
<i>Kalophrynus sinensis</i> (Peters 1867) * Rufous-sided Sticky Frog	LC	OWS

Table 3 (continuation)

Taxa	IUCN (2021-3) Status	DAO 2019-09
Ranidae (N=1)		
<i>Pulchrana grandocula</i> (Taylor, 1920) * Mindanao Striped Stream Frog	LC	OWS
INVERTEBRATES (N=37)		
ARACHNIDA (SPIDERS)		
Araneidae (N=5)		
<i>Gasteracantha janopol</i> Barrion & Litsinger, 1995 * Mindanao Spiny Orb-weaver	NA	OWS
<i>Gasteracantha diadesma</i> Thorell, 1898 * Mindanao Spiny Orb-weaver	NA	OWS
<i>Gasteracantha parangdiadesma</i> Barrion & Litsinger, 1995 * Mindanao Spiny Orb-weaver	NA	OWS
<i>Parawixia dehaani</i> (Doleschall, 1859) Abandoned-web Orb-weaver	NA	OTS
<i>Poltys illepidus</i> C. L. Koch, 1843 Tree Stump Spider	NA	OTS
Theraphosidae (N=1)		
<i>Phlogiellus baeri</i> (Simon, 1877) * Philippine Dwarf Tarantula	NA	OTS
Thelyphonoidae (N=1)		
<i>Thelyphonoides semperi</i> Kraepelin, 1897 * Mindanao Whip Scorpion	NA	OWS
COLEOPTERA (BEETLES)		
Buprestidae (N=2)		
<i>Chrysochroa fulminans cobaltina</i> Fisher, 1922 Metallic Wood-boring Beetles	NA	OTS
<i>Chrysodema smaragdula</i> (Olivier, 1790) Jewel Wood Beetle	NA	VU
Cerambycidae (N=1)		
<i>Cereopsius luctor</i> (Newman, 1842) * White Spotted Longhorned Beetle	NA	OWS

Table 3 (continuation)

Taxa	IUCN (2021-3) Status	DAO 2019-09
Curculionidae (N=2)		
<i>Metapocyrtus apoensis</i> Schultze, 1925 ★ Mindanao Green Jewel Weevil	NA	VU
<i>Metapocyrtus geniculatus</i> Waterhouse, 1842 * Black Weevil	NA	VU
Lucanidae (N=1)		
<i>Prosopocoilus buddha</i> (Hope, 1842) Stag Beetle	NA	OTS
Scarabaeidae (N=3)		
<i>Carlschoenherria philippinica</i> (Brenske, 1894) * Scarab Beetle	NA	OWS
<i>Chalcosoma atlas</i> Linnaeus, 1758 Atlas Beetles	NA	OTS
<i>Heterorrhina macleayi</i> (Kirby, 1818) Green Scarab Beetle	NA	OTS
LEPIDOPTERA (BUTTERFLY)		
Nymphalidae (N=6)		
<i>Elymnias casiphonides casiphonides</i> Semper, 1892 ★ Palmfly	NA	OWS
<i>Elymnias congruens congruens</i> Semper, 1887 * Palmfly	NA	OWS
<i>Ideopsis juvena manillana</i> Moore, 1883 * Grey Glassy Tiger	NA	OWS
<i>Ragadia melindena melindena</i> C.& R. Felder, 1863 * Striped Ringlet Butterfly	NA	OWS
<i>Ypthima sempera chaboras</i> (Fruhstorfer, 1911) * Brush-footed Butterfly	NA	OWS
<i>Ypthima stelleria stellerea</i> (Moore, 1892) * Five-ringed Butterfly	NA	OWS
Pieridae (N=1)		
<i>Pareronia boebersi trinobantes</i> Fruhstorfer, 1911 ★ Wanderer	NA	OWS

Table 3 (continuation)

Taxa	IUCN (2021-3) Status	DAO 2019-09
LEPIDOPTERA (MOTH)		
Saturniidae (N=1)		
<i>Attacus caesar</i> Maassen, 1873 * Atlas Moth	NA	OWS
Sphingidae (N=2)		
<i>Ambulyx bakeri</i> (Clark, 1929) * Hawk Moth	NA	OWS
<i>Ambulyx wilemani</i> (Rothschild & Jordan, 1916) * Hawk Moth	NA	OWS
ODONATA (DAMSELFLY)		
Euphaeidae (n=1)		
<i>Euphaea amphicyana</i> Ris, 1930 * Damsel fly	NA	OWS
Platycnemididae (N=3)		
<i>Coeliccia dinocerus</i> Laidlaw, 1925 * Damsel fly	NA	OWS
<i>Risio cnemis flammea</i> Selys, 1882 * Damsel fly	NA	OWS
<i>Risio cnemis tendipes</i> (Needham & Gyger, 1941) * Damsel fly	NA	OWS
ODONATA (DRAGONFLY)		
Libellulidae (N=1)		
<i>Diplacina braueri</i> Selys, 1882 * Skimmer Dragonfly	NA	OWS
ORTHOPTERA (CRICKETS)		
Gryllidae (N=2)		
<i>Cardiodactylus kondoi</i> Otte, 2007 * Bush Cricket	NA	OWS
<i>Paranisitra longipes</i> Chopard, 1925 * Bush Cricket	NA	OWS

