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Journal of Threatened Taxa

Open Access

10.11609/jott.2022.14.11.22039-22206

www.threatenedtaxa.org

26 November 2022 (Online & Print)

14(11): 22039-22206

ISSN 0974-7907 (Online)

ISSN 0974-7893 (Print)

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

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Cover: Mugger Crocodile basking on the banks of Savitri River at Mahad in Maharashtra, India. © Utkarsha M. Chavan.

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 November 2022 | 14(11): 22039–22057

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

https://doi.org/10.11609/jott.7640.14.11.22039-22057

#7640 | Received 01 September 2021 | Final received 20 September 2022 | Finally accepted 25 October 2022

OPEN ACCESS

COMMUNICATION

New records of pteridophytes in Mount Matutum Protected Landscape, South Central Mindanao, Philippines with notes on its economic value and conservation status

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Abstract: New records on distribution of pteridophytes in Mount Matutum Protected Landscape were documented. The species list was accounted with reference to specimen collections from various herbaria posted in digital databases and reliable literature on pteridophyte flora. Results further showed 105 new records for MMPL and its vicinity-South Cotabato, Sarangani province and General Santos City. From these, seven were new records for South Central Mindanao Region (Region 12). About 19 families, 56 genera were represented – 41 were epiphytes, 10 lithophytes, and 45 soil inhabitants, the rest with dual habits – two (ground and lithophytic); seven (epiphytic and lithophytic). Moreover, 11 species were found to be threatened based on national list while local conservation assessment based on relative frequency noted 91 threatened species. A conservation plan for these valuable species in the protected landscape is also proposed to ensure sound intervention and sustainable environment for this plant group.

Keywords: Ferns, General Santos, lycophytes, Matutum, protected area, Sarangani, South Cotabato.

Editor: K.P. Rajesh, The Zamorin's Guruvayurappan College (affiliated to University of Calicut), Kozhikode, Kerala, India. **Date of publication:** 26 November 2022 (online & print)

Citation: Galope-Obemio, C.D., I.E. Buot Jr. & M.C. Banaticla-Hilario (2022). New records of pteridophytes in Mount Matutum Protected Landscape, South Central Mindanao, Philippines with notes on its economic value and conservation status. *Journal of Threatened Taxa* 14(11): 22039–22057. https://doi.org/10.11609/jott.7640.14.11.22039-22057

Funding: Commission on Higher Education (CHED) Department of Science and Technology-Philippine Council for Agriculture, Aquatic and Natural Resources Research Division (DOST-PCAARRD) United States Agency for International Development (USAID) Protect Wildlife Project.

Competing interests: The authors declare no competing interests.

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Author contributions: Christine Dawn Obemio lead author. Assisted in the study conception and design, collected, analyzed data, interpreted the results and drafted the manuscript. Inocencio E. Buot, Jr. led the study conception and design. Assisted in the analysis of data and interpretation of results. Reviewed the draft manuscript and added critically important intellectual content. Maria Celeste Banaticla-Hilario assisted in study conception and design, analysis of data and interpretation of results and drafting the manuscript. Reviewed the draft manuscript and organized the flow of the discussion.

Acknowledgements: The authors would like to thank the Protected Area Superintendent (PASu) office of the Department of Environment and Natural Resources (DENR), South Cotabato, the Protected Area Management Board (PAMB) of Mount Matutum Protected Landscape, the Municipal Environment and Natural Resources Officer of Tupi and Polomolok, South Cotabato, the Municipal and Barangay Local Government Units (Barangay Glandang, Tupi, South Cotabato, and Barangay Palkan, Polomolok, South Cotabato), for their support in this study by granting the necessary permits, guiding the researchers before and during the conduct of the study and providing personnel assistance. This study will not also be possible without the help of the local community guides who led in navigating the protected area and our field assistants, Aljohn Jay Saavedra, and Henry Earl Tayco who aided in the collection and storage of samples. Gratitude is also given to the Commission on Higher Education (CHED), the Department of Science and Technology-Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCAARRD) and Protect Wildlife for providing grant assistance.

INTRODUCTION

A significant understory flora growing in the forest reserves are the pteridophytes or the ferns and lycophytes. These plants are widely distributed both in the tropical and temperate regions especially at higher elevations, and they flourish in moist, shaded habitats (Delos Angeles & Buot 2012). They are known to have high economic value as ornaments, food, and medicine, and are noted for its high ecological importance as indicators of environmental quality (Pouteau et al. 2016; Silva et al. 2018; Khine et al. 2019). Pteridophytes are also host to diverse faunal species (Ellwood & Foster 2004; Beaulieu et al. 2010; Scheffers et al. 2014). However, its richness and diversity are continuously challenged by geogenic and anthropogenic factors that lead to fragmentation and decrease in species over the years (Rodriguez et al. 2011; Silva et al. 2018). It is then very important to know the floristics of pteridophytes in the landscape to have a better understanding on appropriate conservation interventions.

The majestic Mount Matutum Protected Landscape (MMLP) in the South Cotabato, Sarangani and General Santos (SOCSARGEN) region of southern Mindanao, is an important source of pteridophyte diversity. In fact, the entire island of Mindanao has been explored for pteridophyte diversity and about 186 species were identified (Hassler 2004-2022). Meanwhile, 11 species were described and named bearing the epithets of *mindanaoensis, mindanensis* or *mindanaense* – *Adiantum mindanaense, Alsophila mindanensis, Cyclosorus mindanaensis, Thelypteris mindanaensis, Microsorum mindanense, Polypodium mindanense, Polypodium punctatum* ssp. *mindanense, Polypodium punctatum* var. *mindanense, Selaginella mindanaoensis, Tectaria mindanaensis,* and *Aenigmopteris mindanaensis* (Hassler 2004-2022). Though all of these except *A. mindanaense* were already considered synonyms, it still highlights the significant flora in this southern part of the country.

Mount Matutum was declared as protected area in 1995 through the Presidential Proclamation 552, and included in the rooster of Key Biodiversity Areas (KBAs) (Conservation International - Philippines, Haribon Foundation and the Department of Environment and Natural Resources) and Important Bird Areas (IBAs) (Birdlife International 2018) making it a priority site for conservation. It holds forest wealth of significant flora, largely unexplored that could potentially be lost together with the ecosystem services they provide, with influx of population in the surrounding communities.

Scientific studies on Mt. Matutum's biodiversity have been scarce with only a handful published accounts on trees (Obemio et al. 2016), and bryophytes (Azuelo et al. 2016). Similarly, assessments on its faunal resource were limited to anurans (Nuñeza et al. 2017a), reptiles (Nuñeza et al. 2017b), avians (Nuñeza et al. 2019), and bats (Nuñeza et al. 2015). Until this time, these remained the only published accounts for Mt. Matutum.

Interestingly, the earliest pteridophyte exploration in the protected area dates back to more than a hundred years ago (1917) by Copeland where he observed about 99 species. Among these, *Gleichenia peltophora* and *Diplazium calliphyllum* are known in the Philippines from this site only. Also, three species, though currently treated as synonyms, were named after the landscape, namely, *Ctenopteris matutumensis, Dryopteris matutumensis*, and *Selliguea matutumensis*. However, a concerted effort on documenting the Pteridophyte flora of the area remains unfinished.

The present attempt is thus the first of its kind in collating the details from various sources, including data from various herbaria and on recent field studies. It also seeks to present the economic uses associated with the pteridophytes and develop a local conservation status for each as many were not yet assessed with reference to the threatened list by the International Union for the Conservation of Nature (IUCN). As this study is the first attempt to document a more comprehensive account of the pteridophytes in the protected area, a lot of species then are new records for Mount Matutum and its vicinity – south central Mindanao region. The feature of these species is a remarkable milestone for MMPL and a significant step towards strengthening conservation interventions in the protected area. The authors seek to address the gap of an updated floristics and new records of pteridophytes in MMPL that would be crucial in their integration to conservation management as they are inevitably part of the ecosystem and function to enhance stability, resiliency, and sustainability of the landscape. This in turn cascade to the communities in form of ecosystem services, highlighting its conservation value.

MATERIALS AND METHODS

Study Area

Mount Matutum Protected Landscape (MMPL) is an important landmark and ecological watershed of South Cotabato and Sarangani Provinces in Southern Mindanao. It is surrounded by four municipalities (three

in South Cotabato; one Sarangani Province) and 14 barangays (12 South Cotabato, two Sarangani Province). A stratovolcano, this landscape stands to about 2,286 m, covering an approximate area of 14,000 ha of forestland, with 3,000 ha of a primary forest. A community of vascular (trees, pines, ferns) and non-vascular (mosses, liverworts, hornworts) plants thrive in this this primary forest.

The climate in the northwestern and southwestern parts of this protected area is tropical with significant rainfall throughout the year even in the driest months. It is classified as Type IV with reference to Philippine-climate types and tropical wet (Af category) based on the worldwide Köppen-Geiger. Monthly temperature variations are no greater than three degrees Celsius characterized by intense surface heating and high humidity resulting to daily formation of cumulus and cumulonimbus. These conditions favor the growth of different kinds of ferns and fern allies, which greatly prefer shaded and damp habitats. Moreover, the presence of rocky environments, slopes, and host trees make this landscape a host to diverse species of pteridophytes.

Field Methods

Assessment was done following the method of Banaticla & Buot (2004) and Delos Angeles & Buot (2015). A line transect of 10–20 m, depending on the heterogeneity of pteridophyte patches, was established. At least one transect was assessed for every 100 m elevation range. All fern and lycophytes along the transect were documented including epiphytes observed below 2.5 m.

Two sites in MMPL were considered as study areas to represent its northwestern slope (Image 1). Site 1 was in the municipality of Tupi, South Cotabato, accessible through the Glandang Trail (6.3505^{0}N, 125.0570^{0}E) while site 2 was in the municipality of Polomolok, South Cotabato, around the Keumang-Alnamang trail (6.3300^{0}N, 125.0605^{0}E).

