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Lagenandra rubra (Araceae), a new endemic species from Sinharaja Man and Biosphere Reserve, Sri Lanka

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Abstract

During the revision of the genus *Lagenandra* in Sri Lanka we encountered a new species *Lagenandra rubra* from the Sinharaja Man and Biosphere Reserve of Sri Lanka. The new species can be differentiated from all other described *Lagenandra* species by its glossy dark red-maroon twisted limb and the absence of warts on the spathe. With the newly described species, the number of endemic Sri Lankan species of *Lagenandra* rises to fourteen, and the global total rises to twenty-three. Based on the IUCN Red List categories and criteria, the new species is assessed as Critically Endangered under Criterion CR B1ab (ii, iii, iv, v) +2ab (ii, iii, iv, v).

Key words: Biodiversity conservation, Critically endangered, flora of Sri Lanka, Ornamental aquatic plants, Taxonomy

Introduction

The genus *Lagenandra* Dalzell (1852: 289), is an evergreen perennial herb belongs to family Araceae, indicating restricted distribution across Sri Lanka, India and Bangladesh (POWO, 2024). *Lagenandra* is an amphibious/rheophytic plant genus that harbors 22 species (Sivadasan & Babu 1995, Sivadasan *et al.* 2001, Biju *et al.* 2018, Sasikala *et al.* 2019, Madola *et al.* 2021a, Madola *et al.* 2021b, Madola *et al.* 2022; Madola *et al.* 2023a, Mathew *et al.* 2023). Some members of this genus are well-known in the aquarium industry for their ornamental value, resulting from their attractive foliage and inflorescences. This has led to the extraction of these plants from wild Sri Lankan populations by collectors from their natural habitats, leading to the decline in populations (Yakandawala, 2012) and specifically leading to extinction from the wild as some of them are recorded only in a single location. All most all of these species are restricted to Wet Zone of the country and locally known as කෙතල (‘Kethala’).

Sri Lanka harbor 14 species of which 13 are endemic to the country (Nicolson 1987, Madola *et al.* 2021a, Madola *et al.* 2021b, Madola *et al.* 2022, Madola *et al.* 2023a). Interestingly, five endemics with two varieties, *Lagenandra kalugalensis* Madola, Yakand. & K.Yakand. in Madola *et al.* (2021b:190–193); *L. limbusleviterapertae* Madola *et al.* (2023: 63-69); *L. peradeniyae* Madola *et al.* (2022:120) var. *peradeniyae*; *L. peradeniyae* var. *speciosa* Madola *et al.* (2022:120); *L. srilankensis* Madola, Yakand. & K.Yakand. in Madola *et al.* (2021:193–197) and *L. wayambae* Madola *et al.* (2021a: 217–220), of these 13 species were described recently based on the present taxonomic study that initiated in 2018. Plant taxonomic studies are crucial for the conservation of biodiversity as they provide essential information for identifying, classifying, and understanding plant species, enabling effective protection and management of ecosystems. By accurately cataloging plant diversity, taxonomists help in recognizing rare and endangered species, which is vital for prioritizing conservation efforts. In 2023, we were able to re-discover *Lagenandra erosa* de Wit (1978: 36–38) (Madola *et al.* 2023b) which is listed as a Critically Endangered Possibly Extinct [CR(PE)] species in the National Red list 2020. Additionally, understanding the diversity and connections among plant species can inform

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ecological restoration projects and ensure the sustainability of habitats. These studies also contribute to the discovery of new species, which can have significant implications for medicine, agriculture, and ecosystem services.

During field exploration, we encountered an undocumented *Lagenandra* species in the Sinharaja Man and Biosphere Reserve (MAB). This species was later identified as a new taxon endemic to Sri Lanka and is now described and illustrated.

