



## *Lagenandra limbusleviterapertae*, a new addition to the genus *Lagenandra* (Araceae) from Sri Lanka




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### Abstract

*Lagenandra limbusleviterapertae*, a new species of *Lagenandra* from the Hiyare Forest Reserve, Galle District is described and illustrated. The new species can be differentiated from all other described *Lagenandra* species on the basis of the linear limb, where the limb opens only at the base of the tail extending only about 1/5 of the length and the width of the opening remains < 5 mm. Detailed morphological characters, diagnostic comparisons, notes on habitat and ecology are presented. Based on the IUCN Red List categories and criteria, the new species is assessed as Critically Endangered under Criterion B1ab(iii, v)+B2ab(iii, v)+C2a(i).

**Keywords:** Biodiversity conservation, Critically endangered, flora of Sri Lanka, Ornamental aquatic plants

### Introduction

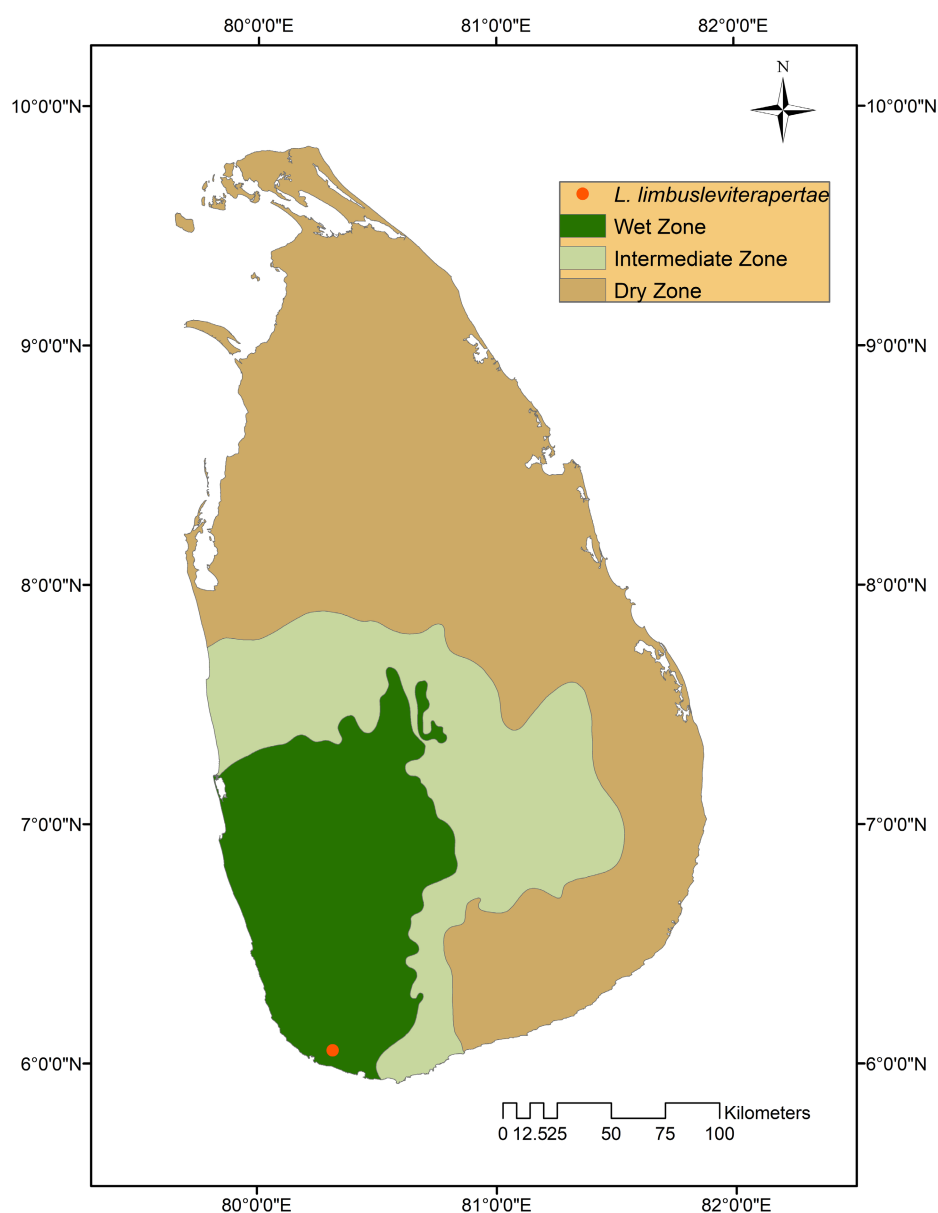
The genus *Lagenandra* Dalzell (1852: 289) of the family Araceae is a threatened group of amphibious/rheophytic plants that have been over exploited from the wild for ornamental purposes as many are popular ornamental aquatics due to their attractive foliage and inflorescences. Subsequently, this has led to a decline in wild populations. Besides the illegal collections, habitat degradation due to anthropogenic activities and surface wash-off are other threats faced by the plant populations inhabiting river banks (Yakandawala 2012; Madola *et al.* 2021a, 2021b and 2022). The plants are known by the vernacular name ‘Kethala’ among the locals.

