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Lagenandra wayambae (Araceae), a new endemic species from a freshwater swamp forest of Sri Lanka

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Abstract

A new species of *Lagenandra* (Araceae), is described and illustrated from Walauwewaththa Wathurana freshwater swamp forest, Bulathsinghala, Sri Lanka. Here we describe the new species as *Lagenandra wayambae* Madola, K. Yakandawala, D. Yakandawala and Karunaratne and provide a detailed description, drawing and colour photographs. We compare the morphology of *L. wayambae* with that of similar members of *Lagenandra* and conduct an assessment of its conservation status. A taxonomic key to the Sri Lankan *Lagenandra* is presented for easy identification. Recognizing a new endemic member enhances the number of Sri Lankan species to nine. According to the IUCN red data category guidelines *L. wayambae* qualifies for Critically Endangered category under Criterion B1ab (ii,iii,v).

Keywords: Biodiversity conservation, Critically endangered, Endemic, Ornamental aquatic plants

Introduction

Lagenandra Dalzell (1852: 289) are evergreen perennial herbs, belonging to the family Araceae, and occupying the amphibian region of rivers, streams and marshy habitats. The genus is endemic to Sri Lanka, Bangladesh, and India, and to date comprises of 16 species (Sivadasan & Babu 1995, Sivadasan *et al.* 2001, Biju *et al.* 2018, Sasikala *et al.* 2019). Sri Lanka accommodates eight species; *L. bogneri* de Wit (1978: 33–34), *L. erosa* de Wit (1978: 36–38), *L. jacobsenii* de Wit (1983: 291), *L. koenigii* (Schott 1859: 81) Thwaites (1864: 334), *L. lancifolia* (Schott 1857: 221) Thwaites (1864: 334), *L. ovata* (Linnaeus 1753: 967) Thwaites (1864: 334), *L. praetermissa* de Wit (1983: 299), and *L. thwaitesii* Engler (1879: 621), of which seven are endemic to the island (Nicolson 1987). *Lagenandra* together with *Cryptocoryne* Fischer ex Wydler (1830: 428) are classified under the tribe Cryptocoryneae of the subfamily Aroideae, the placement based on morphology is also supported by molecular data (Cabrera *et al.* 2008). Certain species of the two genera look morphologically very similar, however, could be distinguished by the differences in leaf vernation and the arrangement of female flowers, where *Lagenandra* exhibit involute (double-rolled) vernation (except *L. undulata* Sastry) and spirally arranged, or in 1–2 whorls, free pistillate flowers opposed to the in-rolled vernation and connately arranged pistillate flowers into a single whorl, in *Cryptocoryne* (Nicolson 1987).

Lagenandra, with its different leaf shapes and colours, and the attractive inflorescence, are well known for its ornamental value, especially in the Europe where it is cultivated and traded (Yakandawala 2012, Yakandawala *et al.* 2013). For this reason, some of these species have been extracted extensively from the wild and therefore, five endemics of the eight species recorded in Sri Lanka are now listed as endangered in the National Red list (MOE 2012). According to our experience and the information gathered during field visits the plant collections still continue, for the ornamental plant industry, urging the acceleration of steps towards its conservation. During the revision of the flora of Ceylon (Sri Lanka) the taxonomic revision of the genus has been completed in 1987 (Nicolson 1987). The

identification keys produced during the revision are mainly based on spathe characters as most of these characters are distinct among species. However, *Lagenandra* being a plant with a seasonal flowering pattern, this poses a barrier in the identification of the plants in the field as well as at exit points of the country during exportation while they are in their vegetative stage. In view of fulfilling the above gap and possibility of recording of new species, a detailed taxonomic study of the genus was initiated with extensive fieldwork in the wet zone of the country. During these field explorations, an unfamiliar *Lagenandra* species was discovered from the Walauwewaththe Wathurana freshwater swamp Forest, Bulathsinghala in the Kalutara District, Sri Lanka and is here described as new to science.

