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Cover: A male Scarlet Skimmer perching on vegetation by the banks of a waterbody. Ink and watercolour illustration by Anandita Pascal.

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ARTICLE

Ecology and conservation concerns of *Indianthus virgatus* (Marantaceae): an endemic species of the Western Ghats–Sri Lanka Biodiversity Hotspot

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Abstract: *Indianthus virgatus* (Roxb.) Suksathan & Borchs., a monotypic species of Marantaceae endemic to the Western Ghats–Sri Lanka biodiversity hotspot, holds important ecological, ethnobotanical, and conservation value. The present study aimed to understand the ecology of *I. virgatus* and to assess its current distribution, threats, and conservation needs. We compiled species' distribution data from herbarium records, online repositories, taxonomic literature, supplemented with field surveys (2023–2025), and ground validation across its range in the Western Ghats. Results indicate that *Indianthus* populations are generally small (10–50 m²) and fragmented, occurring in wet forest ecosystems and along plantation boundaries at elevations of 100–1,200 m. Phenological observations show that the species flowers year-round, with peak flowering during the monsoon. Major threats include habitat loss from agricultural expansion, plantation development, and road construction, compounded by competition from invasive species. While *Indianthus* is classified as Critically Endangered in Sri Lanka, its global conservation status remains unassessed by the IUCN Red List. This study provides baseline ecological, taxonomic, and distributional information, highlighting the species' vulnerability and underscoring the urgent need for conservation measures, including habitat protection, community engagement, and a formal global IUCN Red List assessment.

Keywords: Diversity, ethnobotanical value, habitat, invasive species monotypic, IUCN Red List, threatened flora.

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INTRODUCTION

The Western Ghats (WGs)-Sri Lanka biodiversity hotspot is home to a wide range of endemic plant species, many of which have developed unique adaptations to their specific habitats (Blicharska et al. 2013; Vignesh et al. 2024). *Indianthus virgatus* (Roxb.) Suksathan & Borchs., a monotypic species in the Marantaceae family, is one such plant. Endemic to this hotspot, it holds significant ecological, ethnobotanical, and conservation significance (Suksathan et al. 2009; Sangeetha & Rajamani 2019; Arumugam 2021; Vishnu et al. 2024). The Marantaceae family, known for its diversity in tropical ecosystems, includes several relict species such as *Donax canniformis* K.Schum. and *Stachyphrynium spicatum* (Roxb.) K.Schum., which are confined to specific, often isolated regions (Niissalo et al. 2016; Veldkamp & Turner 2016). *I. virgatus* primarily grows in fragmented, humid habitats across the WGs–Sri Lanka biodiversity hotspot (Suksathan et al. 2009). However, it is increasingly threatened by habitat degradation and human activities.

Despite being classified as Critically Endangered in Sri Lanka (The National Red List 2020), the IUCN Red List status of this species in the WGs–Sri Lanka biodiversity hotspot remains unassessed, highlighting a critical gap in its conservation strategy. Globally, 32 species of Marantaceae have been assessed under the IUCN Red List of Threatened Species, most of which are categorized as Vulnerable or Endangered (Table 1).

The disjunct distributions of wet-zone species in the Indian subcontinent (Karanth 2003), such as *I. virgatus*, reflect evolutionary processes where relict species, once part of widespread distributions, have become restricted to isolated patches due to historical climatic and ecological shifts (Hardie & Hutchings 2010; Tagliari et al. 2021). These species are often vulnerable to extinction because of their narrow ecological niches and limited adaptability to environmental fluctuations (Sax et al. 2013). In the case of *I. virgatus*, ongoing habitat loss due to agricultural expansion, urbanization, overexploitation, and climate change exacerbates the risk of extinction, particularly as its distributions are confined to small, fragmented areas (Vishnu et al. 2024). Despite these challenges, little is known about the population dynamics, distribution patterns, and ecological requirements of this species, limiting the ability to accurately assess its conservation status.

This study provides preliminary ecological insights into *I. virgatus* and the threats it faces within its native range in the WGs. Given the scarcity of prior ecological data for this species, we document its diversity, range delimitation, and taxonomic characteristics. These observations do not constitute a formal assessment but establish a baseline that highlights the species' distinctiveness and potential conservation concerns. With additional data on population size, threats, regeneration dynamics, and ecological requirements, this baseline could inform a more comprehensive evaluation and contribute to a future IUCN Red List assessment.

