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SHORT COMMUNICATION

ASSESSMENT OF THREAT STATUS OF THE HOLLY FERN *CYRTOMIUM MICROPTERUM* (KUNZE) CHING (POLYPODIOPSIDA: DRYOPTERIDACEAE) IN INDIA USING IUCN REGIONAL GUIDELINES

C. Bagathsingh & A. Benniamin

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Assessment of threat status of the holly fern *Cyrtomium micropterum* (Kunze) Ching (Polypodiopsida: Dryopteridaceae) in India using IUCN Regional guidelines

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Abstract: During the field survey in central Western Ghats of India, an interesting dryopteridoid fern species was collected from Nellikathrupodu Range of Billigiri Rangaswamy Temple (BRT) Tiger Reserve of Karnataka. After a critical study of literature, the specimen was identified as *Cyrtomium micropterum* (Kunze) Ching. In India, this species is known only from its type locality Nilgiri and Palani hills of Tamil Nadu. The present collection from the BRT Tiger Reserve shows its extended distribution and forms the first report for the state of Karnataka. The present paper deals with the assessment and conservation status of *Cyrtomium micropterum* (Kunze) Ching in India in accordance with IUCN guidelines for the application of Red List Criteria at regional and national Levels, 2012, Version 4.0. Detailed descriptions, photographs, microphotographs are provided for easy identification of this species.

Keywords: Categorization, GeoCAT, Nilgiris, threatened pteridophytes, Western Ghats.

The seed-free vascular plants of pteridophytes, which include ferns (10,578 species) and lycophytes (1,338 species) are the second most species-rich group of vascular plants composing of ca. 11,916 species

globally (PPG I, 2016). It has, however, received little conservation effort than other plant groups and most species of ferns have not yet been evaluated for their conservation status (IUCN 2017). A huge number of ferns and lycophytes have become threatened (Arcand & Ranker 2008) and the decline is probably due to habitat destruction and loss of mature individuals (IUCN 2019). In India, about 1,107 species of ferns and lycophytes were reported (Fraser-Jenkins et al. 2017) of which nearly about one-third of total Indian populations (337 taxa) are considered to be threatened (Fraser-Jenkins 2012). The Western Ghats, one of the global hotspots of the world, harbors 349 species of ferns and lycophytes (Benniamin & Sundari 2020) among which 38 species are assessed as threatened (Benniamin et al. 2008). The previous assessments, however, could not meet the guidelines of IUCN Red List Categories and Criteria neither at the regional nor national Level (IUCN 2012). Hence, the threatened status of most

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ferns and lycophte species in India remains under-evaluated. The present study is an attempt to assess the threat status of *Cyrtomium micropterum* (Kunze) Ching. (Dryopteridaceae) in India, in accordance with the IUCN Guidelines for application of Red List Criteria at regional and national Levels, 2012, Version 4.0.

During the field survey (2017–2020) the first author collected an interesting dryopteridoid fern species from Nellikathrupodu Range of Billigiri Rangaswamy Temple (BRT) Tiger Reserve, Karnataka (11.91180°N & 77.20776°E). After making detailed studies on morphological characters along with consultation of relevant literature (Manickam & Irudayaraj 1992, 2003; Rajagopal & Bhat 2016; Benniamin & Sundari 2020) and herbarium (BSI, RHT, JCB, MPU), this species was identified as *Cyrtomium micropterum* (Kunze) Ching. On perusal of literature surveys and herbarium consultation, it became apparent that this genus has not been reported in Karnataka. Hence the genus *Cyrtomium* forms a new addition to the pteridophytic flora of Karnataka State, with the single species *C. micropterum* (Kunze) Ching. The paleotropical species *C. micropterum* (Kunze) Ching is distributed in eastern

and southern Africa, Madagascar, and southern India. In India this species is known only from its type locality in Nilgiri Hills and from Palani Hills of Tamil Nadu (Figure 1).