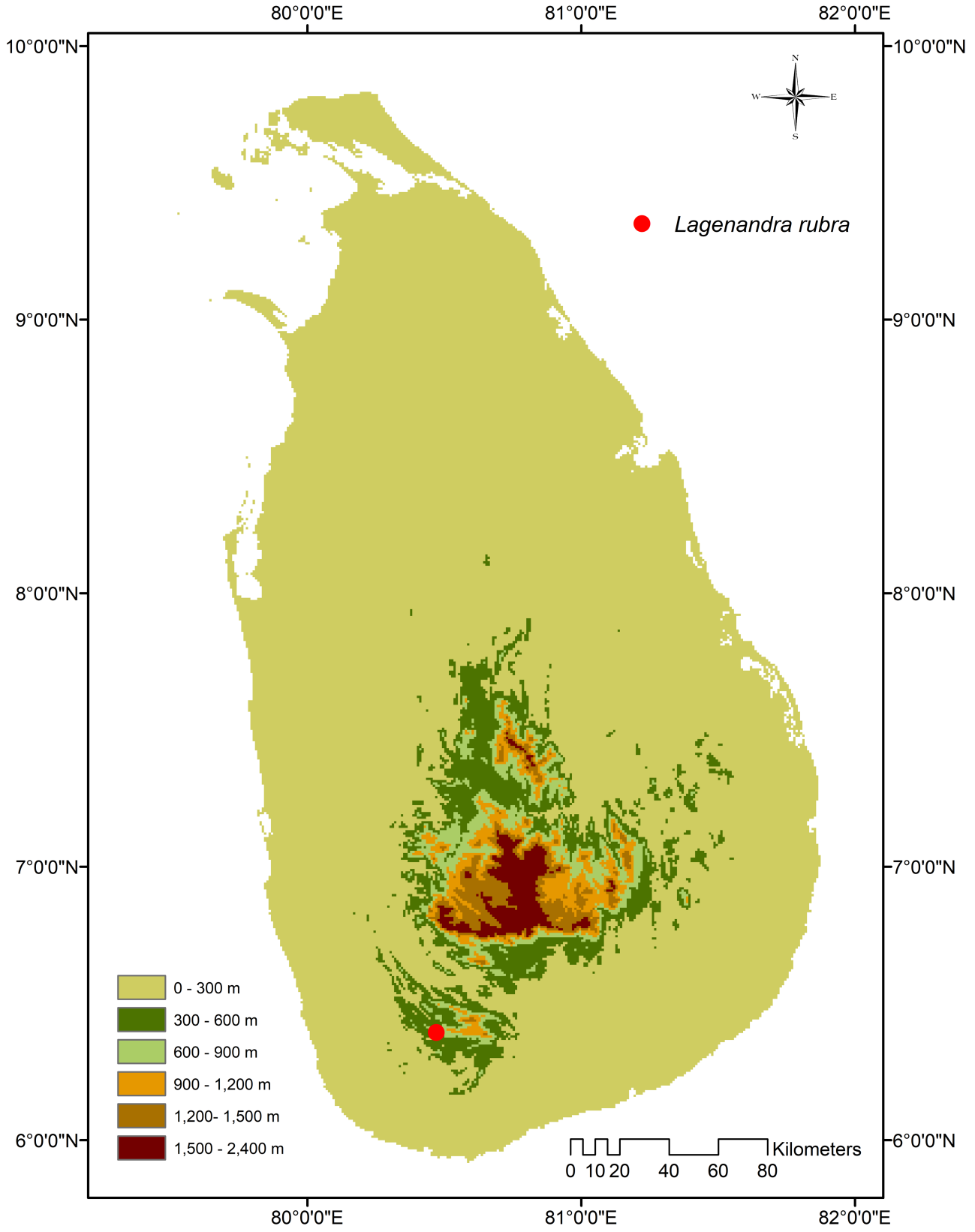

FIGURE 1. Distribution of *Lagenandra rubra* in the island of Sri Lanka.

Materials and methods

The second author came across an un-identified population of *Lagenandra* on February 2022 in a stream close to Lankagama in the Sinharaja MAB Ratnapura District in Sabaragamuwa Province of Sri Lanka (Fig. 1). The population was monitored for flowering and fruiting. The morphological features (Both quantitative and qualitative morphological characters) of the field collected specimens were studied in detail in the laboratory. The morphological features listed were compared with described herbarium specimens of *Lagenandra* species; National Herbarium, Royal Botanic Gardens, Peradeniya (PDA, herbarium codes according to Thiers 2024+), Sri Lanka and on-line herbaria and resources; JSTOR Global Plants (2024), GBIF (2024), Smithsonian: The National Museum of Natural History (2024), *Lagenandra* web page maintained by a collector (Bastmeijer, 2024) and, published literature (de Wit 1978, Graaf & Arends 1986, Nicolson 1987, Sivadasan & Babu 1995, Sivadasan *et al.* 2001, Biju *et al.* 2018, Sasikala *et al.* 2019, Mathew *et al.* 2023).