The number of *Lagenandra* occurring in the country is still unknown and contributing to the knowledge gap in species richness, we have initiated a detailed taxonomic study on the genus *Lagenandra* in Sri Lanka, where up to date the study has described four new *Lagenandra* species from the Wet zone of the island (Madola *et al.* 2021a, 2021b and 2022). Twenty *Lagenandra* species have been recorded for India, Bangladesh and Sri Lanka, of which Sri Lanka harbours thirteen species accounting for 65% of the total recorded species. Of these thirteen species recorded, twelve are endemic (Madola *et al.* 2022). Due to the threat in nature of these species, five endemics are listed as Critically Endangered (CR); another four endemics as Endangered (EN) while one species as Critically Endangered Possibly Extinct (CR(PE)) in the National Red list (The National Red list 2020; Madola *et al.* 2021a, 2021b and 2022). It is interesting to note that *L. erosa* de Wit (1978: 36–38), recorded under CR(PE), is known only from the type specimen, where the collection locality is unknown with no herbarium specimens owned by the National Herbarium, Royal Botanic Gardens Peradeniya.

Continuous field explorations have proven the value of field based taxonomic revisions where we have been able to encounter another undescribed *Lagenandra* species from the Hiyare Forest Reserve, Galle District which is here described as new taxa to science endemic to Sri Lanka.

## Material and methods

The populations of the new plant species were encountered during field studies carried out in the Wet Zone of the country. Therefore, extensive field explorations were carried out along the water courses in the nearby areas and the adjacent areas of Hiyare Forest Reserve, Galle District, between 2018–2023, with repeated field visits to monitor the flowering and fruiting events (Figure 1). The morphological features of the field collected specimens, flowering/fruiting mature individuals, were studied in detail in the laboratory, Plant Molecular Systematics laboratory, Department of Botany, University of Peradeniya, Sri Lanka. Both quantitative and qualitative morphological characters were observed in detail. Measurements were taken from eight flowering individuals and a minimum of five measurements were taken from an individual plant for a particular vegetative character, and the mean of the measurements was taken as the particular character value. Macroscopic parts were observed under a dissecting microscope and a stereomicroscope (LEICA L2). All character measurements were obtained using a ruler (smallest measurement 1 mm) or an eyepiece graticule (smallest measurement 0.1 mm) where appropriate. The morphological features listed were compared with described herbarium specimens of *Lagenandra* species; National Herbarium, Royal Botanic Gardens, Peradeniya, Sri Lanka and on-line herbaria and resources; JSTOR Global Plants (2019), GBIF (2020), Smithsonian: The National Museum of Natural History (2019), *Lagenandra* web page maintained by a collector (Bastmeijer 2023), 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).



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

The distribution map for the plant population was compiled from Global Positioning Signal (GPS) data using the software ArcGIS version 10.4 (ESRI 2017). To determine the conservation status according to the IUCN (2022) recommendations, 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.