The present record with previous studies shows that the habitats of this species, somewhat high altitude on the eastward offshoots of the Western Ghats like Palni Hills, Nilgiri Hills, and BRT Hills are more suitable for this species when compared to Munnar Hills and Tirunelveli Hills on the main tract of the Western Ghats. As far as the Dryopteridaceae members are concerned, most of the species are altitude specific, i.e., 1,300–1,800m. Since the altitude of northern Western Ghats is less than 1,300 m (Maharashtra, Goa, and Gujarat), it is not possible for this species to grow there. This may be due to the requirement of a highly specific ecological niche for this species, which prefers ever-green or partially-exposed semi-evergreen forests at high altitudes. It has also been confirmed that no such specific habitat has been observed on the roadsides of Palni Hills, Nilgiris, and Nellikathuru Podu in the BRT Tiger Reserve, Karnataka. Apart from the altitudinal and physiographic characteristics mentioned above, other climatic factors, in particular the proportion of maritime and land

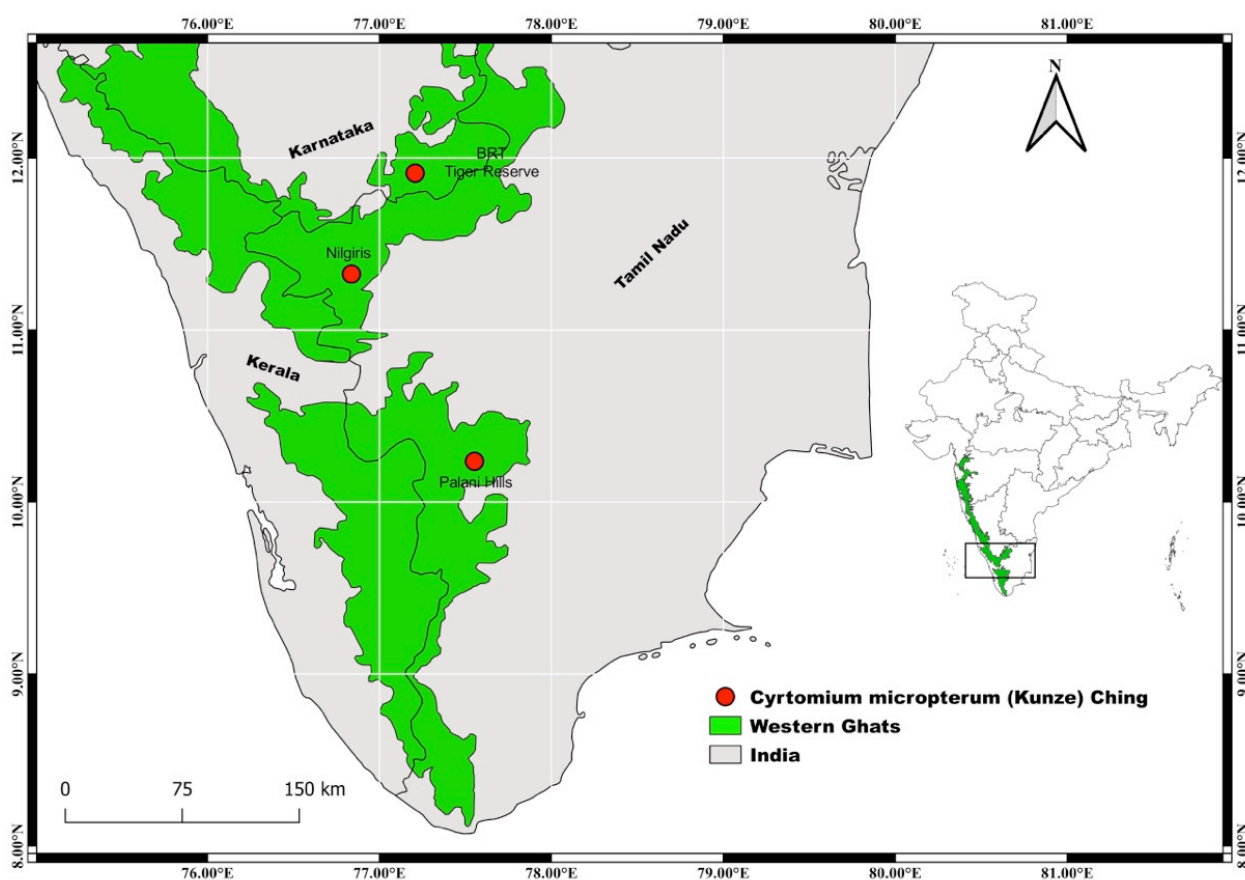


Figure 1. Distribution of *Cyrtomium micropterum* (Kunze) Ching in India.

moisture and temperature, also play an important role in the distribution of this threatened fern as shown in the distribution map (Map 1). In general, all the populations are present on the eastern side of the Western Ghats to get more continental air mass and less maritime air mass as in Africa (Bostock et al. 1998). From the distribution pattern of this species, it is well understood that this species prefers high altitude locations along the eastern border of the main tract of Western Ghats, as opposed to unfavorable regions/localities on both the eastern and western slopes. It is expected to be present in Meghamalai, adjacent to Palni Hills, but due to lack of high altitude, it does not grow there (Mr. Amirtham, pers.comm. 15.11.2020).