All locations were recorded using a Global Positioning System (Garmin Etrex 10, USA). Observations related to habitat health were also recorded. Distribution maps were prepared using ArcGIS version 10.4 software (ESRI 2017) and the Area Of Occupancy, AOO (The area of suitable habitat currently occupied by the taxon) and Extent Of Occurrence, EOO (The area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy) were calculated. Conservation assessments were carried out based on IUCN guidelines 2024.

Taxonomic treatment

Lagenandra rubra Madola, Jayasinghe, Yakand. & K.Yakand., *sp. nov.* (Figs. 2–5)

The spathe of L. rubra slightly resembles that of L. toxicaria var. barnesii Fischer (1938:126) but could be separated by the spathe color been glossy dark red-maroon oppose to light greenish pink/pinkish cream or very pale brown spathe; long limb (ca. 8.0–11.5 cm) oppose to shorter limb (ca.3.0 cm); longer spadix (ca. 2.4–2.6 cm) oppose to shorter (ca. 1.8 cm); lower number of pistillate (ca. 40–45) and staminate flowers (ca. 94–100) oppose to larger number (ca. 70–80 and ca. 175–200 respectively). The leaves resemble those of L. limbusleviterapertae, but can be differentiated by the presence of undulate margins.

Type:—SRI LANKA, Sabaragamuwa Province, Rathnapura District, Sinharaja Man and Biosphere Reserve, 577 m asl. 08 March 2022, *Madola, Jayasinghe, Yakandawala* & *Yakandawala L259* [holotype PDA! (PDA00109887), isotypes PDA! (PDA00109888, PDA00109889), K!].

Evergreen large herb with creeping to erect rhizome ca. 1.8–2.3 cm in diam. Cataphylls ca. 11.0–15.0 cm, dark maroon. Petiole ca. 18.0–36.0 cm long, ca. 0.3–0.6 cm wide, sheath ca. 2.0–4.5 cm long, unequal. Leaf blades upper surface green, lower surface light green, blades more or less oblong, apex narrowly acute, base gradually tapering/acute, margin undulate, blade ca. 22.5–32.0 × 5.0–7.5 cm; midrib visible on upper surface. Peduncle ca. 2.5–8.0 cm long, 0.5–0.7 cm width. Spathe glossy dark red-maroon, warts absent, ca. 18.5–20.7 cm long, kettle ca. 2.0–5.5 × 0.5–1.6 cm, glossy dark maroon longitudinal striations inside; limb ca. 8.0–11.5 × 3.5–5.5 cm, twisted; tail ca. 5.5–8.5 × 0.1–0.3 cm. Spadix ca. 2.4–2.6 cm long; pistillate flower zone ca. 0.4–0.5 × 0.5–0.7 cm; sterile zone ca. 1.0–1.2 cm long; staminate flower zone ca. 0.6 × 0.4 cm; appendix ca. 0.3–0.4 × 0.3–0.4 cm. Pistils ca. 40–45. Staminate flowers ca. 94–100.

Distribution and phenology:—To date distribution of *L. rubra* appears to be restricted to a single locality in Sri Lanka, in the Sinharaja MAB. During the initial observations we recorded nearly 100 individuals, however during the subsequent visits we have noticed a reduction in the number of individuals and at present only around 60 individuals survive. This population is situated at the top of a small waterfall created by the streamlet. The population consisting of both mature and young individuals which are distributed along the bank and in small rock pockets of this streamlet spread over about 5 m distance.

Sinharaja (MAB) is one of the largest tropical rainforest (11331 ha) in southwestern lowlands of Sri Lanka, rich in floral and faunal diversity. It is located in the Sabaragamuwa and Southern provinces, spanning the Ratnapura, Galle, and Matara administrative districts. Sinharaja Forest Reserve was nominated as UNESCO's World Heritage site in 1988. The Western Ghats and Southwestern Sri Lanka are considered one of the 34 biodiversity hotspots, including the Sinharaja MAB (Myers *et al.* 2000, Mittermeier *et al.* 2004, 2011). This highlights both the region's high endemism

and the environmental threats it faces, especially due to anthropogenic activities. The majority of the endemics are in the south western region including the low country wet zone and the central highlands of the country (Gunatilleke & Gunatilleke 1991, Senanayake 1980). In addition to *L. rubra*, the forest reserve harbors several other important threatened amphibious and aquatic plant species, such as *L. bogneri* de Wit (1978: 33–34), *L. thwaitesii* Engler (1879: 621), *Aponogeton rigidifolius* Bruggen (1962: 91), and *Cryptocoryne* Fisch. ex Wydler (1830: 428). However, it is important to note that between 1972 to 1977, Sinharaja forest reserve was significantly destructed by logging activities to supply timber to the plywood industry (Sri Bharathie 1979, NCR 1997).