A total 92 transects were subjected for sampling, Site 1 with 52 and Site 2 with 40 transects. Composition of ferns and fern allies were listed in every transect. Voucher specimens were collected in duplicate to triplicate whenever possible. Geographic location and elevation were determined using a geographic positioning system (GPS) device.

Laboratory Methods

Voucher preparation and identification

Collected specimens from MMPL were pressed and mounted in herbarium sheets. The herbarium specimens were stored, labeled, and prepared for distribution in Mindanao State University-General Santos City and Plant Biology Division, Institute of Biological Sciences, UPLB herbaria. Taxonomic identification and determination of distribution records were done using relevant taxonomic literature - Copeland (1958) and online databases (Pteridoportal: https://www.pteridoportal.org/portal/index.php, Co's Digital Flora: https://www.philippineplants.org/, Ferns of the World: https://www.fernsoftheworld.com/). Experts in the field – Barbara Parris (Fern Research Foundation), Fulgent Coritico (Central Mindanao University, Bukidnon, Northern Mindanao), Cherie Cano (University of Southern Mindanao, Kabacan, North Cotabato), were also consulted to validate the specimen identification. Based on these the new records, new distribution and rediscovered pteridophyte species in Mount Matutum and its vicinity - surrounding provinces of South Cotabato, Sarangani Province and city of General Santos were identified.

New records were evaluated and described with reference to relevant literature and database information. Key literature were the Fern Flora of the Philippines (Copeland 1958), and others such as Ebihara et al. (2006), Lehtonen et al. (2013), Parris & Sundue (2020). Database searches were also made through Cos Digital Flora of the Philippines (Pelser et al. 2011 in www.philippineplants.org), Catalogue of Life (Species 2020) (www.catalogueoflife.org), Flora of China (www.efloras.org) and Pteridoportal (Pteridophyte Collections Consortium) (www.pteridoportal.org) World Ferns (Hassler 2004–2022) and Flora Malesiana – www.floramalesiana.org (accessed 27 April 2018).

The conservation status of new records was determined from International Union for the Conservation of Nature (IUCN) Threatened List version 2021 from www.iucn.org, and the Department of Environment and Natural Resources (DENR) Administrative Orders (DAO) 2017–11 which features the Updated List of Threatened Philippine Plants and their Categories.

Local Conservation Assessment

Local assessment of conservation was done using the relative frequency of species distribution in MMPL with reference to the work of Villanueva and Buot (2020). Relative frequency (RF) was determined by the ratio of the number of transects where the species were observed and the total number of transects. Frequency below < 0.1% was considered critically endangered (CR), > 0.1 – 0.4% endangered (EN), > 0.4 – 0.7 vulnerable (VU),

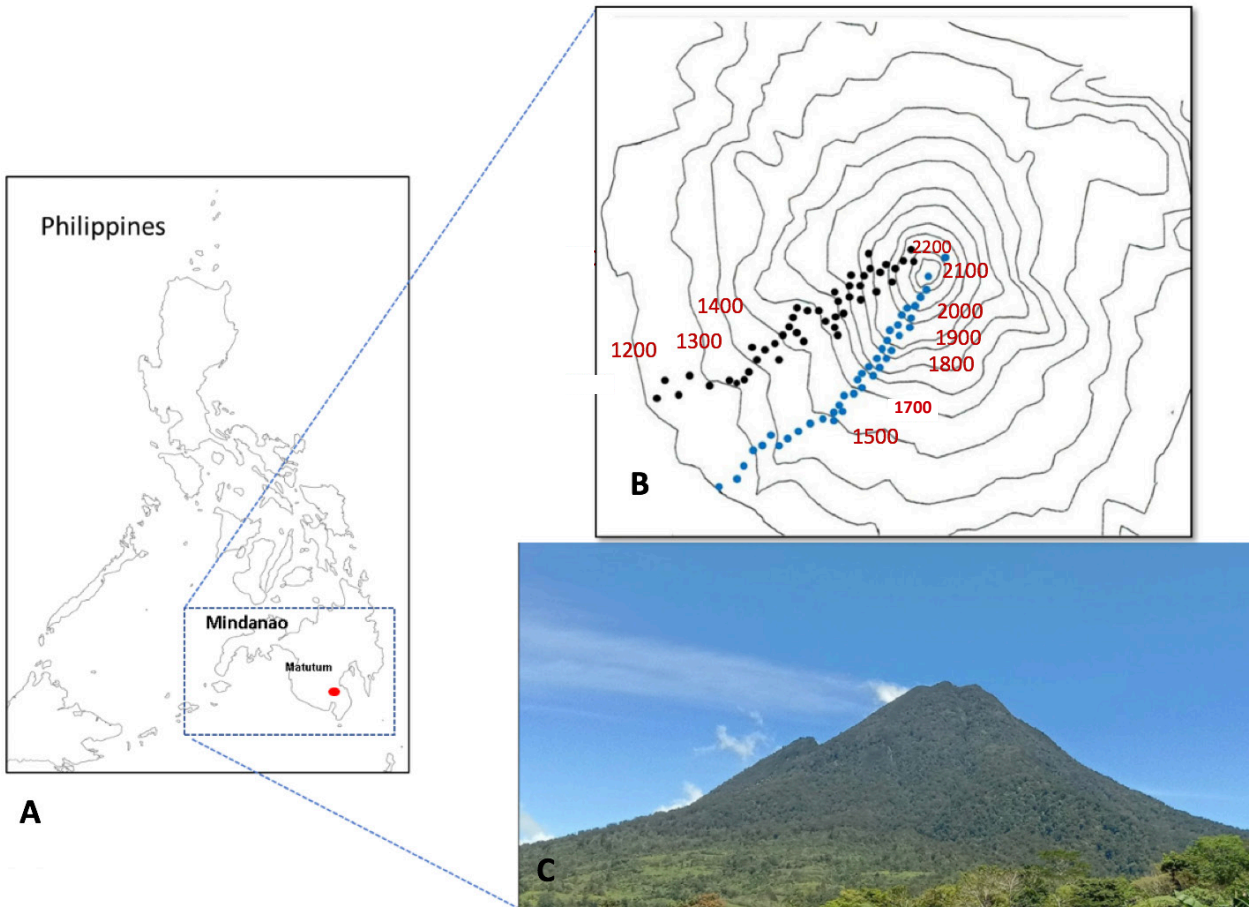

Figure 1. Study Site: A—Location of Mount Matutum in Mindanao | B—Sampling sites in the North-West aspect of Mount Matutum | C—A view of Mount Matutum Protected Landscape.

0.7 -1 nearly threatened (NT), and > 1 least concerned (LC). This local assessment highlighted the conservation status of those species found in MMPL that were not yet assessed in IUCN nor identified in DAO (2017–11).

RESULTS AND DISCUSSION

New Records in Mount Matutum Protected Landscape (MMPL)

Earlier studies recorded about 160 pteridophytes in Mount Matutum (Copeland 1917; Gaerlan et al. 1992; Gonzales 2001; Mindanao State University-General Santos City 2013), while this present undertaking adds another 105 taxa, totaling to 265 species in the Matutum area. Of these, 12 were lycophytes while 93 were monilophytes (ferns). As to habit, 45 were terrestrial, 41 epiphytes, 10 lithophytes and the rest showed dual habits such as terrestrial & lithophytic (two species) and epiphytic & lithophytic (seven species) (Table 1).

Copeland (1917) observed 57 ferns which were highlighted in his work on Fern Flora of the Philippines. Seventy-five years later, Gaerlan et al. (1992) collected 24 species as part of the biodiversity inventory of Philippine National Musuem. The next assessment was done in 2001 by Dr. Gonzales which showed 188 species and so far, the largest collection prior to this study. Meanwhile, MSU-GSC did an assessment in the lowland forest in 2013 and enlisted about 42 species. The works of Dr. Gonzales and MSU-GSC were unpublished records.

On the opposite side of MMPL, in Mount Busa, Kiamba, Sarangani Province, about 114 pteridophytes were observed from the exploration by Barcelona & Busemeyer (1993) based on digitized herbarium specimen collections from Miami University, Willard Sherman Turrell Herbarium (MU) and National Museum of Natural History-US Botany published in Pteridophyte Collections Consortium (www.pteridoportal.org). Meanwhile, in the Allah Valley Protected Landscape, northern part of MMPL, no records of pteridophytes have been known yet.

Interesting new records are the *Athyrium nakanoi,*

Table 1. Composition of new records in MMPL (with exsiccatae) and description of their spot characters and habit.