MATERIALS AND METHODS

Species distribution data of *I. virgatus* were compiled through herbarium consultations and opportunistic field surveys. Herbarium records were examined at the Kerala Forest Research Institute (KFRI), Herbarium of the French Institute of Pondicherry (HIFP), Central National Herbarium, Howrah (CAL), Calicut University Herbarium (CALI), Tropical Botanic Garden and Research Institute (TBGT), and the Botanical Survey of India herbaria at Coimbatore (MH) and Pune (BSI), following standard herbarium acronyms listed in the Index Herbarium. Online repositories (e.g., GBIF, Plants of the World Online) were also referred to for specimen citations and occurrence data (Supplementary Table 1).

Field visits were carried out across ~35–40 sites spanning Goa, Karnataka, Kerala, and Tamil Nadu between August 2023 and February 2025. These were opportunistic surveys, guided by herbarium records, literature, and local reports. At each location, GPS coordinates were recorded using a Garmin ETREX 32x. Opportunistic observations were made on habitat type, associated vegetation, and land-use pressures. Select sites were revisited multiple times to assess habitat stability and persistence of subpopulations.

Population size and patch structure were documented qualitatively, with estimates of patch extent (m^2) and approximate abundance categories (scattered individuals, small clumps, dense patches). Information on co-occurring species was obtained through opportunistic field observations, as systematic plot-based inventories were not conducted. Species threats, including invasive species, proximity to plantations, and ongoing road expansion near *I. virgatus* populations, were directly assessed in the field. Ethnobotanical knowledge was compiled from qualitative information shared by local communities and supplemented with data from published sources.