## Results

Detailed investigation of the morphology of specimens and comparison with the previously recorded species provided undoubted evidence that the *Lagenandra* species encountered is a new species. It was noted that Balakrishnan in 1971 collected a specimen from the same location but was identified as *Aponogeton crispus* Thunberg (1784: 73) (Aponogetonaceae) and later during the revision of the Sri Lankan *Lagenandra* in 1987 by Nicolson, the specimen was identified as *L. koenigii* (Schott 1859: 81) Thwaites (1864: 334), (Hiyare Reservoir, 20 Nov. 1971, Balakrishnan 993 [US]). The new species named as *Lagenandra limbusleviterapertae* is described, with an updated key for the accurate identification of all the *Lagenandra* species occurring in Sri Lanka. The distribution map is given in Figure 1.

## Taxonomy

### *Lagenandra limbusleviterapertae* Madola, D.Yakandawala & K.Yakandawala, *sp. nov.* (Figs. 2–6)

*Lagenandra limbusleviterapertae* can be differentiated from all other described species on the basis of the linear limb (5.0–9.5 × 1.0–1.5 cm), where the limb opens only at the base of the tail extending only about 1/5 of the length and the width of the opening remains < 5 mm.

**Type:**—SRI LANKA, Southern Province, Galle District, Hiyare Forest Reserve of Sri Lanka, 110 m asl. Collected 11 October 2018, Madola, Yakandawala & Yakandawala L48 (holotype PDA!, isotypes PDA!, K!).

Evergreen large herb with creeping to erect rhizome ca. 1–3 cm in diam. Cataphylls ca. 7–15 cm, 1–2 keeled. Petiole ca. 16–33 cm long, ca. 0.3–0.9 cm wide, sheath ca. 3–9 cm long, unequal. Leaf blades upper surface green/dark green, lower surface green/dark green, rarely dark purple in some plants, blades more or less oblong or linear, apex narrowly acute, base gradually tapering/acute or slightly rounded, margin entire, blade ca. 17–28 × 4–9 cm; midrib visible on both surfaces and prominent on the lower surface. Peduncle ca. 4–13 cm long, 0.3–0.5 cm width. Spathe light/dark maroon or light cream, with no distinct warts, ca. 9–16 cm long, kettle ca. 1.2–1.7 × 1.1–1.3 cm, dark maroon smooth longitudinal striations inside; limb ca. 5.0–9.5 × 0.9–1.5 cm, un-twisted, opens only at the base of the tail extending only about 1/5 of the length and width of the opening remains < 5 mm, cream and/or light maroon with regular white stripes and/or vertically irregularly pattern; tail ca. 1.2–6.0 × 0.1–0.3 cm. Spadix ca. 1.2–2.0 cm long; pistillate flower zone ca. 0.4–0.6 × 0.5–0.8 cm; sterile zone ca. 0.2–0.7 cm long; staminate flower zone ca. 0.3–0.5 × 0.3–0.4 cm; appendix ca. 0.1–0.3 × 0.1–0.2 cm. Pistils ca. 35–45, closely arranged. Style clearly visible. Staminate flowers ca. 60–70. Infructescence up to 19 cm long (including the peduncle), prolate, capsules fleshy up to 30–35, with warty out-growths. Seeds 1–2, size ca. 0.5–0.7 × 0.2–0.4 cm and longitudinally ridged.