Families and species composition (Common Name)	Description	Habit	Exsiccata
I. Lycopodiopsida (Fern Allies)			
1. Lycopodiaceae			
Huperzia javanica (Sw.) Fraser-Jenk. (Fir clubmosses)	Stem ascending, dichotomously branched, leaves whorled, narrowly elliptic, margin serrate, apex caudate, spores trilete	Epiphyte.	OBEMIO453MSU
Lycopodium clavatum L. (Common clubmoss)	Stem creeping with erect tips, dichotomously branched of unequal length, leaves small, moss-like, spirally arranged, dimorphic strobili, adventitious roots present	Ground.	OBEMIO587MSU
Phlegmariurus delbrueckii A.R. Field & Bostock (Tassel fern)	Pinnate, leaves alternate, compact, ovate-obtuse, 3 mm wide x 5 mm long, apex rounded-cuspidate, base cuneate, strobili dichotomous 20–35 mm, straight	Epiphyte	OBEMIO451MSU
Phlegmariurus verticullatus (L.f) A.R. Field (Tassel fern)	Stems dichotomously branching, leaves bristle-like, strobili terminal	Epiphyte	OBEMIO419MSU
Pseudodiphasium volubile (G. Forst.) Holub	Scrambling, horizontal stems, spreading, numerous dichotomous branching, dimorphic, fertile stems with short linear leaves, pendulous strobili at tip, sterile leaves widely spaced, linear-peltate.	Ground.	OBEMIO555MSU
2. Selaginellaceae			
Selaginella boninensis Baker (Spikemoss)	Stems long, creeping, large leaves oblong, alternate small leaves ovate, spiral, apex acute, base rounded, rhizophore filiform	Lithophyte	OBEMIO485MSU
Selaginella biformis A. Br. ex Kuhn (Spikemoss)	Stems long, creeping, branched on upper part, stramineous, primary leafy branches flattened, ovate, leaves on stem ovate-lanceolate, apex acute, base rounded, rhizophore on rhizomes	Lithophyte	OBEMIO549MSU
Selaginella engleri Hieron (Spikemoss)	Stems erect, fronds bipinnate, alternate, pinna ovate, sporangia at tips of fertile pinna, branched microphylls contiguous	Ground	OBEMIO7396PBDH
Selaginella gastrophylla Warb. (Spikemoss)	Stems erect, fronds bipinnate, alternate, pinna ovate, leaves on stems unappressed, widely spaced, microphylls not contiguous, sporangia at tips of fertile pinna, cylindrical	Ground	OBEMIO488MSU
Selaginella involvens (Sw.) Spring (Spikemoss)	Stems erect, leaves on stems scale-like, pale yellow, median stems branched, fronds pinnate, ovate-triangular, ventral leaves contiguous, sporangia terminal	Lithophyte	OBEMIO486MSU
Selaginella remotifolia Spring (Spikemoss)	Stems branched from base; secondary branches forked. Fronds pinnate, axillary leaves ovate, acute, leaves on branches elliptic-lanceolate, not overlapping	Ground	OBEMIO489MSU
II. Polypodiopsida (Ferns)			
1. Aspleniaceae			
Asplenium affine Sw.	Pinnatifid-bipinnatifid.alternate, opposite at base, petiolulate, lobed, acuminate apex, pinnules aternate, rounded apex, cuneate base, stalked, acroscopic pinnules smaller, lower pinnules more lobed. Sori linear forming V shape over lamina veins	Lithophyte	OBEMIO052MSU
Asplenium cuneatum Lam.	Lamina ovate. Pinna triangular, apex aristate, base convex, pinnules fan-shape, basal pinnules larger, lobed, apex toothed, base convex-truncate, actinodromous. Sori linear 3–4 interspersed over veins	Epiphyte	OBEMIO053MSU
Asplenium elmeri Christ	Stipe clumped or solitary, Lamina bipinnate, ovate, alternate, pinnules alternate, basal pinnule larger, fan-shaped. Sori laminar, linear, single or paired at segments.	Lithophyte	OBEMIO056MSU
Asplenium horridum Kaulf. (Lacy spleenwort)	Stipe scaly, lamina pinnate, alternate, lobes cut down halfway the costa, margin with deep sinuses, pinna linear-lanceolate, apex attenuate, base convex. Sori linear parallel and very near the costa	Ground	OBEMIO074MSU
Asplenium laserpitiifolium Lam.	Lamina tripinnate, alternate, pinnae ovate, pinnules obovate, rachis dark brown, apex acute, base cuneate. Sori linear incline over veinlets.	Epiphyte	OBEMIO7283PBDH
Asplenium lobulatum Mett.	Stipe clumped (2 or more), Lamina pinnate, triangular, acuminate apex, truncate base, basiscopic pinna opposite, acroscopic subopposite, reduced, pinnules lanceolate, acuminate, truncate-cuneate-convex base, margin serrate. Some basal pinnules forming prominent lobes on one side of the blade. Sori linear, inclined close to midrib	Epiphyte	OBEMIO169MSU

Families and species composition (Common Name)	Description	Habit	Exsiccata
Asplenium longissimum Blume (Spleenwort)	Pinnate, ovate, attenuate apex, base, truncate, pinna alternate, stalked or sessile, apex attenuate, base truncate-convex. Sori linear dark-brown inclined close to costa	Ground	OBEMIO7395PBDH
Asplenium pellucidum Lam.	Stipe clumped, Lamina elliptic, pinna lanceolate-triangular, leaf base covering rachis on the ventral side, margin lobed, apex acute, base truncate. Sori linear inclined with ends touching the costa	Epiphyte	OBEMIO303MSU
Hymenasplenium excisum (C. Presl) S. Linds.	Pinnate, thin, papyraceous, wedge-shape, rounded apex, truncate base, toothed, unlobed, sori linear over veinlets, 2 venation cladodromous, decurrent attachment, stele haplostele, x-shape xylem.	Epiphyte	OBEMIO049MSU
Hymenasplenium subnormale Copel.	Pinnate, lamina ovate-triangular, cordate base, attenuate apex, pinna ovate reduced at apex, opposite-subopposite, rounded apex, truncate base., sori linear, inclined halfway from costa	Lithophyte	OBEMIO7379PBDH
2. Athyriaceae			
Athyrium puncticaule (Blume) T. Moore (Lady fern)	Evergreen pinnatifid, Lamina triangular-lanceolate, pinna stalked, margins serrate, apex acute, base cuneate, basiscopic pinna strongly auriculate. Sori medial on the veins, round	Ground	OBEMIO7252PBDH
Athyrium nakanoi Makino (Lady fern)	Evergreen, rhizome creeping-ascending, erect, frond solitary or caespitose, bipinnate, lamina papyraceous, pinnae linear-lanceolate,pinnules, pinnatifid, deltoid, apex acuminate, base truncate, basal pinnules ovate-lanceolate.margin shallowly lobed. Sori continuous, U-shape, over tertiary veins	Ground	OBEMIO7251PBDH
Cornopteris banaohensis (C. Chr.) K. Iwats. & M.G.Price	Stipe clumped, frond coriaceous, short, Lamina short, papyraceous, lower pinna bipinnatisect, opposite, larger than acroscopic pinna. Pinna apex acuminate, pinnules cuneate, base truncate, dissection almost to the midrib. Sori parallels the midrib, bright orange	Ground	OBEMIO7253PBDH
Diplazium dilatatum Blume (Twinsorus ferns)	Fronds pinnate-bipinnatifid, lamina dark green adaxially, pinna opposite-sub-opposite, sessile-subsessile, acroscopic pinna smaller, less lobed, base of pinnule wider, apex acuminate, base truncate. Sori linear inclined along costa forming v-shape	Ground	OBEMIO235MSU
Diplazium geophilum Alderw. (Twinsorus ferns)	Evergreen. pinnate, lamina ovate, pinnae short-stalked, wide ovate, rounded-acute apex, base of the pinna asymmetric, deeply-lobed. Sori linear grooved over craspedodromous veinlets.	Ground	OBEMIO225MSU
Diplazium sorzogonense (C. Presl.) C. Presl. (Twinsorus ferns)	Stipe clumped, fronds pinnatifid, pinnae oblong-triangular, apex acuminate, base cuneate, basal and apical segments reduced. Sori linear, on veinlets half-way to margin	Ground	OBEMIO602MSU
3. Cyatheaceae			
Alsophila apoensis (Copel) R.M. Tryon (Tree fern)	Tree fern. Tripinnatifid, Frond glabrescent, coriaceous, pinnules sessile, oblong, short acuminate, segments serrulate toward apex. Sori costal, globose	Ground	OBEMIO7255PBDH
Alsophila hermannii R.M. Tryon (Tree fern)	Tree fern. Tripinnatifid, Frond glabrescent, coriaceous, pinnules sessile, triangular, caudate, truncate, serrulate toward apex. Sori costal, globose	Ground	OBEMIO7256PBDH
Alsophila heterochlamydea (Copel.) R.M. Tryon (Tree fern)	Tree fern. Tripinnatifid, Pinnules sessile, pinnate at base, segments oblong, serrulate at apex. Sori costal, obsolete.	Ground	OBEMIO016MSU
Sphaeropteris elmeri (Copel) R.M. Tryon (Tree fern)	Tree fern. Tripinnate. Pinnules triangular, apex caudate, base truncate, segments, oblong, apex rounded, thin, papyraceous. Sori costal, small, circular on sides of secondary veins	Ground	OBEMIO177MSU
Sphaeropteris glauca (Blume) R.M. Tryon (Tree fern)	Tree fern. Tripinnate. Pinnules triangular, acuminate apex, truncate base, untoothed, segments oblong, papyraceous, rounded apex, sessile, up to 14 veins on a side. Sori costal, globose about 7 pairs	Ground	OBEMIO029MSU
Sphaeropteris lepifera (J.Sm. ex Hook.) Copel. (Tree fern)	Tree ferns. Tripinnate, Pinnules short-stalked, oblong, truncate base, segments pinnate, linear, acute apex. Sori costal, globose	Ground	OBEMIO7257PBDH
4. Dennstaedtiaceae			
Histiopteris incisa (Thunb.) J.Sm. (Bat's wing fern)	Rhizome robust, creeping, fronds widely spaced, widely ovate slightly dimorphic with fertile lobes slightly narrower, pinnae pale green, opposite, wide-angle with deep lobation on margins, sori marginal continuous, linear and exindusiate surrounded by reflexed leaf margin.	Ground	OBEMIO7258PBDH