A few representative sites were repeatedly

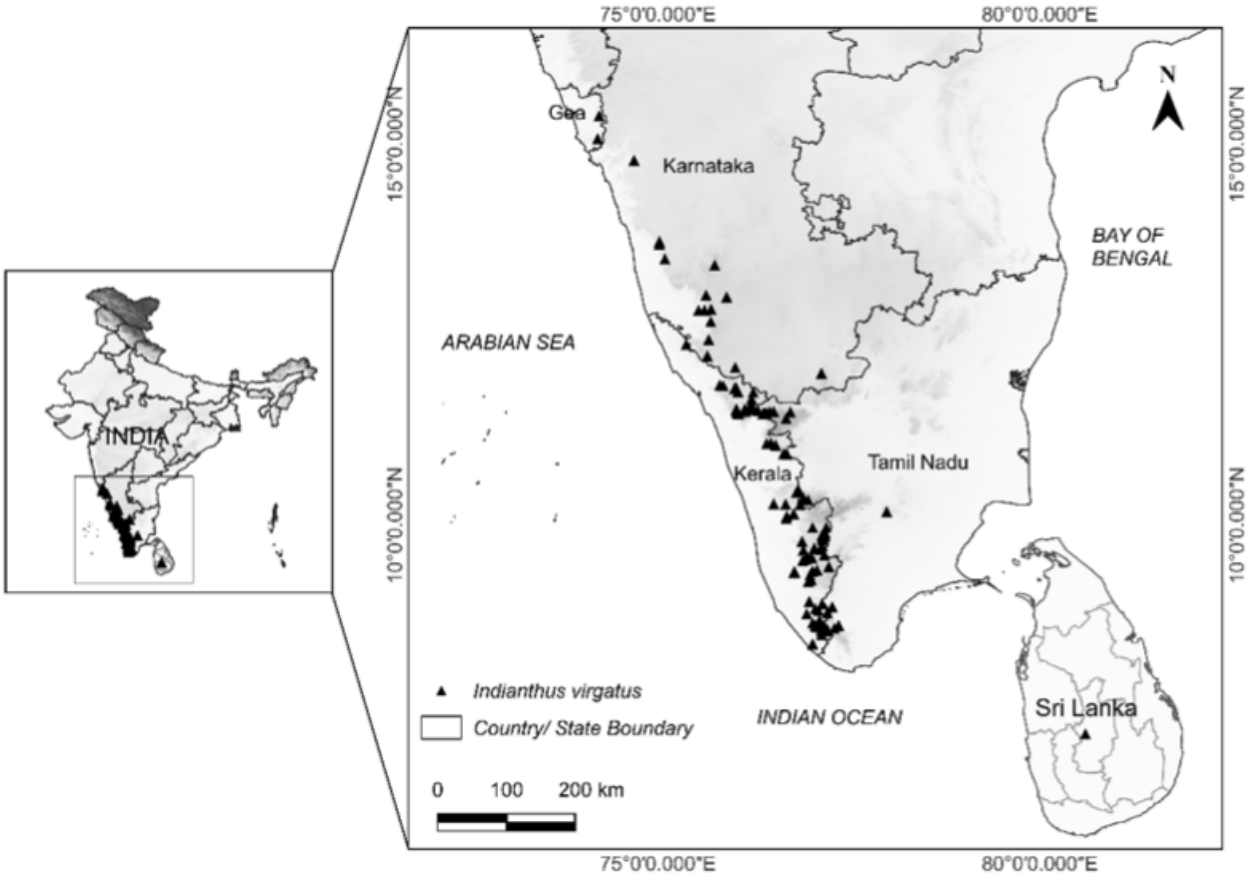

Figure 1. Map showing the distribution of *Indianthus virgatus* in India and Sri Lanka.

monitored through continuous field visits between August 2024 and February 2025 to assess population stability, habitat conditions, and land-use dynamics. In addition to distributional surveys, detailed taxonomic observations were carried out using both field collections and herbarium specimens. Photographs were taken with a Canon EOS 3000D camera, while flowers were dissected and imaged under a stereo microscope (Lawrence and Mayo; Model: LYNX LM-52-3621). The identification key was developed following Suksathan et al. (2009), with modifications based on a comparative study of herbarium collections and direct examination of live specimens (Supplementary Table 1). Taxonomic characters were described from field observations and comparative analyses with reference literature (Keshavamurthy & Yoganarasimhan 1990; Mohanan & Sivadasan 2002; Bhat 2014; Nayar et al. 2014).

RESULTS

Field surveys confirmed the presence of *I. virgatus* across numerous fragmented locations in the WGs, specifically in Goa, Karnataka, Kerala, and Tamil Nadu (Figure 1). Subpopulations were generally small, with patch sizes ranging from approximately 10–50 m² and an average of about 20 m². Historical herbarium records, spanning from 1857–2023, corroborated these observations, showing that the species has maintained a scattered and discontinuous distribution over time. In Sri Lanka, populations were largely restricted to the Central and Sabaragamuwa provinces, consistent with earlier reports of their critical endangerment in the wild.

Indianthus is a monotypic endemic genus confined to the wet zones of the WGs and Sri Lanka. The species is also reported from a few Myristica swamps in Kulathupuzha, Anchal, and Shendurney (Image 1). It thrives largely in moist and humid environments, favouring evergreen and semi-evergreen forest patches. The species is commonly found in swampy areas, particularly along the banks of perennial and temporary

streams, which provide consistent moisture essential for its growth and survival. It also occurs on rocky, sloping hills of tea, coffee, and cardamom plantations, often in proximity to forest boundaries. These habitats are typically located at mid and higher elevations, ranging 300–1,200 m, though populations can occasionally be found at lower elevations between 100 and 300 m. Many of its populations are located adjacent to plantations of tea, coffee, and cardamom, which share a similar ecological niche (Image 2). This overlap with human-modified environments emphasizes the need for conservation measures, as habitat disturbances can threaten its survival.

Phenology and Taxonomic History

Indianthus is a tall, perennial herb exhibiting flowering and fruiting throughout the year, with peak reproductive activity during the monsoon and post-monsoon seasons. This phenological pattern is strongly influenced by seasonal rainfall, as the species responds to the availability of moisture and favourable climatic conditions. Flowering and fruiting are rarely observed during summer (April–May), highlighting the species' reliance on monsoonal cycles for optimal reproductive performance. The holotype species, *Phrynium virgatum,* was first validated by Roxburgh in 1810. He observed that "it was found in the late Dr. Anderson's garden at Madras and subsequently introduced to the Botanic Garden at Calcutta". The specimen was initially reported to have been collected from Tinnevelly–Travancore. However, after several revisions concerning morphological and taxonomic distinctions, the species was reclassified into the distinct genus *Indianthus* by Suksathan et al. (2009), based on phylogenetic evidence.