**FIGURE 2.** Habitat of *Lagenandra limbusleviterapertae*, on the banks of the streamlet.

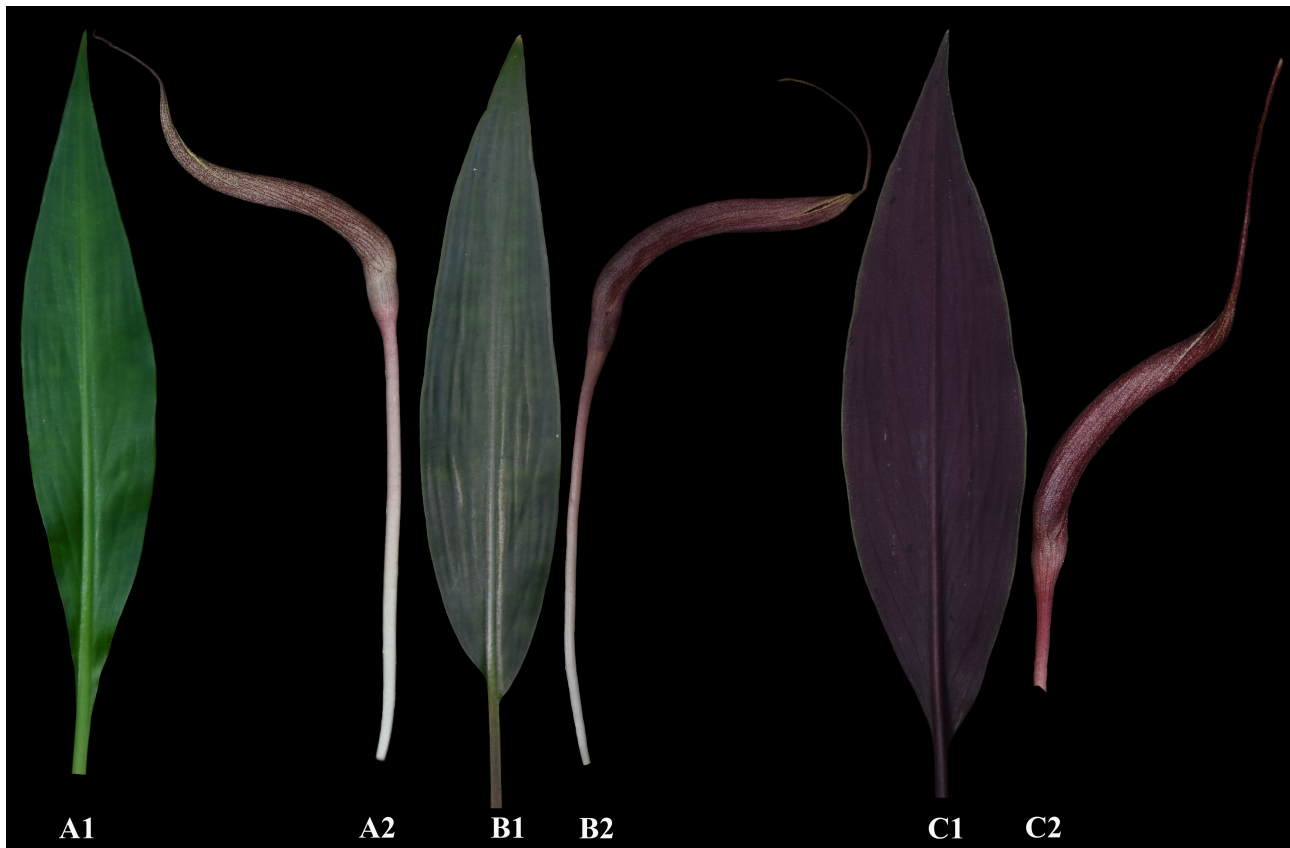
**Distribution, phenology and conservation status:**—To date distribution of *L. limbusleviterapertae* appears to be restricted to one locality in Sri Lanka, which is close to the Reservoir in the Hiyare Forest Reserve. The population is spread along about 50 m on the side of a streamlet and consists of about 130 young and mature individuals.





**FIGURE 3.** Habit of *Lagenandra limbusleviterapertae*; A. Leaves with lighter green upper surface and light cream mixed with marron spathes. B. Leaves with dark green upper surface and purple lower surface and dark marron spathe. C. Leaves with dark green upper surface maroon spathe., all occurring together along the stretch of the streamlet.





**FIGURE 4.** Variation in leaf and spathe colour of *Lagenandra limbusleviterapertae*; A1. and A2. Leaves with lighter green upper surface and light cream mixed with marron spathes. B1. and B2. Leaves with dark green upper surface and maroon spathe. C1. and C2. Leaves with dark green upper surface and purple lower surface and dark marron spathe. Note that A1. And B1. are upper leaf surfaces while C1. is lower surface.