Table 3 (continuation)

Taxa	IUCN (2021-3) Status	DAO 2019-09
ORTHOPTERA (GRASSHOPPERS)		
Tetrigidae (N=3)		
<i>Diotarus verrucifer</i> Stål, 1877 ★ Mindanao Helmed Pygmy Grasshopper	NA	OWS
<i>Hirrius mindanaensis</i> Stål, 1877 ★ Mindanao Black Pygmy Grasshopper	NA	OWS
<i>Hymenotes triangularis</i> Westwood, 1837 * Dead Leaf Pygmy Grasshopper	NA	OWS
PHASMATODEA (STICK INSECT)		
Bacillidae (N=1)		
<i>Euobrimus atherura</i> Rehn & Rehn, 1939 ★ Mindanao Stick Insect	NA	OWS

Legend: (NA = Not Assessed, LC = Least Concern, OWS = Other Wildlife Species, NT = Near Threatened, OTS = Other Threatened Species, VU = Vulnerable, EN = Endangered, CR = Critically Endangered) based on IUCN (2021-3) and DAO (2019-09) for plants. Asterisk (*) represents Philippine endemic species and the star symbol (★) denotes Mindanao faunal region endemics.

The study recorded 37 species of insects from 10 invertebrate groups, including spiders (N = 6 species; 16.2%), a scorpion (N = 1 species; 2.7%), beetles (N = 9 species; 24.3%), butterflies (N = 7 species; 18.9%), moths (N = 3 species; 8.1%), damselflies (N = 4 species; 10.8%), a dragonfly (N = 1 species; 2.7%), crickets (2 species; 5.4%), grasshoppers (N = 3 species; 8.1%) and a stick insect (1 species; 2.7%).

The 37 species of invertebrates were represented by 18 families (Araneidae, Bacillidae, Buprestidae, Cerambycidae, Curculionidae, Euphaeidae, Gryllidae, Libellulidae, Lucanidae, Nymphalidae, Pieridae, Platycnemididae, Saturniidae, Scarabaeidae, Sphingidae, Tetrigidae, Thelyphonidae, and Theraphosidae). The family Nymphalidae is the most represented invertebrate family, documenting six (16.2%) endemic species.