Taxonomic Treatment

Perennial rhizomatous herb, forming dense tufts; stems erect, slender, simple, green, glabrous, three to six m tall (c. 10–18 ft), thickened at nodes; rhizome short, creeping, fibrous. Leaves distichous; sheath tubular, green; petiole slender, up to three cm long; lamina lanceolate, 15–45 × 4–20 cm, coriaceous, bright green, margin entire, apex cuspidate, base cuneate, surfaces glabrous; young leaves light green, becoming uniformly green at maturity. Inflorescence terminal, panicle, up to 70 cm long, dichotomously branched, many-flowered; pedicels slender, up to one cm long, with hairy prophyll two to three cm long. Flowers white, odourless, paired, bracts green, lanceolate, c. 3 × 0.2 cm, persistent; sepals three, lanceolate; corolla with five distinct petals, of which the two outer are petaloid, and the three inner are differentiated into two lateral obovate staminodes (0.6–0.8 cm long) and a third united with the single fertile stamen to form a petaloid structure bearing the anther. Inner staminodes smaller, inconspicuous. fertile stamen one, anther basifixed; ovary inferior, trilocular; style slender, curved, stigma curved, three-lobed. Fruit is a green, dehiscent capsule with a persistent perianth; seeds one to three, ellipsoidal, glossy (Image 1).

Vernacular name: Malabar Arrowroot (English), Kattu Kuva, Kuva (Malayalam), Koovai, Malakkuvai (Tamil), Geta-oluwa (Sinhala), Koove (Kannada).

Specimens examined: West Bengal, Calcutta Botanic Garden, Royle, PH00017033 (CAL!); Travancore/ Tinnevelly (Holotype), s. coll. #6616A–D, K001124308–K001124310 (CAL!); India, Wallich N. #6616, K000357867 (CAL!). India, Kerala, Thrissur, Kollathirumedu, Vazhachal, 06.vii.1988, N. Sasidharan.; MH 7451 (MH!); Tamil Nadu, Courtallam, K. Subramanyam, 100865 (CALI!); Kerala, 8 km from Athirumala, Thomas V.P. & Prasanth A.V. 02.iii.2008, 103044 (CALI!); Kerala, Pambla Dam, Dani Francis & Prof. Santhosh Nampy. 08.iii.2017, 152012 (CALI!); Kerala, Calvary Mount, Dani Francis & Santhosh Nampy. 06.ix.2017, 154367 (CALI!); Kerala, near Valara Waterfalls, Dani Francis & Santhosh Nampy. 27.xii.2017, 156530 (CALI!); Tamil Nadu, Nadugani, 26.ii.1970, J.L. Ellis. 33599 (MH!); Tamil Nadu, Kulivayal, 25.vii.1972, E. Vajravelu. 41791 (MH!); Tamil Nadu, Gudalur, 11.iii.1969, D.B. Deb. 31666 (MH!); Tamil Nadu, Devala, Ooty, 12.i.1927, J.S. Gamble. 15602 (MH!); Kerala, KFRI 4940; Sri Lanka, Peradeniya, Thwaites G. 1855, *Clinogyne virgata* (Roxb.) Benth. PDA!

Distribution Delimitation

Indianthus virgatus has frequently been listed in several botanical databases, including in Plants of the World Online (POWO), to occur in India, Sri Lanka, and the Andaman Islands. In Florae Indicae Enumeratio: Monocotyledonae (Karthikeyan et al. 2009), the species was treated under the synonym *Donax virgata* (Roxb.) K.Schum. in Bot. Jahrb. Syst. 15: 440 (1892) and cited as distributed in the Andaman & Nicobar Islands, India, and Sri Lanka. This treatment has subsequently been adopted in later compilations and online platforms, which may have reinforced a distributional ambiguity. Field surveys, critical examination of herbarium collections, and a review of floristic literature indicate that there are currently no verifiable specimens or authentic records confirming the species' distribution in the Andaman Islands. All confirmed records are restricted to the WGs of India and Sri Lanka. The geological history of the Andaman Islands, which are