Families and species composition (Common Name)	Description	Habit	Exsiccata
Miicrolepia strigosa (Thunb.) C. Presl (Lace Fern)	Fronds wide-ovate, bipinnatifid, pinnae alternate, attenuate apex, convex base, pinnules subsessile,	Ground	OBEMIO7259PBDH
Monachosorum henryi Christ	Rhizome erect. Lamina ovate-triangular, pinna oblong, pinnules ovate-lanceolate, base truncate-round, thin, basal pinnules more lobed, apical pinnules more lanceolate, sori circular at vein ends, petiole round, solenostele stele, 2-linear vascular bundles	Ground.	OBEMIO176MSU
5. Dicksoniaceae			
Dicksonia amorosoana Lehnert & Coritico (Amoroso's wooly tree fern)	Ground tree fern. tripinnatifid, lamina dark green adaxially, light green abaxially, pinna subsessile, lanceolate, base truncate, attentuate apex, basal segmentshorter, sori circular, spores globose	Ground.	OBEMIO7260PBDH
6. Dryopteridaceae			
Arachniodes amabilis (Blume) Tindale	Rhizome creeping, Fronds oblong-ovate, bipinnate, coriaceous, acroscopic pinnules reduced, apex caudate, base cuneate. Sori terminal on veinlets	Ground, Lithophyte	OBEMIO7325PBDH
Bolbitis heteroclita (C. Presl) Ching	Rhizome horizontal. Frond odd-pinnate, opposite, apical lamina larger, elliptic, caudate apex, cuneate base, margin crenose, dimorphic, secondary veins brochidodromous, tertiary veins reticulate, opposite-subopposite, tertiary veins. Sori naked covering fertile blades	Epiphyte	OBEMIO7261PBDH
Dryopteris hendersonii (Bedd.) C. Chr. (Wood fern).	Tripinnatifid. Fronds wide ovate, pinnae alternate, base pinnae larger, pinnules triangular-oblong, acuminate apex, truncate-oblique base, lobe, apex toothed. Sori round, indusiate	Ground	OBEMIO484MSU
Dryopteris purpurascens (Blume) Christ (Wood fern).	Frond pinnatisect-bipinnatisect, alternate, pinnae triangular, apex acuminate with alternate tooth along margins, pinnules triangular, acuminate apex, rounded base, base pinnules of larger pinna pinnate, toothed, acroscopic pinnules toothed. Sori costal, round, side by side the midvein.	Ground	OBEMIO502MSU
Dryopteris permagna M. Price (Wood fern).	Ground, bipinnatifid on acroscopoc pinna tripinnatifid on lower pinna, alternate, triangular, acuminate apex, base truncate, acroscopic segments pinnatisect, lower to middle segments serrate. Sori round, parallel along midrib and secondary veins	Ground	OBEMIO7262PBDH
Polystichum moluccense T. Moore	Tripinnate, alternate, dark green adaxial, pinnae oblong, acuminate apex, rounded base, pinnules thick, rough, ovate-triangular, base lobed, truncate-oblique, apex acute, toothed. Sori round, laminar over veinlet tips	Epiphyte	OBEMIO393MSU
Polystichum elmeri Copel.	Bipinnate, alternate, light green on adaxial, pinnae oblong, acuminate apex, convex base, pinnules thick, rough, ovate, base truncate-oblique.	Epiphyte	OBEMIO5833MSU
Teratophyllum aculeatum (Blume) Mett. ex Kuhn	Bathyphylls pinnate-bipinnate, alternate, dichotomously branched, rhizome creeping. Lamina pinnate, lanceolate. Fertile pinnae alternate, linear. Sori continuous covering entire blade of fertile leaf.	Epiphyte/ Climber	OBEMIO7263PBDH
7. Hymenophyllaceae			
Abrodictyum pluma (Hook.) Ebihara & K. Iwats.	Rhizome creeping. Fronds tufted, alternate, oblong, opposite at base, pinna reduced, needle-like middle pinna larger, segments clumped, dichotomous tips. Sori cup-shape at vein ends of basal segments.	Epiphyte	OBEMIO468MSU
Abdrodictyum obscurum (Blume) Ebihara & K. Iwats.	Rhizome creeping, stipe dark or light brown, lamina tripinnate-quadripinnate, herbaceous, triangular-ovate, pinnae oblong-ovate, apex obtuse-acute, widely-tooth, base cuneate. Sori apical on some segments, involucres cylindrical.	Lithophyte	OBEMIO469MSU
Crepidomanes minutum (Blume) K. Iwats.	Rhizome branching, stipe dark brown, lamina ovate, base cuneate, thin filmy, entire, segments linear, apex obtuse, base rounded-cordate. Involucres funnelform	Lithophyte	OBEMIO7264PBDH
Crepidomanes grande (Copel.) Ebihara & K. Iwats.	Rhizome short, erect, tufted fronds, lamina quadipinnate, ovate-oblong, Sori tubular on distal part of fronds	Ground, Lithophyte	OBEMIO735MSU
Hymenophyllum ramosii Copel. (Filmy fern)	Rhizomes long, creeping, lamina pinnate-tripinnatifid, elliptic-triangular, alternate, pinna ovate, Sori bud-shape on apical portion of lamina	Epiphyte	OBEMIO616MSU
Hymenophyllum denticulatum Sw. (Filmy fern)	Rhizomes long, creeping, rachis narrowly-winged, toothed, lamina bipinnatifid, pinnae alternate, wide-ovate, margins wide-serrate, veins prominent at abaxial portion. Sori cup-shape at tips of acroscopic segments	Epiphyte, Lithophyte	OBEMIO546MSU

Families and species composition (Common Name)	Description	Habit	Exsiccata
Hymenophyllum fimbriatum J. Sm (Filmy fern)	Rhizomes long, creeping, rachis narrowly-winged entire nearly toward the base, alternate, elliptic, pinna ovate pinnatisect, Sori at tip of acroscopic segments with slightly extruded involucres	Epiphyte, Lithophyte	OBEMIO545MSU
Hymenophyllum holochilum (Bosch) C. Chr. (Filmy fern)	Rhizome long, creeping, rachis narrowly-winged almost inconspicuous, pinnatifid, alternate, margins toothed, elliptic, pinnae deltoid, sparsely toothed, unequally cuneate-oblique. Sori on acroscopic segments, involucres elongate-elliptic, receptacles exserted.	Epiphyte, Lithophyte	OBEMIO7266PBDH
Hymenophyllum imbricatum Blume (Filmy fern)	Rhizomes, long, creeping, bipinnatifid, stipe and rachis winged, lamina bipinnatifid, alternate, wide space between pinnae, pinnae wide-ovate, terminal segments filiform margin entire, sori involucre wide, round.	Epiphyte	OBEMIO544MSU
Hymenophyllum nitidulum (Bosch) Ebihara & K. Iwats. (Filmy fern)	Rhizomes long, creeping, filiform, stipes almost wingless, lamina obovate, dichotomously lobed, dissected at base, lobes linear or forked. Sori terminal on lobes, involucres deltoid-like, sunken	Epiphyte	OBEMIO736MSU
Hymenophyllum pallidum (Blume) Ebihara & K. Iwats. (Filmy fern)	Rhizomes long, creeping, stipes hairy at base, lamina bipinnatifid, oblong, obtuse apex, cuneate base, pinnae alternate, sessile, ovate. Sori terminal on acroscopic pinnae, enclosed	Epiphyte, Lithophyte	OBEMIO547MSU
Hymenophyllum serrulatum (C. Presl) C. Chr. (Filmy fern)	Rhizome, long, creeping, stipe hairy, wingless, lamina translucent, ovate, bipinnatifid-tripinnatifid, pinna alternate, oblong-ovate,stalked, apex round, lobed. Sori axillary on acroscopic portion	Epiphyte	OBEMIO601MSU
Hymenophyllum thiudium Harrington (Filmy fern)	Rhizome, long, creeping, stipe narrowly winged, lamina bipinnatifid-tripinnatifid, pinna alternate, ovate, sori at terminal tips of ultimate segments, involucres capitate.	Epiphyte	OBEMIO7268PBDH
Vandenboschia auriculata (Blume) Copel.	Frond creeping, alternate, oblong, petiolulate, basal pinnules wider, wide ovate. Sori apical on acroscopic segments.	Epiphyte	OBEMIO7269PBDH
8. Hypodematiaceae			
Leucostegia truncata (D. Don) Fraser-Jenk.	Fronds tripinnate, ovate, coriaceous, pinna alternate, triangular, size increasing toward base, pinnules ovate-triangular, apex acuminate, base convex, basal segments in basal pinnae deeply lobed, widely ovate, rounded base, obtuse apex. Sori kidney-shaped on veinlet ends.	Ground	OBEMIO347MSU
9. Lindsaceae			
Odontosoria retusa (Cav.) J. Sm.	Fronds tripinnate-pinnate, pinnae alternate, ovate, stalked decurrent to rachis, acuminate apex, base convex, pinnules fan-shape, stalked, truncate apex, cuneate base.Sori linear on apex of pinnules in false indusium	Ground	OBEMIO737MSU
Tapeinidium pinnatum (Cav.) C. Chr.	Rhizome short, creeping, fronds pinnate, elliptic-oblong, papyraceous, pinna linear, apex acuminate, subsessile, rachis stramineous, margin shallowly crenate, apex acuminate, base cuneate. Sori submarginal on vein ends, cup-shape indusia	Ground	OBEMIO7274PBDH
Tapeinidium gracile (Blume) Alderw.	Rhizome short, creeping, fronds ovate, alternate, pinna elliptic-linear, acuminate apex, rounded base, upper pinna pinnatifid, lower pinnules pinnatifid, linear. Sori round, marginal	Ground	OBEMIO738MSU
Lindsaea pulchella (J. Sm.) Mett. ex Kuhn	Rhizome long, creeping, fronds linear, acuminate apex, papyraceous, lower pinnae opposite, upper sub-opposite, triangular, truncate apex, cuneate base. Sori submarginal on vein ends.	Epiphyte, Climber	OBEMIO7270PBDH
Osmolindsaea odorata (Roxb.) Lehtonen & Lehtonen	Rhizome short, creeping, fronds pinnate, lamina wide, lanceolate, pinnae alternate, truncate apex, slightly lobed convex base. Sori marginal, elongated, interrupted	Lithophyte	OBEMIO739MSU
10. Marratiaceae			
Angiopteris evecta Sw. (Giant fern)	Fronds tripinnate, alternate, pinna elliptic-oblong, fleshy, pinnules stalked, apex acuminate, serrate, rounded base, margin crenose, Sori submarginal, oval shape.	Ground	OBEMIO7275PBDH
Ptisana pellucida (C. Presl) Murdock	Fronds bipinnate, alternate, fleshy, pinna ovate, pinnules lanceolate, apex acuminate, base rounded, margins serrate. Sori oval, submarginal.	Ground	OBEMIO428MSU