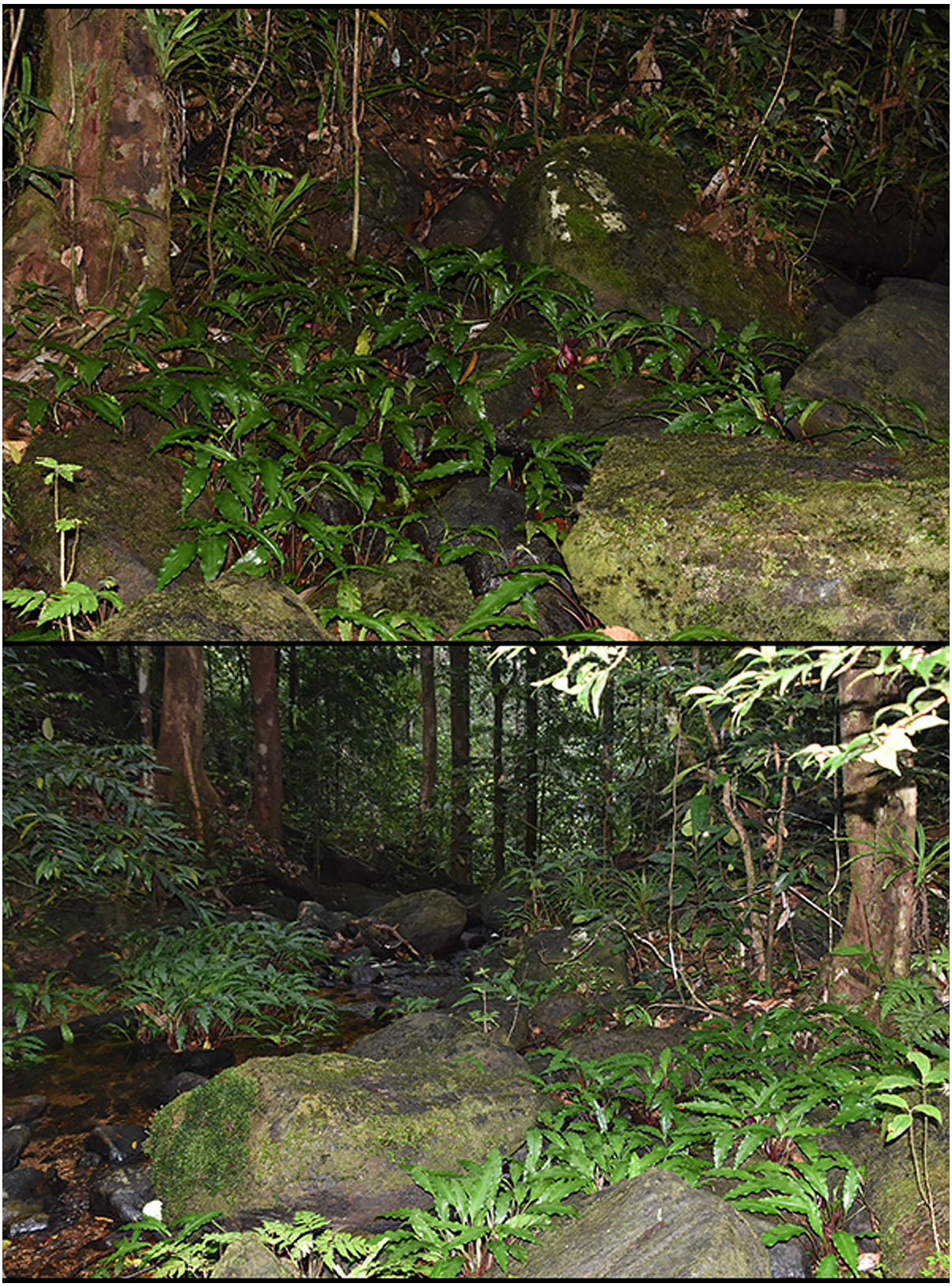

FIGURE 2. Habitat of *L. rubra*.

FIGURE 3. Habit of *Lagenandra rubra*.

FIGURE 4. *Lagenandra rubra*; A. Leaf. B. and C. Spathe from different angles showing the opening in the limb. D. Kettle with the spadix. E. Pistillate flower zone. F. Appendix and staminate flower zone.