Hiyare Forest Reserve is a Tropical wet lowland evergreen forest located in the Galle district (low country wet zone) extended over an area of 250 ha which consists of 22.22 ha of man-made reservoir (De Silva, 1996). The Tributary of the river Gin Ganga, the stream Mahadola rises in the western part of the catchment and field studies conducted revealed high biodiversity among flora and fauna including many endemics (Silva, 1996, Hapuarachchi & Kathriarachchi, 2012).

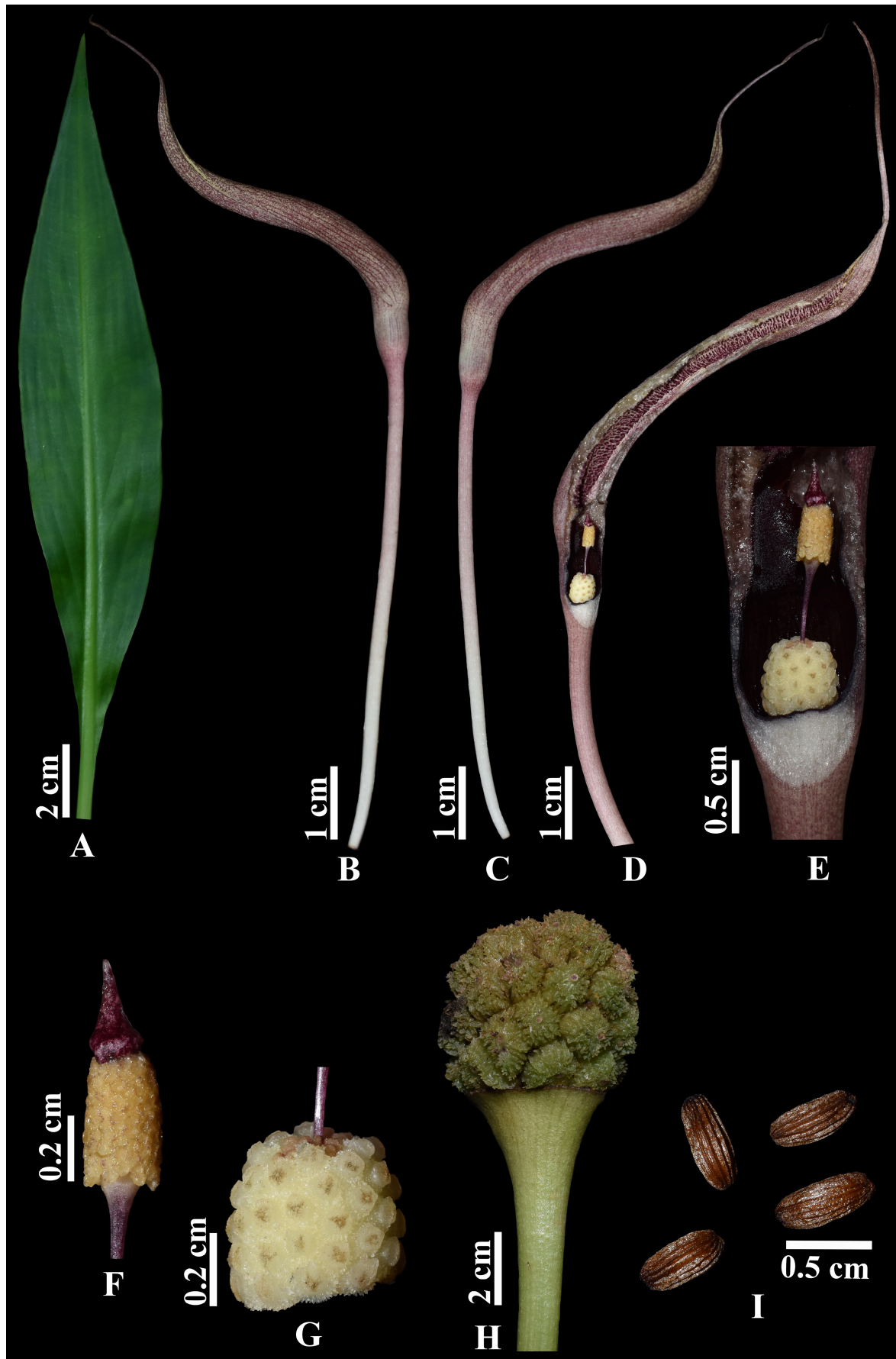
Peak flowering of *L. limbusleviterapertae* was observed from November-April and fruiting from January-July and November. Occasionally flowering in May to June.