All the 31 species of *Cyrtomium* are maritime-moisture-loving ferns common in Japan to Africa where all the species are strictly restricted to the easternmost coastal border. But the Indian diploid and triploid apogamous species of *Cyrtomium* shows the difference in the requirements of maritime and land moistures. Thus the triploid *C. caryotideum* requires more moisture with the coolest climate in contrast to the diploid apogamous *C. micropterum* which requires a cooler climate with comparatively less moisture. With the above details on the global distribution of the genus *Cyrtomium*, the present gatherings of *Cyrtomium micropterum* from BRT Tiger Reserve is a very important record for its complete distribution range in India.

MATERIALS AND METHODS

Extensive field exploration was carried out between 2017 and 2020 in different seasons of the year and geographical coordinates were recorded using geographical positioning system (GPS). Plant identification was done by consulting relevant literature (Manickam & Irudayaraj 1992, 2003; Benniamin & Sundari 2020) and herbaria consultation (BSI, RHT, JCB, MPU). Photomicrographs were taken using an Olympus stereo microscope SZ61. Herbarium specimens were deposited at the Botanical Survey of India, Western Regional Centre Herbarium (BSI). A distribution map was constructed using open-source software QGIS Ver. 3.12.0. Assessment of threat status was carried out according to the IUCN Red List Criteria at Regional and National Levels, 2012 (version 4.0). Mature individuals were also counted as per the guidelines of IUCN 2010. The area of occupancy (AOO) and extent of occurrence (EOO) were calculated using the open-source online software GeoCAT (Geospatial Conservation Assessment Tool, Bachman, et al. 2011), available at <http://geocat.kew.org/>

RESULTS

Cyrtomium micropterum (Kunze) Ching

Icon. Fil. Sin. 3: t. 127. 1935. Image 1. Benniamin & Sundari, Pteridophytes of Western Ghats-A Pictorial guide: 41. f. 113. 2020; Fraser-Jenk. et al., Annot. Checkl. Indian. Pterid. 2: 215. 2018. *Aspidium anomophyllum* f. *micropterum* Kunze, Linnaea 24: 278–279. 1851. *Phanerophlebia caryotideae* var. *micropteris* (Kunze) C.chr., Manickam, Fern Fl. Palani Hills, 132. 1986; Manickam & Irudayaraj, Pterid. Fl. West. Ghats, S. India: 272. t. 209. 1992; Manickam & Irudayaraj, Pterid. Fl. Nilgiris S. India: 157. 2003.