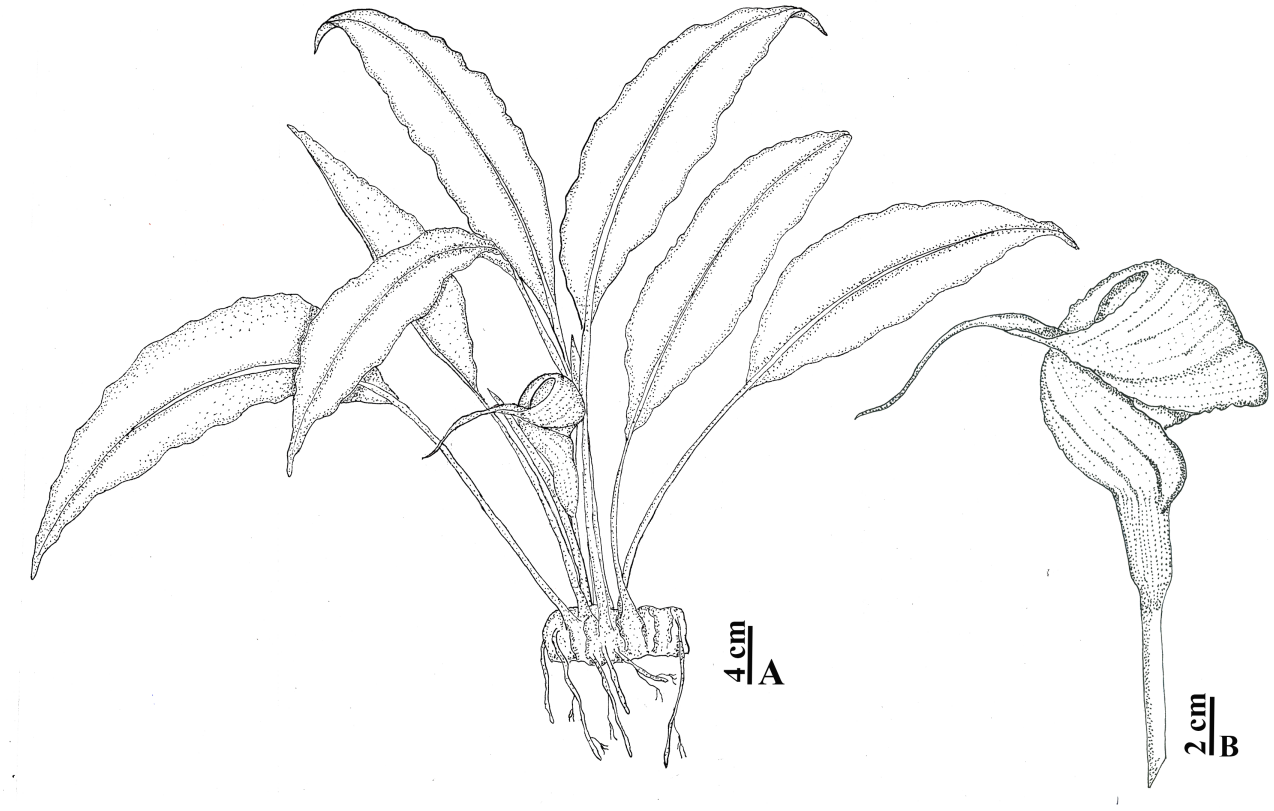

FIGURE 5. *Lagenandra rubra*; A. Habit. B. Spathe.

Peak flowering of *L. rubra* was observed from February to April. However, despite several visits to the site during the period from 2022 to 2024, we were unable to observe fruiting following the flowering season. The only instance of observing immature fruit was in May 2023. Due to heavy rains during the monsoon season, which created rapid water currents, we were unable to observe any mature fruit during subsequent field visits.

Habitat:—The plants inhabit a shady streamlet in a Primary Tropical Rainforest.

Eponymy:—The specific epithet *rubra* highlights the distinctive red-maroon color of the spathe.

Vernacular name:—රත් කෙතල ‘(Rath Kethala)’.

Other specimens examined (paratypes):—Lankagama-Ilumba kanda trail, 2022 Feb 23, *H.Jayasinghe, D.Dhanushka, S.Kanishka HDJ 1493* (PDA! PDA00109825).