The calculated AOO accounted to 4 km<sup>2</sup> while we were unable to calculate the EOO due to the presence of only one data point. Therefore, the EOO was also taken as equal to AOO. Considering the facts that *L. limbusleviterapertae* being restricted to only one locality in the country, and the number of healthy individuals in the population is restricted to around 130 young and mature individuals, scattered along the bank of a streamlet in the reservoir. Following the present IUCN guidelines (2022); based on Criterion B and C this species qualifies for Critically Endangered category (CR) under the thresholds for B1, B2 and C2. Further evaluation under the Criterion B, B1 and B2, based on geographic range, with only 4 km<sup>2</sup> of EOO and AOO, number of locations is considered as 1 (a) and the subpopulations exhibited a continuing decline in the quality of habitat (iii) and number of mature individuals (v). When considering all these facts, *L. limbusleviterapertae* qualifies for CR category under Criterion B1ab (iii, v) + B2ab (iii, v). According to the Criterion C; Small population size and decline, where the number of mature individuals been < 250, and with an observed, estimated, projected, or inferred continuing decline in the number of mature individuals in each subpopulation C2a (i), qualifies for the CR category under Criterion C2. Considering all these facts, *L. limbusleviterapertae* qualifies for Critically Endangered category under Criterion B1ab(iii, v)+B2ab(iii, v)+C2a(i)

**Habitat:**—The plants inhabit the banks of a shady streamlet in the Tropical Low Country Evergreen Rain Forest.

**Vernacular Name:**—‘Hiyare kethala’ (Sinhala).





**FIGURE 5.** *Lagenandra limbusleviterapertae*; A. Leaf. B. and C. Spathe from different angles showing the opening in the limb. D. Spathe dissected and opened. E. Kettle with the spadix. F. Appendix and staminate flower zone. G. Pistillate flower zone. H. Infructescence and I. Seeds.