Isosyntype: India, Tamil Nadu, Nilgiris, Hohenacker #913 (MPU image!).

Herbs perennial; rhizome erect, densely covered with persistent leaf base and scales; scales lanceolate, fimbriate at margins, long acuminate at apex, brownish-black; stipes tufted, 15–48 cm long, brown at base, green towards above, densely scaly at base, grooved above. Leaves unipinnate; lamina oblong with trilobed terminal pinna, 50–60 cm long, dark green; pinnae 10–12 pairs, slightly ascending, subopposite, ovate to lanceolate, c. 7 × 2.5 cm, auriculate at acroscopic end, blunt auricle, serrate at margin, acute at apex, petiolate, widely spaced, brown unicellular hairs on both surfaces; veins anastomosing with included veinlets; rachis as for stipe; sori indusiate, indusium fimbriate at margins, reniform, orbicular, scattered, seated on free veinlet, 32 spores per sporangium; spores bilateral, monolete, laesura long, exine thick, perine highly folded to form tubercle like structures all over the spore, darkish brown, 18–20 µm long.

Specimen examined: 205936 (BSI), 29.xi.2018, India, Karnataka state, BRT Tiger reserve, Nellikathurupodu range, 11.91180°N, 077.20776°E, 1,370m, coll. C. Bagathsingh (Image 4). 17687 (RHT!), 03.v.1981, India, Tamil Nadu State, Palani Hills, on the slopes of Perumal Peak, 1,800m, coll. V.S.Manickam.

Phenology: Fertile from August to January.

Habitat & Ecology: This species was found growing in a terrestrial habitat as small colonies on fully shaded evergreen forest floors, between 1,600 and 1,800 m.

Global distribution: Ethiopia, Kenya, Lesotho, Malawi, Madagascar, South Africa, Tanzania, Uganda, and India; **India:** Nilgiris and Palani Hills of Tamil Nadu and BRT Tiger Reserve of Karnataka (present report).

Threat status assigned: Endangered (B2ab(iii,v)).

Cyrtomium micropterum (Kunze) Ching is placed under the Endangered (ER) category in the present assessment as the species is restricted to only three locations in India. The extent of occurrence is 7,152.25