Material and methods

Field studies were carried out in Walauwewaththe Wathurana freshwater swamp forest and the adjacent area in Bulathsinghala, Kalutara District, in the wet zone of Sri Lanka between 2018–2020 with repeated field visits to monitor the flowering and fruiting events (Figure 1). The morphological characters of the field collected samples were studied in detail in the laboratory, Faculty of Agriculture & Plantation Management, Wayamba University of Sri Lanka. Both quantitative and qualitative morphological characters were studied 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 taken using a ruler (smallest measurement 1 mm) or an evepiece graticule (smallest measurement 0.1 mm) where appropriate. The morphological features 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, 2018) and, literature (de Wit 1978, Graaf & Arends 1986, Nicolson 1987, Sivadasan & Babu 1995, Sivadasan et al. 2001, Biju et al. 2018, Sasikala et al. 2019). The distribution map was compiled from GPS data using the software ArcGIS version 10.4 (ESRI 2017) and the distribution maps were compiled. Conservation assessment of the newly described Lagenandra species follows IUCN (2019).

Results

Detailed investigation of the specimens' morphology and comparison with the previously recorded species provided convincing evidence that it is a new *Lagenandra* species. The new species *Lagenandra* wayambae is described, along with a key for the accurate identification of all the *Lagenandra* species found in Sri Lanka.

Taxonomic treatment

Lagenandra wayambae Madola, K.Yakandawala, D.Yakandawala & Karunaratne sp. nov. (Figs. 2-4)

Leaves of *L. wayambae* are similar in shape and length with that of *L. thwaitesii* but differs by having narrower leaves, absence of a silver line in the margin and leaf blades that are placed mostly at more or less right angle to the upright petiole. Similarly, the spathe of *L. wayambae* resembles that of *L. lancifolia* but possess large number of warts outside and a yellow spadix.

Type:—SRI LANKA, Western Province, Kalutara District, Walauwewaththa Wathurana freshwater swamp forest Bulathsinhala, 30 m asl, Collected 20th February 2020, *Madola, K. Yakandawala and D. Yakandawala L169* (holotype PDA!, isotypes PDA!, K!).

Evergreen small herb with creeping to erect rhizome ca. 0.4-0.6 cm in diam. Cataphylls ca. 2-6 cm. Petiole ca. 7-17 cm long (longer when covered with sand), ca. 0.1-0.3 cm wide, sheath ca. 1.2-1.7 cm long, unequal. Leaf blades green to dark green, blades are placed mostly at more or less right angle to the upright petiole. Blade mostly linear lanceolate or rarely linear ovate, 6-10 times longer than broad, apex acute, long tapered, base acute or obtuse, margin entire, blade ca. $8-15 \times 1-2$ cm; midrib visible on both surfaces and prominent on the lower surface. Peduncle ca.

0.2-0.5 cm long and occasionally even up to 6.6 cm long when covered with sand, 0.1-0.7 cm width, terete. Spathe dark maroon warty outside especially on the limb, ca. 1.0-4.5 cm long, kettle ca. $0.4-0.9 \times 0.5-0.9$ cm, dark maroon with smooth longitudinal striations inside; limb ca. 0.4-3.2 cm, opening by a slight twist dark maroon and horizontally irregularly ribbed inside; tail ca. 0.2-0.4 cm. Spadix ca. 0.4-0.6 cm long; pistillate flower zone ca. $0.1-0.2 \times 0.3-0.5$ cm; sterile zone ca. 0.1 cm long (whitish pink); staminate flower zone ca. $0.1-0.3 \times 0.2-0.4$ cm (yellow); appendix ca. 0.1 cm long (dark maroon). Pistils ca. 15, up-right with rather short protuberances below the subdome-shaped stigma. Style clearly visible. Staminate flowers ca. 70. Infructescence up to 11 cm long, oblate with few fruitlets, peduncle 0.2-6.6 cm long, fleshy capsule up to 10, with warty out-growths. Seeds 1-2, size ca. $0.4-0.6 \times 0.3-0.4$ cm and longitudinally ridged.



FIGURE 1. Map of Sri Lanka indicating the location of *Lagenandra wayambae*, the freshwater swamp forest in Walauwewaththa Wathurana, Bulathsinghala, Sri Lanka.