Families and species composition (Common Name)	Description	Habit	Exsiccata
11. Oleandraceae			
Oleandra sibbaldi Grev.	Rhizome long-creeping, fronds elliptic, base cuneate, apex acuminate, membranous, with sparse catenate hairs, costa, hairy, darker on lower surface. Sori inframedial, reniform.	Epiphyte	OBEMIO091MSU
12. Ophioglossaceae			
Botrychium daucifolium Wall. ex Hook. & Grev. (Moonwort)	Rhizome erect, lamina bipinnate, pinnate to bipinnate, herbaceous, pinnae alternate-subopposite, short stalked or subsessile, triangular, pinnules ovate, apex acute-acuminate, base rounded, serrate, basal pinnules lobed. Sori round on separate fertile stalks	Ground	OBEMIO7276PBDH
13. Plagiogyriaceae			
Plagiogyria glauca (Blume) Mett.	Pinnate, Fronds ovate, pinna linear, acuminate, base truncate, subsessile, glaucous ventral surface, adaxial surface green, margin serrate. Sori tetrahedral	Ground, Lithophyte	OBEMIO473MSU
14. Polypodiaceae			
Calymmodon gracillimus (Copel.) Nakai ex H. Itô	Small, caespitose, linear, segments alternate, triangular, up to 2mm. Sori round numerous enclosed by folds of margin.	Epiphyte	OBEMIO7277 PBDH
Chrysogrammitis glandulosa (J.Sm.) Parris	Pinnatisect. Lamina lanceolate, apex acute, base cuneate. Segments triangular, larger at middle, decreasing toward apex. Sori round, 1 in acroscopic segments, 2-3 along middle segments.	Epiphyte	OBEMIO033MSU
Drynaria aglaomoprha Christenh (Oak leaf fern)	Pinnatisect, dimorphic, coriaceaous, margin crenose. Sori continuous, oval-square-shaped almost filling the segment	Epiphyte, Lithophyte	OBEMIO7279 PBDH
Drynaria descensa Copel. (Oak leaf fern)	Pinnatisect, dimorphic, coriaceous, margin crenose. Sori circular scattered on abaxial surface	Epiphyte, Lithophyte	OBEMIO7280PBDH
Dasygrammitis malaccana (Baker) Parris (Shaggy fern)	Stipe clumped, fronds pinnate, lanceolate-oblong, aristate, base cuneate, pinna alternate-sub-opposite, sessile, linear, apex rounded. Sori continuous on apical portion of pinna	Epiphyte	OBEMIO740MSU
Goniophlebium subauriculatum (Blume) C. Presl (Lacy Pine Fern)	Pinnate, alternate, pinna linear, light green, apex acuminate, base auriculate, short-stalked, margin mildly serrate. Sori globose, parallel with midrib, within reticulate veinlets	Epiphyte	OBEMIO467MSU
Goniophlebium persicifolium (Desv.) Bedd.	Pinnate, alternate, stalked, pinna lanceolate, apex narrowly acuminate, base oblique, margins crenose to mildly serrate. Sori orbicular on both sides of midrib within reticulate veinlets	Epiphyte	OBEMIO539MSU
Goniophlebium pseudoconnatum Copel.	Pinnate, alternate, pinna linear, dark green, apex acuminate, base auriculate, short-stalked, margin mildly serrate. Sori globose, parallel with midrib, within reticulate veinlets.	Epiphyte	OBEMIO540MSU
Leptochilus insignis (Blume) Fraser-Jenk.	Pinnatisect. Pinna broadly ovate, rounded base, acute apex, sinus increasing to the base, segments elliptic, aristate. Sori oval randomly interspersed	Epiphyte.	OBEMIO115MSU
Loxogramme avenia (Blume) C. Presl	Simple, lamina linear-obovate, acute apex, base attenuate, midrib raised on abaxial side, symmetrical. Sori tubular, parallel the midrib on acroscopic side.	Epiphyte.	OBEMIO741MSU
Loxogramme paralella Copel.	Simple lamina, obovate. dark green abaxial, light green adaxial, Sori linear lining the veins spaced increasingly to the middle of the blade.	Epiphyte.	OBEMIO742MSU
Loxogramme scolopendriodes (Gaudich.) C.V.Morton	Simple lamina, lanceolate, Sori linear inclined on the midrib at acroscopic side	Epiphyte, Lithophyte	OBEMIO035MSU
Oreogrammitis jagoriana (Mett ex Kuhn) Parris & Sundue	Simple, leaf linear, hirsute,apex obtuse, base attenuate, margin entire, Sori circular, exindusiate, one on each side of costa.	Epiphyte	OBEMIO057MSU
Oreogrammitis reindwarti (Blume) Parris	Simple, small-leaf, apex acuminate, base attenuate, margin crenate or non-crenate, hirsute. Sori circular, exindusiate, one on each side of midrib.	Epiphyte	OBEMIO596MSU
Prosaptia celebica (Blume) Tagawa & K. Iwats.	Stipe clumped, lamina elliptic, pinnatisect, coriaceous, pinnae linear. Sori oval, submarginal	Epiphyte	OBEMIO743MSU
Prosaptia multicaudata (Copel) Parris	Stipe clumped, lamina widely elliptic, pinnatisect, coriaceous, pinna linear, apex attenuate. Sori oval at an angle toward the midrib, halfway from apex never reaching the base	Epiphyte.	OBEMIO370MSU
Selliguea albidosquamata (Blume) Parris	Odd-pinnate. Alternate, Long-stalked. Pinna lanceolate, stalked, apex acumate, base cuneate, symmetrical, margin entire, lined with bright white scales. Sori small, dot shape between the midrib and margin	Epiphyte	OBEMIO7287PBDH

Families and species composition (Common Name)	Description	Habit	Exsiccata
Thylacopteris papillosa (Blume) Kunze ex J.Sm.	Pinnate-pinnatisect. Lanceolate. Thin, papery. Pinna linear, round apex, lowest pinna pinnate, sessile.Sori at tip of veinlets, appearing to be embedded on the adaxial side. Tertiary veins cladodromous	Epiphyte	OBEMIO7288PBDH
Tomophyllum macrum (Copel.) Parris	Stipe clumped, pinnatisect, subopposite, segments linear-elliptic, round apex, rachis and midrib prominent, black, Sori round exindusiate, sub-marginal	Epiphyte	OBEMIO7289PBDH
Tomophyllum millefolium (Blume) Parris	Rhizome erect. Stipes in whorls. Bipinnate-pinnatisect, Pinnules alternate, narrowly linear.	Epiphyte.	OBEMIO7290PBDH
15. Pteridaceae			
Adiantum hosei Baker (Maidenhair fern)	Pinnate, trifoliate, papyraceous, linear-lanceolate, pinnules alternate, sessile, oblong, stipe thin, black, sori marginal, false indusium	Ground. Lithophyte	OBEMIO7291PBDH
Antrophyum parvulum Blume	Simple, thick, entire, obovate, base attenuate, apex cuspidate-round. Sori linear over reticulate veins	Ground	OBEMIO577MSU
Pteris oppositipinnata Fee (Brake fern)	Ground. Broadleaved. pinnate, Lamina thick, ovate, pinna opposite, pinnatisect, basal pinnae divergent, ovate-oblong, acuminate apex, convex base, pinnules with rounded apex, sori elongate, marginal, tertiary veins cladodromous	Ground	OBEMIO247MSU
Vaginularia junghuhnii Mett.	Rhizome short creeping, Stipe clumped, pinna linear, coriaceous, apex acute, base cuneate. Sori continuous at the abaxial side	Epiphyte	OBEMIO181MSU
16. Tectariaceae			
Tectaria dissecta (G.Forst.) Lellinger (Halberd fern)	Rhizome ascending, Stipe solitary, fronds pinnatifid-bipinnatifid, pinna subopposite, margin deeply-lobed, apex acuminate, base obtuse, base segments pinnate, apex rounded. Sori circular, marginal at acroscopic pinnae.	Ground	OBEMIO7298PBDH
Tectaria melanocaulos (Blume) Copel. (Halberd fern)	Stipe and rachis black, innatifid-bipinnatifid large-leaf, wide-ovate, basal pinnae pinnate, margins serrate and lobed, apex acuminate, base rounded. Sori interspersed over the abaxial portion of the lamina	Ground	OBEMIO7297PBDH
17. Thelypteridaceae			
Chingia ferox (Blume) Holttum	Fronds pinnate, stipes to rachis bristle-like, pinna alternate, short-stalked, acuminate, round base, basal pinna oriented downwards, margin mildly lobed, Sori circular in two adjacent rows within each lobe segment	Ground	OBEMIO7292PBDH
Christella acuminata (Houtt.) Holttum	Pinnatifid, lamina wide-ovate, pinna opposite at base, sub-opposite towards acroscopic pinna, acuminate, base sagittate with basal pinna oriented downwards, pinnae triangular, acuminate, truncate. Sori circular submarginal terminating at ends of lobes	Ground	OBEMIO179MSU
Christella dentata (Forssk.) Brownsey & Jermy	Pinnatifid, Lamina widely elliptic, apical and basal pinna reduced, oblong, acuminate, basal pinna oriented downwards, margins moderately lobed. Sori circular, submarginal	Ground	OBEMIO745MSU
Pneumatopteris laevis (Mett.) Holttum	Stipes clumped, frond pinnate, widely-ovate, alternate, acuminate, pinnae lanceolate,	Ground	OBEMIO541MSU
Pneumatopteris nitidula (C. Presl) Holttum	acuminate, obtuse. Sori circular submarginal Stipes whorled, frond pinnate, wide ovate, pinna linear-triangular, opposite-sub-opposite, lobed halfway to costa. Sori circular at mid-portion of veinlets	Ground	OBEMIO7294PBDH
Pronephrium nitidum Holttum	Pinnatifid. Lamina wide ovate, pinna opposite, deeply-lobed, 190 mm long x 130 mm wide, basal pinna pinnate sessile, rachis black. Sori interspersed within tertiary veins forming areoles.	Lithophyte	OBEMIO744MSU
Sphaerostephanos ellipticus (Rosenst.) Holttum	Stipes clumped, rachis pilose, frond pinnate, wide-elliptic, pinna liner-triangular, acuminate, truncate, margin moderately-lobed. Sori circular over lamina in lobe margins	Ground	OBEMIO7296PBDH