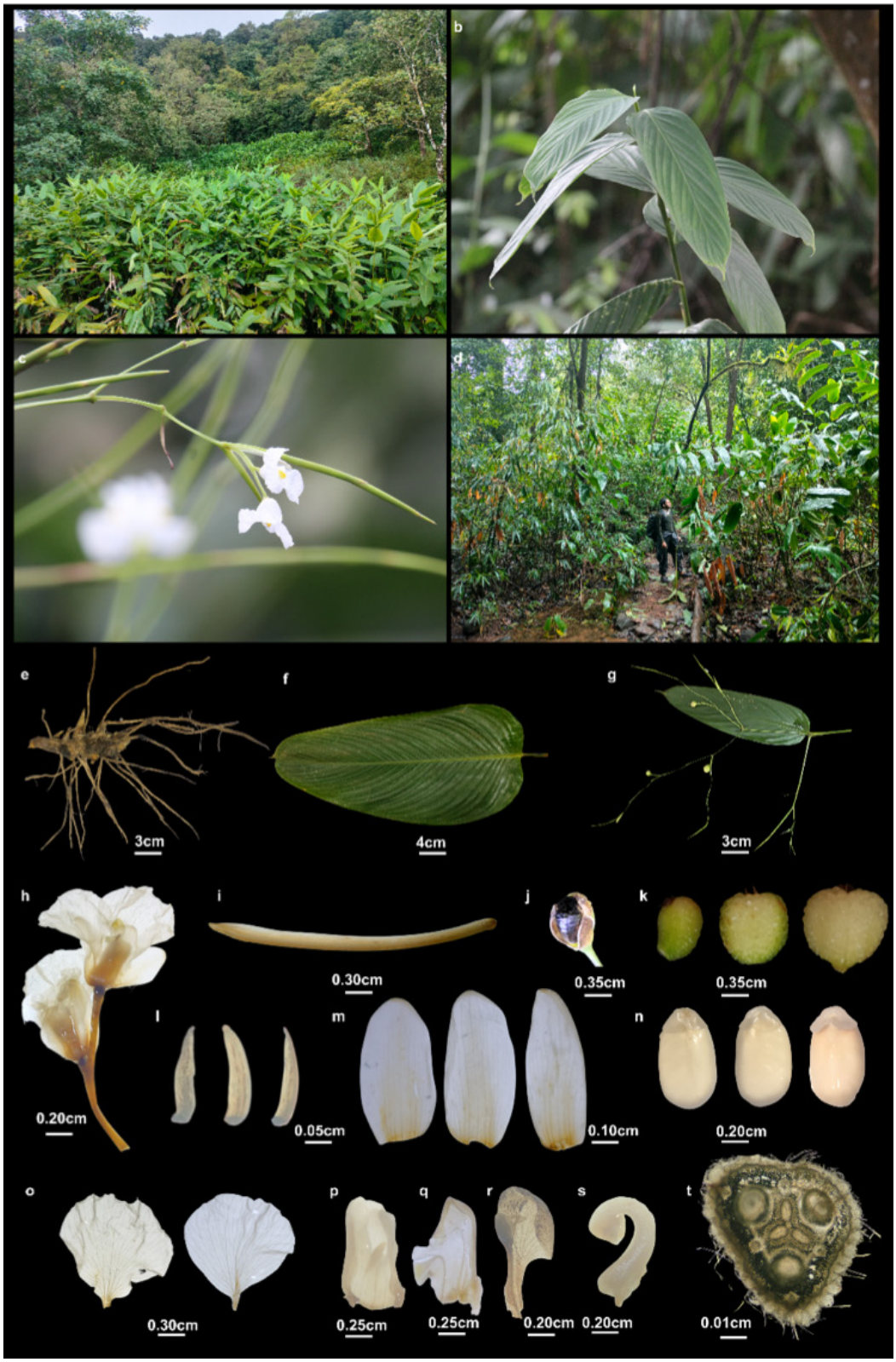

Image 1. ***Indianthus virgatus*** **(Roxb.) Suksathan & Borchs.: a—Dense understory population in Ranipuram, Kerala (CWGs) | b—Young and mature distichous leaves showing lanceolate lamina and glabrous surfaces | c—Paired white flowers | d—Individuals in a shaded forest understorey | e—Short fibrous rhizome | f—Single leaf showing coriaceous texture, entire margin, and cuspidate apex | g—Leaf with inflorescence branches, Panicle | h—Paired white flowers | i—Hairy prophyll | j—Dehiscent capsule | k—one, two, three seeded fruit | l—bracts - three | m—calyx - three | n—Seeds - three glossy | o—Outer petals - two | p & q—Petaloid staminode | r—Epipetalous stamen, basifixed | s—Stigma curved | t—Transverse section of the ovary showing trilocular structure. © Shreekara Bhat Vishnu.**