Threatened Flora and Fauna

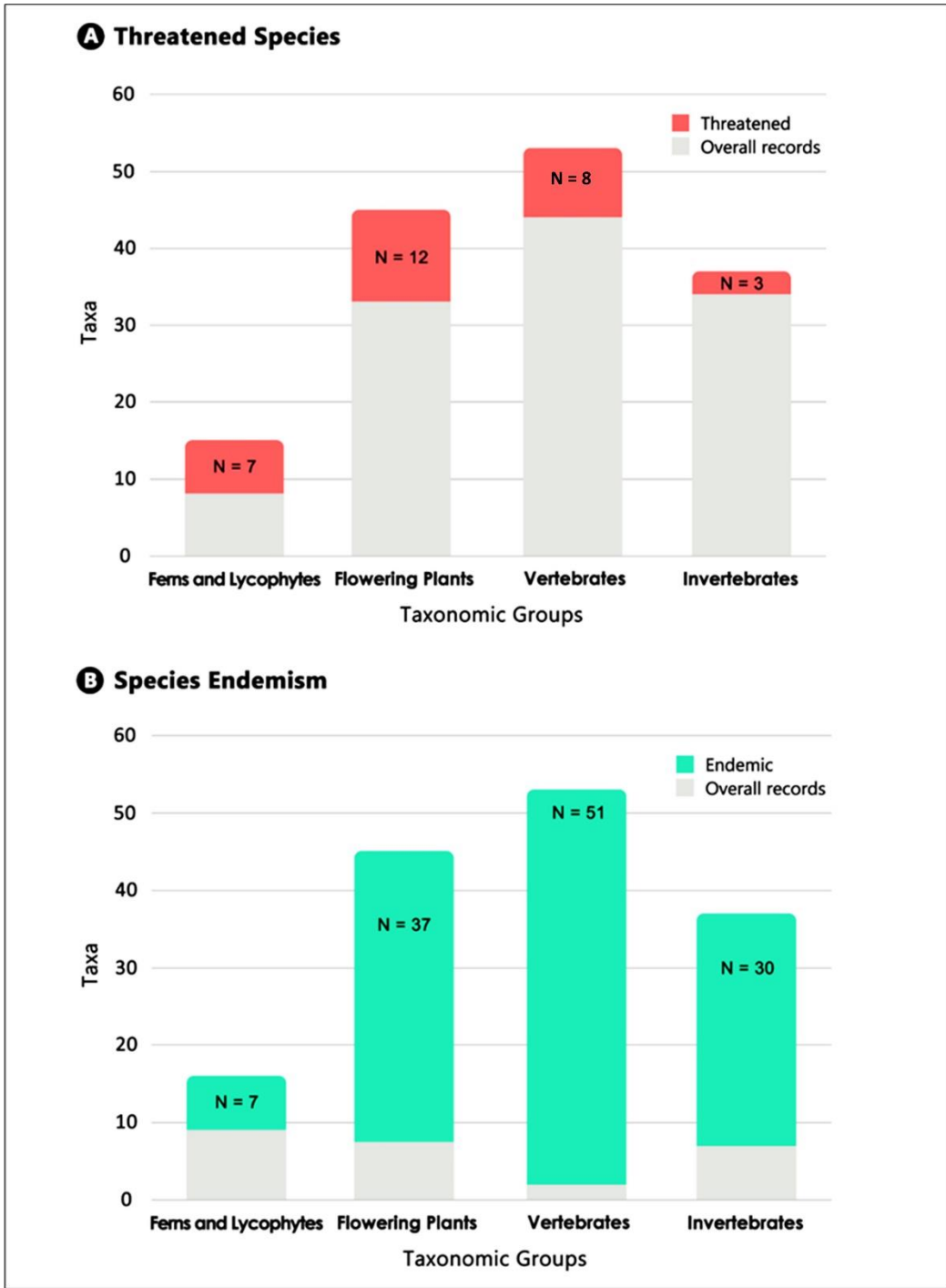
The assessment resulted in recording 31 species of threatened flora (N = 19 species; 12.6%) and fauna (N = 12 species; 7.9%) shown in Figure 5A. The documented threatened flora includes seven species of ferns and lycophytes and 12 species of flowering plants. The threatened ferns include the vulnerable *A. heraclea* (Kunze) Copel., *A. splendens* (J.Sm.) Copel., and *P. opaca* (C.Presl) J.Sm.; the endangered *S. glauca* (Blume) R.M.Tryon, *P. carinatus* (Desv. ex Poir.) Ching; and the critically endangered *H. zeylanica* (L.) Hook and *P. grande* (A.Cunn. ex Fée) J.Sm. Among the flowering plants, the threatened species consist of the vulnerable *D. dao* (Blanco) Merr. & Rolfe, *S. polysperma* (Blanco) Merr., *D. discolor* Willd., *D. philippinensis* A.DC, *M. grandifolia* (Blanco) Merr., and *C. williamsii* Elmer; and the endangered *P. cumingii* Merr. & Rolfe, *P. indicus* Willd., *S. toppingii* (Elmer) Merr., *A. leptocladus* Radlk., and *V. parviflora* Juss.; and the critically endangered *P. mindanaense* Merr. based on IUCN (2021-3), DENR DAO (2019-09) and Fernando et al. (2022).

Other recorded threatened species of plants include *D. solida* (G.Forst.) Sw., *A. evecta* (G.Forst.) Hoffm for ferns and *K. pinnatum* (Blanco) Merr., *C. ovatum* Engl., *C. mercadoi* S.Vidal, *L. philippinensis* Merr. and *P. caninum* Blume for flowering plants.

The faunistic survey recorded eight vertebrates and three invertebrates classified as threatened species (Figure 5A). These consist of (Table 3) the vulnerable *M. wetmorei* Taylor, 1934 for mammals, *B. philippensis* (Kaup, 1851) and *C. mindanensis* Steere, 1890, for birds, *H. pustulatus* Escholtz, 1829 for lizards, and *C. smaragdula* (Olivier, 1790), *M. apoensis* Schultze, 1925 and *M. geniculatus* Waterhouse, 1842 for beetles. *C. amboinensis* (Riche in Daudin, 1802) and *P. affinis* Tweeddale, 1877 are known as endangered species of turtle and bird, respectively; while *P. amethystinus* Bonaparte, 1855, and *L. philippensis* (Müller, 1776) are known as critically endangered species of birds based on IUCN (2021-3) and DENR DAO (2019-09).