Athyrium puncticaule, Calymmodon gracillimus, Dicksonia amorosoana, *Diplazium geophilum*, *Dryopteris purpurascens*, *Oreogrammitis jagoriana*, *Oreogrammitis reinwardtii*, *Prosaptia multicaudatum*, *Prosaptia celebica*, *Sphaerostephanos ellipticus,* as they are the first or second occurrence report in the region or Mindanao. Mt. Matutum holds the second record so far in the country for *A. nakanoi* and *D. amorosoana. A. nakanoi* used to be documented in India, Nepal, Bhutan, China, Taiwan, Japan, Indonesia, and Malaysia and was first seen in the country in Mount Dulang-dulang Kitanglad Range, northern Mindanao (Coritico et al. 2019). The tree fern *D. amorosoana* on the other hand, is a recently described narrow endemic species of *Dicksonia* from the Philippines, first observed in Mount Apo, Kidapawan, North Cotabato, Mindanao (Lehnert & Coritico 2018). Its second distribution record is in MMPL and to date, occurrence is confined to South Central Mindanao (Region 12). Abundance in MMPL of these species is marked as rare with < 5 species and frequency data of < 10%.

The species *C. gracillimus*, *O. reinwardtii*, and *O. jagoriana* are noteworthy records of grammitid ferns as they are not only new observations in MMPL and surrounding provinces, but also new for Region 12. They were last observed in 1904 & 1909 and 1904 & 1924, respectively, in Mount Apo and Davao Region (www.pteridoportal.org, www.worldplants.de/worldferns). Similarly, *S. ellipticus* an endemic fern, is a new record for the region with type specimens found in Mindanao – Agusan & Zamboanga, from 1911–1912 collections (www.pteridoportal.org).

Also forming the new records for South Central Mindanao are *Asplenium laserpitiifolium, D. geophilum, P. multicaudatum* and *P. celebica* which were all observed in the montane forest of MMPL. There were also ferns discovered by E. Copeland in 1917 which at that time were second occurrence records in the entire Philippines — *Sphaerostephanos urdanetensis, Cornopteris opaca, Cornopteris philippinensis*. Meanwhile, based on worldwide database for herbarium collections, two species in Mount Matutum recorded by Copeland in 1917 remained to be the only record so far in the country namely *G. peltophora* and *Diplazium calliphyllum*.

These new records in MMPL provide significant contribution to the biodiversity heritage of Mindanao island. Prior to this study, published accounts on pteridophyte diversity has largely been from two regions — 10 (Mt. Malindang & Mt. Kitanglad Range in Bukidnon) and 11 (Mt. Hamiguitan Range). The highest richness reported here was in Mt. Kitanglad Range which totalled to 439 with a total account of 632 species for the entire Mindanao island (Amoroso et al. 2011). It is expected then that the account on species richness will change with the results from this study.

Several species were also highlighted as useful either as medicine, food, or ornamental (Table 2). Tree ferns (*Alsophila, Sphaeropteris*) have been used as source

Table 2. Economic uses from several new records of ferns and lycophytes in MMPL.

Species	Uses	Reference
Adiantum spp.	Ornamental	Oloyede 2012
Angiopteris evecta Sw.	Medicinal. Leaf extract used to treat dysentery, blood diseases and ulcers. Spores used to treat leprosy and other skin diseases. Antiviral, antihyperglycemic and analgesic	Benjamin 2011
Asplenium cuneatum Lam.	Medicinal. Vermifuges (anthelmintic)	Burkill 1985
Asplenium spp.	Ornamental	Simpson 2019
Christella dentata (Forssk.) Brownsey & Jermy	Medicinal. Anti-bacterial. Antihyperglycemic and analgesic activity of leaves	Srivastava 2007; Manhas et al. 2018
Drynaria spp.	Ornamental	Simpson 2019
Dryopteris spp.	Medicinal. Abortifacient, anthelmintic. Food. Rhizomes source of fats (90% monoethenoid acids)	May 1978; Srivastava 2007; Mannan et al. 2008;
Lycopodium clavatum L.	Medicinal. Emetic for stomach disorders, cure for kidney and lung diseases, analgesic, antioxidant, anti-cancerm anti-inflammatory, neuroprotective, immunomodulatory and hepatoprotectivel nosebleeding and heal wounds , treatment for learning and memory impairment ,diuretic and anti-spasmatic , cure headaches . Household Material (mats)	May 1978; Srivastara 2007; Benjamin 2011; Oloyede 2012;; Hanif et al. 2015; Bhardwaj & Misra 2018
Pseudodiphasium volubile (G. Forst.) Holub	Ornamental. Table decoration	Benjamin 2011
Odontosoria chinensis (L.) J. Sm.	Medicinal. Cure for chronic enteritis. Ornamental. landscape plant	Ho et al. 2010; Oloyede 2012
Tree ferns *(Alsophila, Sphaeropteris)*	Food. Rhizomes as source of starch	Ripperton 1924; Leach 2003

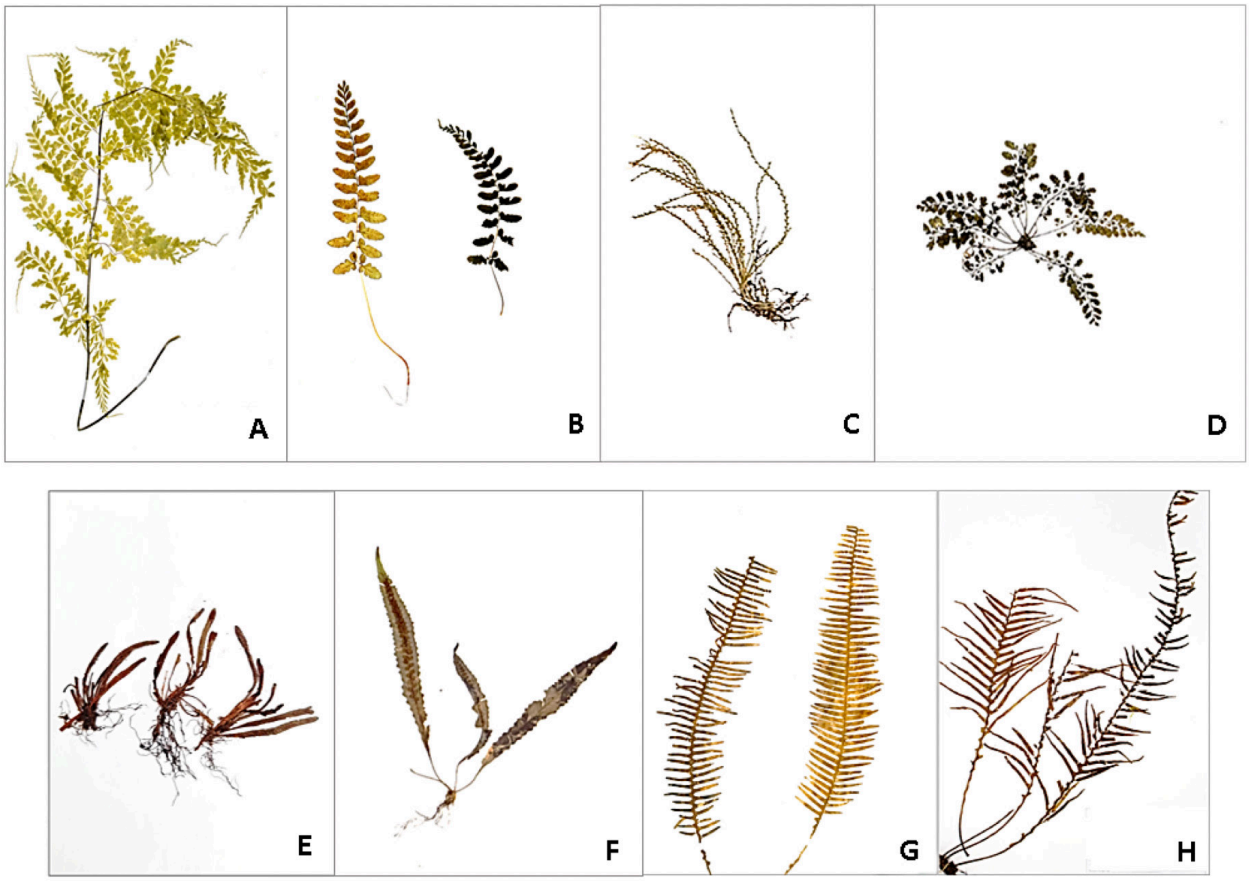

Image 2. Noteworthy Ferns in MMPL: First distribution record in South Central Mindanao Region A—*Asplenium laserpitifolum* (Habit: Epiphyte/ Lithophyte, Elevation: 1,300 m) | B—*Athyrium nakanoi* (Habit: Ground, Elevation: 2,100 m) | C—*Calymmodon gracilis* (Habit: Epiphyte, Elevation: 2,100 m) D—*Diplazium geophilum* (Habit: Ground, Elevation: 2,000 m) | E—*Oreogrammitis jagoriana* (Habit: Epiphyte, Elevation: 2,100 m) | F—*Oreogrammitis reindwartii* (Habit: Epiphyte, Elevation: 2,000 m) | G—*Prosaptia celebica* (Habit: Epiphyte, Elevation: 2,100 m) | H—*Prosaptia multicaudatum* (Habit: Epiphyte, Elevation: 2,100 m).

of starch in Hawaii (Ripperton 1924; May 1978; Leach 2003) while in India it is sought from stems of giant ferns *Angiopteris* (Liu et al. 2012). Starch is an important product worldwide used for different purposes – preservative, thickening agent, food enhancer and stabilizer and key ingredients in pastas, soups, sauces (Mason 2009; Egharevba 2019). Fern starch has been used as additive along with rice, potato and corn flour in the production of liquor and soft drinks (Liu et al. 2012). Meanwhile, fats from rhizomes have been extracted from *Dryopteris* which contains 90% monoethenoid (unsaturated) acids (May 1978).