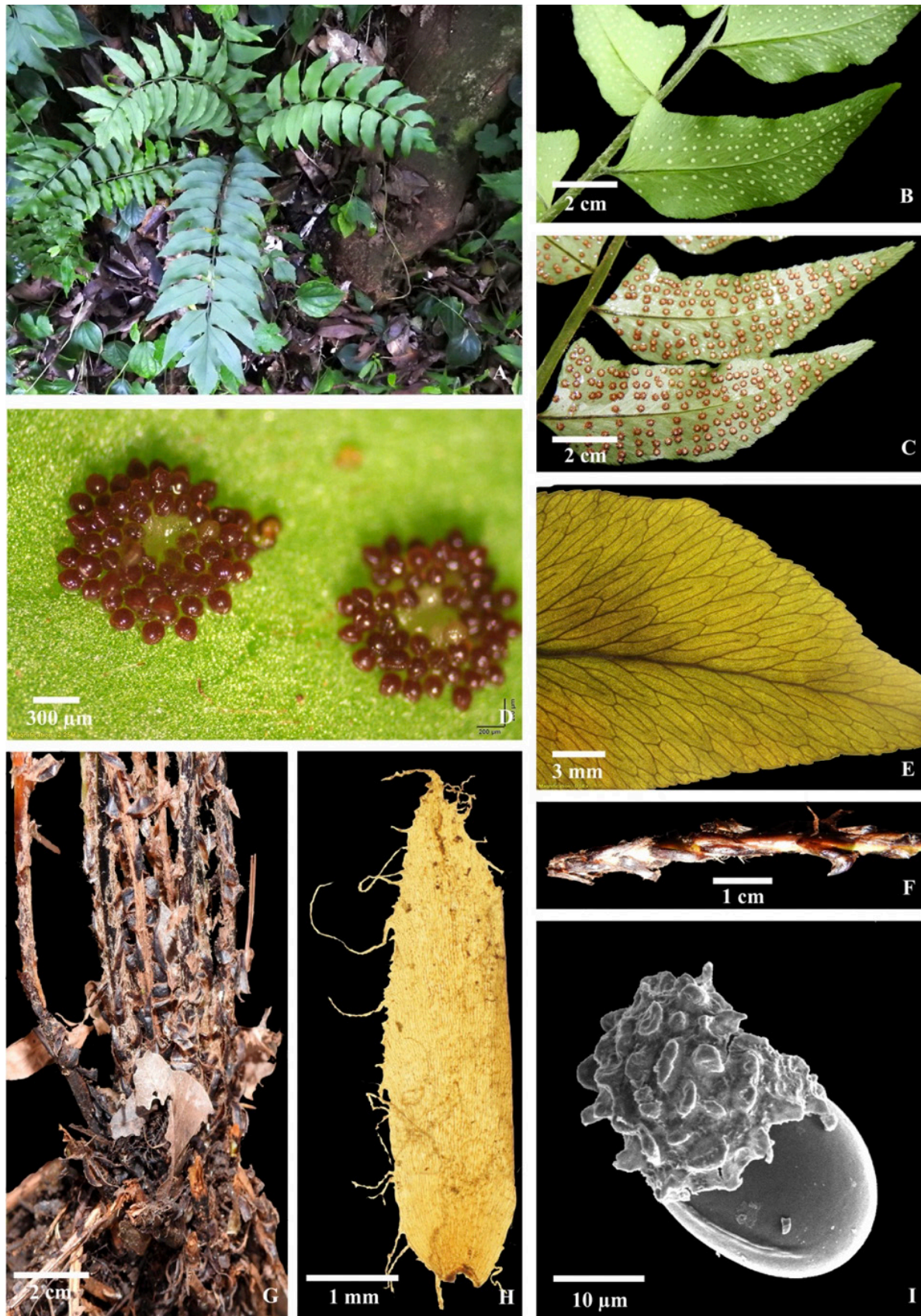


Image 1. *Cyrtomium micropterum* (Kunze) Ching: A—habitat | B&C—fertile fronds | D—close view of sporangia | E—anastomosing veins with included veinlets | F—stipe base | G—rhizome | H—scale | I—spore morphology under scanning electron microscope. © C. Bagathsingh.