Image 2. The habitat degradation and population decline of *Indianthus virgatus* in the Western Ghats. In Wayanad. a—The species is observed growing alongside the invasive *Mikania micrantha*, while in other areas | b—Encroachment by *Tithonia diversifolia* has led to noticeable reductions in population. In Kallar, Thiruvananthapuram | c—*Indianthus* individuals were found within dense *Mucuna bracteata* cover, indicating altered habitat conditions | d—Patch size was drastically reduced due to clearing of vegetation surrounding the roads, Gaalibeedu, Madikeri | e—Few individuals of *Indianthus* surviving on the edge of plantations, Idukki | f—Landslides, proximity to cardamom plantations where *Indianthus* has been washed out, Idukki | g–h—Highway expansion in Sakleshpura (KA) resulted in the destruction of more than 50–60 % of the *Indianthus* habitat and subpopulations. Remaining fragments of *I. virgatus* in Thiruvananthapuram (Kallar) | i—*I. virgatus* adjacent to streams and rubber plantations. © Shreekara Bhat Vishnu.

Table 1. IUCN Global and Sri Lanka National Red List status of Indian Marantaceae species.

Species	IUCN Status (Global)	National Red List (Sri Lanka)
Donax canniformis (G.Forst.) K.Schum.	-	-
Indianthus virgatus (Roxb.) Suksathan & Borchs. (*Schumannianthus virgatus* (Roxb.) Rolfe)	-	CR B2ab(i,ii,iii) (PE)
Maranta arundinacea L.	Not Applicable (cultivated)	-
Phrynium imbricatum Roxb.	-	-
Phrynium nicobaricum Didr.	-	-
Phrynium pubinerve Blume (*Phrynium rheedei* Suresh & Nicolson)	-	EN B1ab(i,ii,iii) +2ab(i,ii,iii)
Schumannianthus dichotomus (Roxb.) Gagnep.	-	-
Stachyphrynium placentarium (Lour.) Clausager & Borchs.	-	-
Stachyphrynium repens (Retz.) K.Schum.	-	-
Stachyphrynium spicatum (Roxb.) K.Schum. (*Stachyphrynium zeylanicum* (Benth.) K.Schum.)	LC	CR(PE)
Thalia geniculata L.	Not Applicable (cultivated)	-

part of the Burma–Java subduction arc and have never been connected to mainland India–Sri Lanka (Pal et al. 2003), does not support a vicariance explanation for the species' distribution. Furthermore, dispersal seems improbable, since *I. virgatus* produces capsular fruits with arillate seeds dispersed primarily by ants (Horvitz & Beattie 1980), a mechanism poorly suited for transoceanic transport. Overall, these observations suggest that reports of *I. virgatus* from the Andaman Islands should be regarded as unsubstantiated until supported by verifiable collections.

Habitat Destruction and Threats

The species in the southern WGs is distributed in Myristica swamps, which are a Critically Endangered ecosystem in itself. Further north, across the central WGs, the species' distribution is found adjacent to tea- coffee plantations and highways. As per our field observations, these areas are highly uncertain and dynamic due to changing landscapes, ongoing road construction, and plantation expansions. Invasive species such as *Chromolaena odorata* (L.) R.M.King & H.Rob., *Mikania micrantha* Kunth, *Tithonia diversifolia* (Hemsl.) A.Gray, *Miconia crenata* (Desr.) DC., *Lantana camara* L., and *Mucuna bracteata* DC. ex-Kurz were also found co-occurring with *I. virgatus* (Image 2), which may inhibit the growth and expansion of its subpopulations as these invasive species are shown to have negative allelopathic effects (Del Fabbro & Prati 2015; Thiébaut et al. 2019). In the CWGs, Goa represents the northernmost distribution record of *Indianthus,* which occurs in less than five fragmented sites (Datar et al. 2005; Datar & Lakshminarasimhan 2013). These distributions are largely confined to areas adjacent to plantations and lie outside protected regions, highlighting their extreme vulnerability.