Medicinal ferns have been used since ancient times for common diseases — gastric, inflammatory, infections, because of the ethnobotanical knowledge on their potential as antibacterial, anti-inflammatory, diuretics and pain killers passed on to generations (Ho et al. 2010). Medicinal value was identified in *Lycopodium clavatum, Selaginella involvens, Angiopteris evecta, Christella dentata, Asplenium cuneatum,* and *Dryopteris* species while ornamental uses were featured in several *Asplenium*, *Adiantum* and, *Drynaria* species, and in *Odontosoria chinensis* and *Pseudodiphasium volubile* (Table 2). On the other hand, ornamental ferns have been sought to provide aesthetic value for the enjoyment of the public and potentially for environmental protection and management (Oloyede 2012) and interestingly, more money is spent for this than for all other uses (May 1978).

Notable from the list of new records is *L. clavatum* having been widely documented for medicinal purposes. It has been known as emetic for stomach disorders (Srivastava 2007), cure for kidney and lung diseases, analgesic, antioxidant, anti-cancer, anti-inflammatory, neuroprotective, immunomodulatory, and hepatoprotective (Bhardwaj & Misra 2018). It was also explored as potent treatment for learning and memory impairment (Hanif et al. 2015). It is diuretic

Image 3. Noteworthy Ferns in MMPL: A —Herbarium collection from Pteridophyte Collections Consortium of *Diplazium calliphyllum* by Copeland (1917), the only record in the country | B—Field picture of *Gleichenia peltophora*, also the only record in the country recorded by Copeland (1917) | C—Field picture of *Dicksonia amorosoana*, the second distribution record for Mindanao and the country; first discovered in Mount Apo, North Cotabato.

and anti-spasmatic and also smoked with *Selaginella rupestris* to cure headaches (Watt & Brandwijk 1962). In Sweden, *L. clavatum* is also woven into mats (May 1978).

The checklist of new records for MMPL highlights the significance of the landscape as biodiversity area in South Central Mindanao. It confirms the favorable microenvironment brought about by stable ecosystem processes in the landscape (MMPL), thereby able to house unique plants, enhancing the natural heritage. The discovery of these new records after more than 100 years, is a significant achievement, realizing that there had been few explorations in between then and now. Moreover, knowledge of species occurrence is crucial to biodiversity conservation as this provides basis for scientific-based efforts to restore diversity at its different levels (Pavlik 1995; Mehltreter 2010; Cutko 2009; Green et al. 2009; Weigelt et al. 2019). It is perceived that this study would jumpstart the continuous and regular monitoring and inventory of pteridophytes in order to aid planning, management, and policy development for the protected area. This would further lead to the inclusion of MMPL pteridophyte flora in national and worldwide botanical data and provide extensive compilation of geographic species at regional, national, and global levels.

The discovery of many economic uses of ferns and lycophytes is very instrumental to raising awareness and appreciation on the utilitarian values of this plant group. Studies to elucidate the bioactive products found in its various plant parts have led to its integration in drug discovery and potential use for various chronic and infectious diseases (Ho et al. 2010; Baskaran et al. 2018). Likewise, its ornamental values serve a pivotal role in environmental protection and management interventions and can be harnessed to improve environmental landscapes (Oloyede 2012). As the country is among the richest in pteridophyte diversity in Asia, avenues for expanding current knowledge on their utilitarian as well as ecological values are numerous, waiting to be explored.

Conservation status of the new records

With reference to IUCN Threatened List 2021, it can be grasped that all new records in MMPL belong to the Not Assessed (NA) category. The DAO-2017-11 of DENR is another reference which also integrated the national red list of threatened species (in reference to IUCN) developed in 2008 by Fernando et al. (2008). From this, a total of 11 species from new records were in the threatened category. The rest belong to other wildlife species (OWS) which refers to the native species in the landscape that were not classified to any of the threatened category. Meanwhile, seven of these new records were found to be endemic, confined only in the country.

Local assessment tool based on the relative frequency values showed a different picture as many of the OWS in DAO were placed in threatened category (Table 3). From the NA of IUCN, the OWS of DAO and native species which is roughly the least-concerned at national, and global levels, 20 were classified under CR, 44 under EN, sixVU and nine NT. Only nine species were noted to be relatively the same with least concerned status. Meanwhile, from the not threatened but endemic species (NA in IUCN, OWS in DAO and Endemic), two were found to be CR, three EN and one VU.

Under the threatened and native species category (NA in IUCN, threatened in DAO, native), one was found as CR, three were endangered, two vulnerable, one NT and four were LC. Further, the threatened and endemic category enlisted one VU and three LC species.

The local conservation status developed in this study is a simple categorical classification intended to have an immediate reference for conservation priority of pteridophyte species in MMPL. It is a vital alternative in the absence of data from IUCN which generally considers global distribution of high-valued plant species (Langenberger 2006; Villanueva & Buot 2020). As can be drawn from this study, the new records in MMPL were not yet assessed in IUCN except for one species, *Sphaeropteris glauca,* which was classified as least concerned. Some were also highlighted in the national list DAO 2017–11. The use of relative frequency scores could serve as reliable representation of the species' adaptation, higher RF as widely-adapted while low RF values depict restricted-range species. It is significant as in the case of MMPL which needs immediate reference as scientific information is scarce. Moreover, it can be modified in the future to include other factors that may influence their diversity and distribution such as harvest use, economic uses, threats, and other ecological factors similar to those highlighted in several works (Bacchetta et al. 2012; Rana et al. 2020; Villanueva & Buot 2020).

High priority species based on local assessment along with their endemicity and threatened status at the national level (DAO 2017–11) would serve as basis for inclusion in management plans and advocacy interventions for MMPL. Based on frequency records, these species are not widely-adapted and their elevation range is limited. Alongside that is the gradual increase of human-led activities that can potentially threaten the health of the landscape. The rise of tourist sites, plantation areas, and human settlements around MMPL, collection of wildlife species in prohibited zones, and unauthorized trekking activities in MMPL would in the long run cause degradation of the landscape. Moreover, majority of these locally threatened flora are found along montane to upper montane forest (1,600–2,000 m). As such, this study proposed for the recognition of this altitudinal range as fern biodiversity hotspot. As such, conservation programs can be focused towards the species in this zone as they could be the most sensitive to environmental changes and may in the future vanish in the landscape.

CONCLUSION

The discovery of more than one hundred new records for South Central Mindanao region and MMPL highlights its rich natural heritage and confirms its significance as key biodiversity area for pteridophytes. It is a significant addition to current botanical information as it addressed gaps in knowledge of ferns and lycophytes. The determination of conservation priority species and hotspot fern area (1,600–2,000 m) is hoped to serve as vital reference for the integration of pteridophytes in local conservation plans for MMPL.

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Table 3. New records in MMPL highlighting their category as to geographic distribution, international (IUCN), national (DAO) and local assessment based on relative frequency (RF).

Families and Species Composition	Species category as regards geographic distribution	IUCN 2021	DAO 2017-11	Relative Frequency (RF)	Local Assessment based on RF
1. Lycopodiaceae					
Huperzia javanica (Sw.) Fraser-Jenk.	Indigenous	NA	OWS	0.403	VU
Lycopodium clavatum L.	Indigenous	NA	OWS	0.109	EN
Phlegmariurus delbrueckii A.R. Field & Bostock	Indigenous	NA	OWS	0	CR
Phlegmariurus verticullatus (L.f) A.R. Field	Indigenous	NA	OWS	0.019	CR
Pseudodiphasium volubile (G. Forst.) Holub	Indigenous	NA	OWS	0	CR
2. Selaginellaceae					
Selaginella boninensis Baker	Indigenous	NA	OWS	0.33	EN
Selaginella biformis A. Br. ex Kuhn	Indigenous	NA	OWS	0.11	EN
Selaginella cupressina (Willd.) Spring	Indigenous	NA	OWS	0.11	EN
Selaginella engleri Hieron.	Indigenous	NA	OWS	0.22	EN
Selaginella gastrophylla Warb.	Indigenous	NA	OWS	0.7	NT
Selaginella involvens (Sw.) Spring	Indigenous	NA	OWS	0.44	VU
Selaginella remotifolia Spring	Indigenous	NA	OWS	0.28	EN
1. Aspleniaceae					
Asplenium affine Sw.	Indigenous	NA	OWS	0	CR
Asplenium cuneatum Lam.	Indigenous	NA	OWS	0.14	EN
Asplenium elmeri Christ	Indigenous	NA	OWS	0.31	EN
Asplenium horridum Kaulf. *Asplenium laserpitiifolium* Lam.	Indigenous Indigenous	NA NA	OWS OWS	0.31 0.21	EN EN
Asplenium lobulatum Mett.	Indigenous	NA	OWS	1.56	LC
Asplenium longgisimum Blume	Indigenous	NA	OWS	0.7	NT
Asplenium pellucidum Lam.	Indigenous	NA	OWS	0.44	VU
Hymenasplenium excisum (C. Presl) S. Linds.	Indigenous	NA	OWS	2.19	LC
Hymenasplenium subnormale (Copel.) Nakaike	Indigenous	NA	OWS	0.22	EN
2. Athyriaceae					
Athyrium nakanoi Makino	Indigenous	NA	EN	0.33	EN
Athyrium puncticaule (Blume) T. Moore	Indigenous	NA	OWS	0.22	EN
Cornopteris banaohensis (C. Chr.) K. Iwats. & M.G. Price	Indigenous	NA	OWS	0	CR
Diplazium dilatatum Blume	Indigenous	NA	OWS	1.44	LC
Diplazium geophilum Alderw.	Indigenous	NA	OWS	0.38	EN
Diplazium pseudocyatheifolium Rosenst.	Indigenous	NA	EN	0.22	EN
3. Cyatheaceae					
Alsophila apoensis (Copel.) R.M. Tryon	Endemic	NA	EN	0.42	VU
Alsophila hermannii R.M. Tryon *Sphaeropteris elmeri* (Copel.) R.M. Tryon	Endemic Endemic	NA NA	EN VU	1.56 0.28	LC EN
Sphaeropteris glauca (Blume) R.M. Tryon	Indigenous	LC	EN	1.69	LC
Alsophila heterochlamydea (Copel.) R.M. Tryon	Endemic	NA	VU	1.56	LC
Sphaeropteris lepifera (J.Sm. ex Hook.) R.M. Tryon	Indigenous	NA	EN	0.28	EN
4. Dennstaedtiaceae					
Histiopteris incisa (Thunb.) J.Sm.	Indigenous	NA	OWS	0.88	NT
Microlepia enulose (Thunb.) C. Presl	Indigenous	NA	OWS	0.22	EN