The other threatened animal species include *N. samarensis* Peters, 1861 for vertebrates and *P. dehaani* (Doleschall, 1859), *P. illepidus* C. L. Koch, 1843, *P. baeri* (Simon, 1877), *C. fulminans cobaltina* Fisher, 1922, *P. buddha* (Hope, 1842), *C. atlas* Linnaeus, 1758, and *H. macleayi* (Kirby, 1818) for invertebrates.

Figure 5
The Species Composition and Conservation status of Threatened (5A) and Endemic (5B) Plants and Animals on Mount Agad-Agad



Endemic Flora and Fauna

The overall survey accounted for seven species of endemic ferns and lycophytes, 37 species of endemic flowering plants, 51 species of endemic vertebrates, and 30 species of endemic invertebrates (Figure 5B). Notable endemics that occur only on Mindanao island include the following plants: *A. evecta* (G.Forst.) Hoffm, *P. xiphioides* (Christ) Holttum, *H. apoensis* Kloppenb. & Siar., *B. malindangensis* Merr., *C. utile* Kosterm., *P. mindanaense* Merr., *A. leptocladus* Radlk., and *Z. matutumense* Mood & Theilade; and animals *T. semperi* Kraepelin, 1897, *M. apoensis* Schultze, 1925, *E. casiphonides casiphonides* Semper, 1892, *D. verrucifer* Stål, 1877 and *H. mindanaensis* Stål, 1877. This implies that Mount Agad-Agad, which is home to diverse threatened and endemic plants and animals, is an important habitat and refuge for flora and fauna that occur only in this region and are found nowhere else in the world.

Despite immense pressure on urbanization, habitat modification, and the introduction of invasive alien species of plants (*Sweitenia macrophylla* King., *Lantana camara* L., *Piper aduncum* L.) and animals (*Eleutherodactylus planirostris* (Cope, 1862), *Kaloula pulchra* (Gray, 1831), *Rhinella marina* (Linnaeus, 1758), and *Rhynchophorus ferrugineus* (Olivier, 1790)), numerous threatened and endemic terrestrial flora and fauna continue to take shelter in this massif.

Consequently, several ferns and lycophytes in the study of Coritico and Amoroso (2020) in four protected areas in Mindanao (i.e., Mount Hamiguitan, Mount Apo, Mount Kitanglad, and Mount Malindang) were also recorded on Mount Agad-Agad. These include the *Angiopteris evecta*, *Davallia solida*, *Sphaeropteris glauca*, *Phlegmariurus carinatus*, *Aglaoomorpha splendens*, and *Helmintostachys zeylanica*. In the case of *H. zeylanica*, previous reports accounted for the species as edible and mostly detected in muddy areas and of lower elevation (Ginantra et al. 2015; Manna et al. 2013). On Mount Agad-Agad, however, *H. zeylanica* is usually found under shaded areas and coconut trees. It was also locally reported to have medicinal uses.

Comparatively, floristic records on Mount Agad-Agad documented numerous endemic trees (>20 species) compared to the recent floristic study of Zapanta et al. (2019) in the disturbed habitats of Mount Apo Natural Park. These endemic trees include *Dillenia philippinensis*, *Vitex parviflora*, *Cinnamomum mercadoi*, and several other trees listed in the floristic accounts of this study.

Mount Agad-Agad houses about 3% of the unique endemic plants and animals in the entire country. The abundance of several seed dispersal species such as the endemic fruit bats and birds, and pollinators like birds, butterflies, and other bats validates

the thriving healthy population of terrestrial biodiversity on Mount Agad-Agad. It is also noteworthy that the present study documented two Mindanao Island endemic pygmy grasshoppers, the *D. verrucifer* (Stal, 1877) and the *H. mindanaensis* (Stal, 1877), the latter was first documented since its description.

CONCLUSION AND RECOMMENDATION

Comprehensive information on threatened and endemic flora and fauna demonstrates the significant biodiversity of Mount Agad-Agad and supports the endorsement of this massif as an important local conservation area (LCA). An urgent call for the implementation of long-term protection and local conservation initiatives is needed for this significant mountain ecosystem. Sustainable ecotourism development and eco-friendly livelihood are highly recommended. Safeguarding the ecosystem of Mount Agad-Agad would mean securing the vital biodiversity of Iligan City.

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