Use and Trade

Indianthus virgatus is widely utilized by tribal communities in Kerala and Tamil Nadu, including the Mulla Kurumba, Kuruchiya, and Kani tribes. Its leaves and rhizomes are traditionally used to treat ailments such as dysentery and skin diseases (Silja et al. 2008; Rajith & Ramachandran 2010; Sangeetha & Rajamani 2018, 2019). Interactions with local communities further revealed ethno-veterinary applications, such as employing the leaves to alleviate joint pain in livestock. Beyond medicinal applications, *I. virgatus* plays an important ecological role. For example, the field observations indicate that *I. virgatus* is among the preferred feed for elephants and wild boars, while also serving as a nectar source for butterflies and other faunal assemblages. The species also holds significant cultural and culinary value. In parts of Kerala and Karnataka, its leaves are used as an alternative to banana leaves for preparing traditional dishes and are used in hotels across the southern WGs for daily meal service. In a prominent Kerala temple, the leaves are used to serve prasadam. During the rainy season, leaves are used to make protective coverings against rain, locally referred to as '*Gorabalu*' in Kannada. Near Kulathupuzha, leaves are harvested daily for similar purposes.

These diverse ethnobotanical practices underline the cultural, medicinal, ecological, and commercial significance of *I. virgatus*, emphasizing the importance of further research on its applications, sustainable use, and conservation.

Conservation Status of Indian Marantaceae

Although *I. virgatus* is listed as Critically Endangered in Sri Lanka (CR B2ab (i,ii,iii); The National Red List 2020), it has not yet been evaluated for the global IUCN Red List. A review of other Indian Marantaceae indicates that most species remain unassessed globally, despite several being regionally rare or threatened. Table 1 summarizes the IUCN Global and Sri Lanka National Red List status of selected Indian Marantaceae, highlighting significant gaps in conservation evaluation. These findings emphasize the need for formal global assessments and conservation prioritization of endemic and relict taxa, given their restricted distributions and susceptibility to habitat disturbance.

CONCLUSION

The present study represents the first comprehensive attempt to document the taxonomy, distribution, and threats to *I. virgatus*, a monotypic taxon of high conservation value. By combining field observations, herbarium and live specimen studies, and opportunistic records of co-occurring species, we were able to delineate its ecological niche and highlight the fragility of its remaining populations. Our findings indicate that *I. virgatus* exists in fragmented patches, confined to habitats that are under pressure from plantations, road construction, and invasive species. Since the species is habitat-specific and sensitive, these conditions not only threaten the survival of existing populations but also limit the species' potential for natural regeneration and population expansion. Given its restricted range, observed population decline, and vulnerability to

Key to selected Asian Marantaceae genera

1a. Plants without real above-ground stems, forming ground-level rosettes of leaves **2**
1b. Plants with distinct above-ground stems (caulescent) **3**
2a. Flower groups strongly compact (brachyblastic); bracteoles absent; sepals short (≤⅓ length of corolla tube); fruit dehiscent, one to two seeded ..... ***Stachyphrynium***
2b. Flower groups brachyblastic or sub-brachyblastic (slightly elongated); bracteoles absent or one per flower; sepals ≥½ as long as corolla tube; fruit dehiscent, one to three seeded ..... ***Phrynium***
3a. Inflorescence a terminal panicle up to 70 cm; flower groups dolichoblastic; bracteoles absent; stamen with large petaloid appendage; fruit three-seeded, dehiscent ..... ***Indianthus***
3b. Inflorescence not a large terminal panicle; flower groups dolichoblastic, two-flowered **4**
4a. Bracteoles absent; corolla tube shorter than lobes; fruit three-seeded, dehiscent ..... ***Schumannianthus***
4b. Bracteoles present, small and glandular; stems tall, branched; fruit one- to two-seeded, indehiscent ..... ***Donax***
4c. Bracteoles absent, fruit one-seeded, indehiscent, caryopsis-like ..... ***Halopegia***

ongoing habitat disturbances, *I. virgatus* requires urgent conservation action. A formal assessment by the IUCN Red List is crucial to provide global recognition of its threatened status and facilitate policy-level interventions. Additionally, community engagement and habitat protection strategies will be essential to protect the species and its unique microhabitat.

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