Proposed conservation status:—So far *L. rubra* has been found only from its type locality. Estimates for its EOO and AOO are 4 km^2 due to its occurrence in only one locality. Considering Criteria B, both under sub criterion B1 and B2, EOO (<100 km^2) and AOO (<10 km^2) *L. rubra* meets the CR thresholds. However, in order to qualify for this threatened category, species must meet at least 2 conditions of the three specified (a), (b) and (c). The habitat of *L. rubra* is an evergreen tropical forest but is continuing decline or degraded due to fast water currents occurred perhaps due to intensified rain fall catalyzed by climate change. Further Rhizomes were eaten by wild boars as well. Now the population has reduced compared to the first sighting. Hence an immediate ex-situ conservation program is needed. The genus is pollinated by insects and the decline in seed set could be attributed for the absence of the particular insects (Order Diptera) in the environment. In addition to habitat loss, decline in area of occupancy, no of locations and the population size qualifies for both sub-criteria (a) and (b). Further there is no information available to determine if any extreme fluctuations are happening for this species. Further *L. rubra* could be evaluated under Criterion D, very small or restricted population which increase the risk of extinction. With a population size of around 60 *L. rubra* qualify for Endangered category (EN D). During the evaluation of the IUCN Red List conservation status of a taxon under more than one category resulting different statuses, it is recommended to select the highest threatened category for which the taxon qualifies. Therefore, *L. rubra* qualifies to the CR category under criterion B, CR B1ab (ii, iii, iv, v) +2ab (ii, iii, iv, v).

Taxonomic Key

A taxonomic key modified from Nicolson (1987), Madola *et al.* (2021a), Madola *et al.* (2021b), Madola *et al.* (2022), and Madola *et al.* (2023), including the new species, *L. rubra* is given below.

Note that Crusio & Graaf (1986) recognized *L. dewitii* as a species occurring in the country, but according to Nicolson (1987) the species is a variation of *L. praetermissa* and therefore not considered as a separate species.

1. The whole spathe, standing well above the leaves. Leaves aligned more or less parallel to the substrate ..... *L. peradeniyae*
- Spathe placed below the leaves, in some cases only the tail and limb are placed above the leaves (*L. bogneri* and *L. erosa*). Leaves not placed horizontally on the soil 2
2. Spathe distinctly warty outside 3
- Spathe smooth or merely roughened outside by papillae 6
3. Warts large (1.5–3.0 mm long); spathe limb abruptly globular-inflated above the kettle ..... *L. ovata* (Linnaeus 1753: 967) Thwaites (1864: 334)
- Warts small (to 1.0 mm); spathe limb subcylindric 4
4. Spathe large (more than 10 cm long); pistillate flowers more than 60 ..... *L. praetermissa* de Wit (1983: 299)
- Spathe small (up to 10 cm); pistillate flowers less than 40 5
5. Spathe outside with few distinct irregular warts. Leaves linear lanceolate to linear ovate ..... *L. wayambae*
- Spathe outside, rugose or distinct warts. Leaves broadly elliptic or broadly lance-ovate ..... *L. lancifolia* (Schott 1857: 221) Thwaites (1864: 334)
6. Leaf-blade sublinear, ca. 10 × longer than broad 7
- Leaf-blade ovate-lanceolate, to 5 × longer than broad 8
7. Leaf-blade to 50 cm long, margins smooth. Inside of spathe limb strongly laterally ribbed, outside dark purple ..... *L. koenigii* (Schott 1859: 81) Thwaites (1864: 334)
- Leaf-blade to 20 cm long, margins erose. Inside of spathe limb rugose spongy, outside green- lightish yellow ..... *L. erosa*
8. Spathe limb, inflated and opening subhorizontally ..... *L. jacobsenii* de Wit (1983: 291)
- Spathe limb not inflated sub-erect. Spathe cylindrical, and opening subvertically 9
9. Spathe yellow-green, limb inside surface yellowish white ..... *L. bogneri*
- Spathe maroon, limb inside surface maroon 10
10. Limb un-twisted 11
- Limb twisted 12
11. Spathe light maroon/violet; limb opens up widely and is placed 45° to the kettle ..... *L. kalugalensis*
- Spathe light/dark maroon or light cream; limb opens up slightly (<5mm) at the base of the tai ..... *L. limbusleviterapertae*
12 Leaves silver margin absent ..... *L. rubra*
- Leaves silver margin present or with a faint silver margin 13
13. Leaf blade small (up to 20 × 4 cm); dark green, silver margin conspicuous, abaxial surface smooth ..... *L. thwaitesii*
- Leaf blade large (up to 28 × 5.0–10.5 cm); light green; with a faint silver margin, abaxial surface rugrose ..... *L. srilankensis*

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