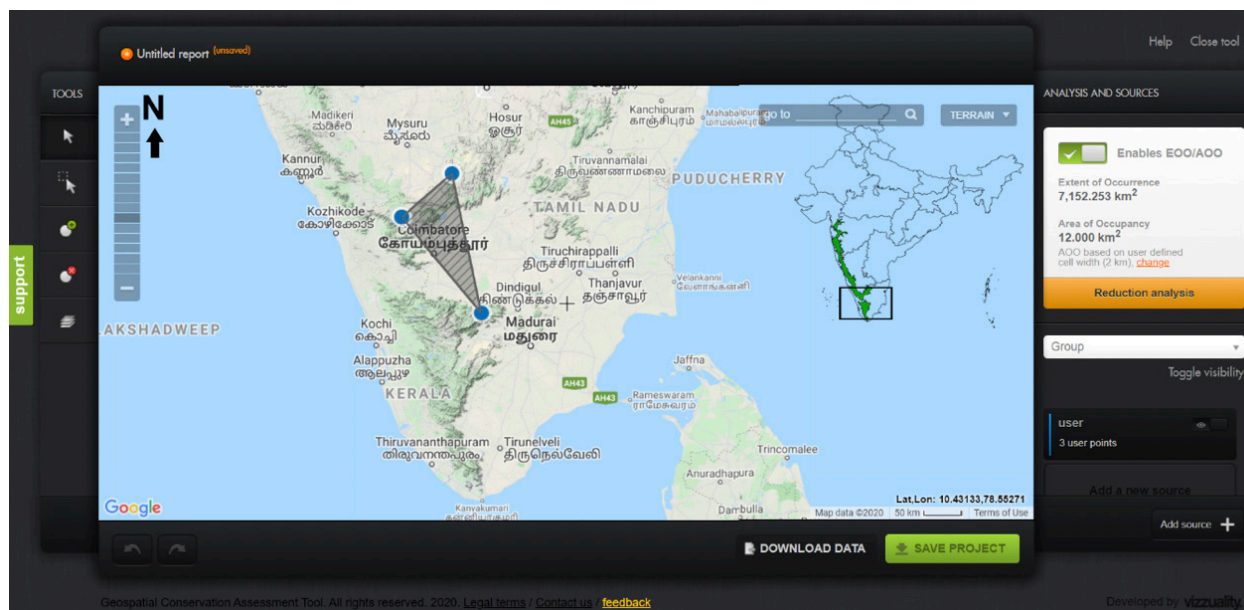


Image 2. Evaluation of area of occupancy and extent of occurrence of *Cyrtomium micropterum* (Kunze) Ching in India using GeoCAT.



Image 3. *Cyrtomium micropterum* (Kunze) Ching introduced at Botanical Survey of India, Pune.

km² which is more than threshold value for Endangered category, so it's not applicable for category assignment and the area of occupancy is estimated to be about 12.00km², which meets criterion B2 for Endangered category. The continuous decline in the quality of habitat (an increase of temperature, and a decrease of air humidity) and the number of mature individuals was observed due to extension of patrol roads, invasions of weeds, poor spore viability & germination rate, increased transport inside the reserve, and other anthropogenic activities which qualify for the Endangered category under sub-criteria B2a,b(iii,v). Due to the lack of adequate information on the number of mature individuals in localities and estimation & reduction in the

size of the population, we couldn't able to apply Criteria A, C, D, and E. Since the distribution of these species is restricted only to the southern Western Ghats of India, the influences of colonization from African countries is not possible. It is still unpredictable for the reason for its diminished capacity for colonization of new habitats in the Western Ghats, though the species is apogamic (development of sporophyte without fertilization). So the threat status of these species will get upgraded if the same trends continue (Detailed justification for this assessment is given in Appendix I)

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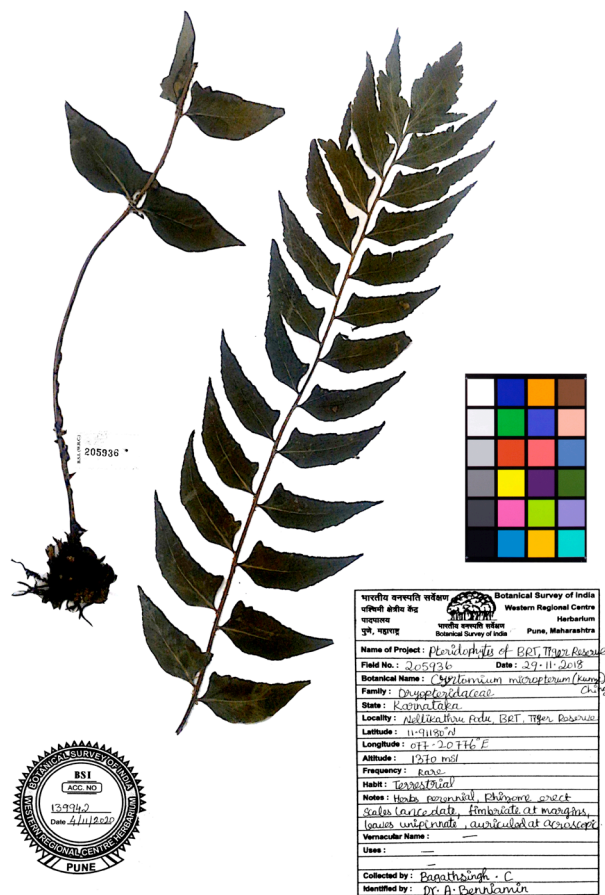


Image 4. Herbarium specimen of *Cyrtomium micropterum* (Kunze) Ching.