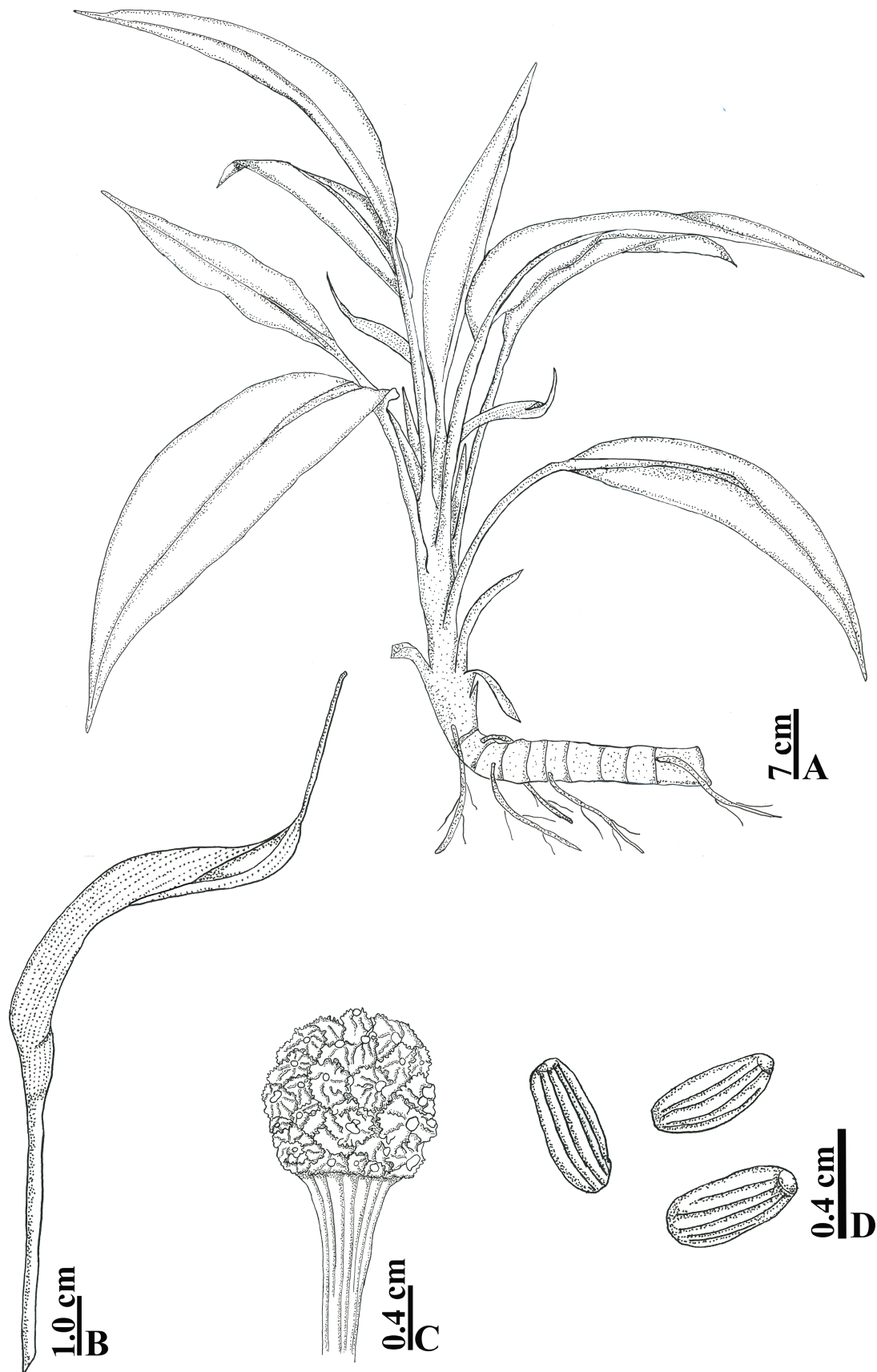


FIGURE 6. *Lagenandra limbusleviterapertae*; A. Habit. B. Spathe. C. Infructescence and D. Seeds.

**Eponymy:**—The species name is formed by a conjunction of the Latin wording for limb, *limbus*; slightly, *leviter* and open, *aperta* (apertae). Adopted here to highlight the distinctive feature of the spathe, the slightly opened limb.



**Additional specimens examined (paratypes):**—Hiyare Forest Reserve, 111 m asl. Collected 16 January 2021, Madola, Yakandawala & Yakandawala L188 (PDA!); Hiyare Reservoir, 20 Nov. 1971, Balakrishnan 993 (US!).

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

1. The whole spathe, standing well above the leaves. Leaves aligned more or less parallel to the substrate ..... *L. peradeniyae* Madola *et al.* (2022: 115).  
– 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* Madola *et al.* (2021: 217)  
– Spathe outside, rugose, not with 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*  
– Leaf-blade to 20 cm long, margins erose. Inside of spathe limb rugose spongy, outside green ..... *L. erosa*
8. Spathe limb, inflated and opening subhorizontally ..... *L. jacobsonii* de Wit (1983: 291)  
– Spathe limb not inflated sub-erect, cylindrical, and opening subvertically\ .....9
9. Spathe yellow-green, limb inside surface yellowish white ..... *L. bogneri* de Wit (1978: 33–34)  
– 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. kalugaleensis* Madola *et al.* (2021: 190)  
– Spathe light/dark maroon or light cream; limb opens up slightly (<5mm) at the base of the tail..... *L. limbusleviterapertae*
12. Leaf blade small (upto 20 × 4 cm); narrowly ovate to lanceolate; dark green, silver margin conspicuous, abaxial surface smooth..  
..... *L. thwaitesii* Engler (1879: 621)  
– Leaf blade large (upto 28 × 5–10.5 cm); ovate to narrowly ovate; light green; with a faint silver margin, abaxial surface rugose..  
..... *L. srilankensis* Madola *et al.* (2021: 193)

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