Families and Species Composition	Species category as regards geographic distribution	IUCN 2021	DAO 2017-11	Relative Frequency (RF)	Local Assessment based on RF
Monachosorum henryi Christ	Indigenous	NA	OWS	2	LC
5. Dicksoniaceae					
Dicksonia amorosoana Lehnert & Coritico	Endemic	NA	OWS	0.42	VU
6. Dryopteridaceae					
Bolbitis enulosete (C. Presl) Ching	Indigenous	NA	OWS	0.42	VU
Dryopteris hendersonii (Bedd.) C. Chr.	Indigenous	NA	OWS	0.22	EN
Dryopteris purpurascens (Blume) Christ	Indigenous	NA	OWS	0	CR
Dryopteris permagna M. Price	Indigenous	NA	EN	0	CR
Polystichum moluccense T. Moore	Indigenous	NA	EN	0.82	NT
Polystichum elmeri Copel.	Endemic	NA	OWS	0.18	EN
Teratophyllum aculeatum (Blume) Mett. ex Kuhn	Indigenous	NA	OWS	0	CR
7. Hymenophyllaceae					
Abrodictyum pluma (Hook.) Ebihara & K.Iwats.	Indigenous	NA	OWS	0.56	VU
Abdrodictyum obscurum (Blume) Ebihara & K. Iwats.	Indigenous	NA	OWS	0.31	EN
Crepidomanes minutum (Blume) K. Iwats.	Indigenous	NA	OWS	0	CR
Crepidomanes grande (Copel.) Ebihara & K. Iwats.	Indigenous	NA	OWS	0.14	EN
Hymenophyllum ramosii Copel.	Indigenous	NA	OWS	0	CR
Hymenophyllum denticulatum Sw.	Indigenous	NA	OWS	0.11	EN
Hymenophyllum fimbriatum J. Sm.	Indigenous	NA	OWS	0.94	NT
Hymenophyllum holochilum (Bosch) C. Chr.	Indigenous	NA	OWS	0	CR
Hymenophyllum imbricatum Blume	Indigenous	NA	OWS	0.88	NT
Hymenophyllum nitidulum (Bosch) Ebihara & K. Iwats.	Indigenous	NA	OWS	0.14	EN
Hymenophyllum pallidum (Blume) Ebihara & K. Iwats.	Indigenous	NA	OWS	0.94	NT
Hymenophyllum serrulatum (C. Presl) C. Chr.	Indigenous	NA	OWS	0.19	EN
Hymenophyllum thiudium Harrington	Indigenous	NA	OWS	0.12	EN
Vandenboschia auriculata (Blume) Copel.	Indigenous	NA	OWS	0.11	EN
8. Hypodematiaceae					
Leucostegia truncata (D. Don) Fraser-Jenk.	Indigenous	NA	OWS	0.88	NT
9. Lindsaceae					
Lindsaea pulchella (J. Sm.) Mett. ex Kuhn	Indigenous	NA	OWS	0.14	EN
Odontosoria retusa (Cav.) J. Sm.	Indigenous	NA	OWS	0.14	EN
Osmolindsaee odorata (Roxb.) Lehtonen & Lehtonen	Indigenous	NA	OWS	0.14	EN
Tapeinidium gracile (Blume) Alderw.	Indigenous	NA	OWS	0.14	EN
Tapeinidium pinnatum (Cav.) C. Chr.	Indigenous	NA	OWS	0.28	EN
10. Mariatiaceae					
Angiopteris evecta Sw.	Indigenous	NA	OTS	1.56	LC
Ptisana pellucida (C. Presl) Murdock	Indigenous	NA	OWS	1.31	LC
11. Oleandraceae					
Oleandra sibbaldi Grev.	Indigenous	NA	OWS	0.14	EN
12. Ophioglossaceae					
Botrychium daucifolium Wall. ex Hook. & Grev.	Indigenous	NA	OWS	0.75	NT

Families and Species Composition	Species category as regards geographic distribution	IUCN 2021	DAO 2017-11	Relative Frequency (RF)	Local Assessment based on RF
13. Plagiogyriaceae					
Plagiogyria glauca (Blume) Mett.	Indigenous	NA	OWS	1.38	LC
14. Polypodiaceae					
Calymmodon gracillimus (Copel.) Nakai ex H. Itô	Indigenous	NA	OWS	0.13	EN
Chrysogrammitis glandulosa (J.Sm.) Parris	Indigenous	NA	OWS	0.14	EN
Dasygrammitis malaccana (Baker) Parris	Indigenous	NA	OWS	0.44	VU
Drynaria aglaomorpha Christenh.	Indigenous	NA	VU	0.22	EN
Drynaria descensa Copel.	Endemic	NA	OWS	0.11	EN
Goniophlebium persicifolium (Desv.) Bedd.	Indigenous	NA	OWS	1	NT
Goniophlebium pseudoconnatum (Copel.) Copel.	Indigenous	NA	OWS	1.44	LC
Goniophlebium subauriculatum (Blume) C. Presl	Indigenous	NA	OWS	0	CR
Leptochilus insignis (Blume) Fraser-Jenk.	Indigenous	NA	OWS	0	CR
Loxogramme avenia (Blume) C. Presl	Indigenous	NA	OWS	0.06	CR
Loxogramme paralella Copel.	Indigenous	NA	OWS	0.06	CR
Loxogramme scolopendriodes (Gaudich.) C.V.Morton	Indigenous Indigenous	NA NA	OWS OWS	0 0.15	CR CR
Oregrammitis beddomeana (Alderw) T.C. Hsu *Oreogrammitis jagoriana* (Mett. ex Kuhn) Parris & Sundue	Indigenous Indigenous	NA NA	OWS OWS	0.19 0.15	EN CR
Oreogrammitis reinwardtii (Blume) Parris	Indigenous	NA	OWS	0.14	EN
Oreogrammitis torricelliana (Brause) Parris	Indigenous	NA	OWS	0.11	EN
Prosaptia contigua (G. Forst.) C. Presl *Prosaptia celebica* (Blume) Tagawa & K. Iwats.	Indigenous Indigenous	NA NA	OWS OWS	0.14 0.15	EN CR
Prosaptia multicaudatum (Blume) Tagawa & K. Iwats.	Indigenous	NA	OWS	0	CR
Prosaptia venulosa (Blume) M.G. Price	Indigenous	NA	OWS	0.14	EN
Selliguea albidosquamata (Blume) Parris	Indigenous	NA	OWS	0.14	EN
Thylacopteris papillosa (Blume) Kunze ex J.Sm.	Indigenous	NA	OWS	0.33	EN
Tomophyllum macrum (Copel.) Parris	Endemic	NA	OWS	0.14	EN
Tomophyllum millefolium (Blume) Parris	Indigenous	NA	OWS	0.14	EN
15. Pteridaceae					
Adiantum hosei Baker	Indigenous	NA	OWS	0.75	NT
Antrophyum parvulum Blume	Indigenous	NA	OWS	0.14	EN
Pteris oppositipinnata Fee	Indigenous	NA	OWS	1.25	LC
Vaginularia junghunii Fee	Indigenous	NA	OWS	0.22	EN
16. Thelypteridaceae					
Chingia ferox (Blume) Holttum	Indigenous	NA	OWS	0	CR
Christella acuminata (Houtt.) Holttum	Indigenous	NA	OWS	0.89	NT
Christella dentata (Forssk.) Brownsey & Jermy	Indigenous	NA	OWS	0.11	EN
Pneumatopteris laevis (Mett.) Holttum	Indigenous	NA	OWS	0.75	NT
Pneumatopteris nitidula (C. Presl) Holttum	Endemic	NA	OWS	0	CR
Pronephrium nitidum Holttum	Indigenous	NA	OWS	0	CR
Sphaerostephanos ellipticus (Rosenst.) Holttum	Endemic	NA	OWS	0	CR
17. Tectariaceae					
Tectaria melanocaulos (Blume) Copel.	Indigenous	NA	OWS	0	CR
Tectaria dissecta (G. Forst.) Lellinger	Indigenous	NA	OWS	0	CR

Legend: NA (Not Assessed), OWS (Other Wildlife Species), CR (Critically endangered), EN (Endangered), NT (Near threatened), LC (Least Concern)

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Journal of Threatened Taxa is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

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Journal of Threatened Taxa

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

November 2022 | Vol. 14 | No. 11 | Pages: 22039-22206
Date of Publication: 26 November 2022 (Online & Print)
DOI: 10.11609/jott.2022.14.11.22039-22206

Publisher & Host

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