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Appendix I

Extent of Occurrence (EOO): EOO for the species was estimated to be 7,152.25km², calculated by using GeoCAT software (Bachman et al. 2011).

Area of Occupancy (AOO): AOO was calculated based on the cell width (2km × 2km) recommended by IUCN and it is estimated to be 12 km² by using GeoCAT software (Bachman et al. 2011).

Number of locations and its information: Based on the field experience by the second author for the last 20 years (1999–2020) in different seasons in India, the species is reported from only three localities, i.e., Perumal Peak of Palani Hills (Manickam 1981; Pounraj 2020), Nilgiris Guliar Reserve, Pachaikadu Shola, Kodanadu Valley in Tamil Nadu (Manickam 1991, 1992), Nellikathuru Podu range in BRT Tiger Reserve, Karnataka (2020, present report). As this species grows nearby roadsides, due to the widening of roads and tourist activities, the locations are severely fragmented. This is also one of the reasons for the rarity of the species. Active searches for the species from additional localities in the Western Ghats have been unsuccessful.

Population numbers and its trends: As far as the population numbers are concerned there are no early reports on mature individuals in any locality (Manickam & Irudayaraj 1992, 2002; Manickam 1994). Dr. V. Irudayaraj and Pounraj (pers. comm. 10.09.2020) have collected this species recently (2020) in Palani Hills and they have found only three mature individuals. While studying the fern diversity of Western Ghats (2004), the senior author (AB) could not relocate this species in Nilgiris and Palni hills in Tamil Nadu except in Kodanadu Valley. Continuous field survey, during the last five years (2016–2020) in different parts of Western Ghats, by the senior author (AB), has resulted in the observation of 25 individuals in the year 2016 and they were reduced to 10 mature individuals in 2019 and recently on 2020 they have been further reduced to only five individuals. Due to the widening of road and tourist activities, the number of individuals is gradually declining. A quite high number of mature individuals (25) were encountered in BRT Tiger Reserve, Karnataka (in 2018) and now it has reduced to 11 individuals. Nearly 70% and 45% population got decreased on the Nilgiris and in the BRT Tiger Reserve, respectively.

Threats: In general, all the populations in all the three localities are growing along shaded roadsides with an easy approach to human beings with periodic roadside cleanings by the local government. In the BRT Tiger Reserve, increased transport activities to the coffee estates within the reserve pose a serious threat to the population and impedes the growth of mature individuals, and most of the matured individuals were uprooted last year, during the expansion of patrol roads in the Reserve. Apart from the anthropogenic pressure, the habitat of *C. micropterum* in the Reserve has been invaded by notorious weeds such as *Chromolaena odorata* (L.) R.M.King & H.Rob., *Ageratina riparia* (Regel) R.M.King & H.Rob. The vigorous growth of these weeds often interrupt the growth of individuals by covering them all over.

Moreover, when compared to the common triploid apomictic *Cyrtomium caryotideum* (Chromosome count database), this diploid apomictic species does not require a humid atmosphere and it prefers to grow at high altitude on the eastward side (Nilgiris, Palni Hills, BRT), more or less on the same longitude of the Western Ghats, with the presence of more continental air masses with less humidity. With the climate change and increase of atmospheric temperature, this species struggles for survival in the existing locations without being able to spread to other localities.

Through this assessment, we strongly recommend conserving this species by both in vivo and in vitro (biotechnological) methods, since it has a high ornamental value. These species have been introduced in the botanical garden of Botanical Survey of India (BSI) Western Regional Centre, Pune as a part of ex situ conservation (Image 3).



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