Distribution, phenology and conservation status:—To date the distribution of *L. wayambae* appears to be restricted to one locality in Sri Lanka, the fresh water swamp forest in Walauwewaththa Wathurana, Bulathsinghala at an elevation of approximately 20–30 m asl. We encountered two populations, that occurs less than 500 m apart, one with very few individuals (less than 10 plants) within the freshwater swamp forest while the larger healthy population occurring in close proximity outside the protected area. The larger population contains about 60 mature plants, and at present, we are not aware of any other locality in Sri Lanka where this species persists.

Lagenandra wayambae flowers in December and January-April. Fruiting February–July. The open inflorescence persists for 3–4 days.



FIGURE 2. Lagenandra wayambae; A. Habitat. B and C. Habit.



FIGURE 3. *Lagenandra wayambae*; A. Spathe showing the opening in the limb of the spathe giving access to the reproductive organs. B. Spathe. Note the twist from the rear side. C. Spathe dissected and opened. D. Spadix. E. Infructescence. F. Seeds.

The calculated AOO accounted to 4 km² 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. wayambae* being restricted to one locality in Sri Lanka, and the number of healthy individuals in the population within the freshwater swamp forest secure very few individuals and the larger healthy population that occur outside the protected area is

subjected to anthropogenic activities, the two populations could be considered as under threat. Further, the population placed outside the protected area is flooded during the rainy season, where the plants remain inundated for few days. In addition, the recent anthropogenic involvements in the close vicinity have instigated muddy waters entering the habitat and sand to deposit after the drainage of the muddy water. This sand permanently covers the plants fully affecting their healthy growth as well as complete disappearing of smaller individuals. Following the present IUCN (2019) guidelines; based on geographic range, with only 4 km² of EOO and AOO, this species qualifies for Critically Endangered category (CR) under the thresholds for both B1 and B2. Considering the anthropogenic activities outside protected area, number of locations is considered as 1 (a). Further, considering the subcategories, the large healthy population of L. wayambae located outside the protected area exhibited a continuing decline in the EOO (bi) and AOO (bii) and exhibited in the quality of the habitat (biii) as well as the number of mature individuals (by). Considering all these facts, L. wayambae qualifies for Critically Endangered category under Criterion B1ab (ii,iii,v) + B2ab (ii,iii,v). Habitat:—The Walauwewaththa Wathurana fresh water swamp forest is a unique ecosystem which is presently under protection of the Central Environment Authority of Sri Lanka (CEA, 2009), and is the only freshwater swamp forest recorded up to date in the country. Freshwater swamp forests are identified as a major sub category among Palustrine (Inland Wetlands) under the Ramsar Classification System for Wetland Types (Ramsar Convention Secretariat, 2016). Located in the Kalu Ganga river basin in the southwestern part of Sri Lanka, along the Batapotte ela, a tributary of the Kalu Ganga (IUCN and CEA, 2006), the water level of the area reaches few feet during the flooding season, which continue up to two or three weeks. The plants occur in the shady, ground layer of the swamp forest inundated in sandy soils with silt. Rare and threatened endemic plant species recorded in this ecosystem include Stemnoporus mooni Thwaites (1992: 129), Mesua stylosa (Thwaites) Kostermans (1969: 430) Areca concina Thwaites (1864: 328) and Diospyros quaesita Thwaites (1864:179) (Gunatilleke et al. 2008). With the recognition of L. wayambae, the significance of this site further increases raising the number of point endemics to three, together with S. mooni and M. stylosa.

Eponymy:—The new species is named after the Wayamba University of Sri Lanka.



FIGURE 4. Lagenandra wayambae; A. Habit. B. Spathe. C. Infructescence. D. Seed.

Key to the species of Lagenandra from Sri Lanka

Modified from Nicolson (1987).

1.	Spathe distinctly warty outside
_	Spathe smooth or merely roughened outside by papillae
2.	Warts large (1.5–3.0 mm long); spathe limb abruptly globular-inflated above the kettleL. ovata
_	Warts small (to 1.0 mm); spathe limb subcylindric
3.	Spathe large (more than 10 cm long); pistillate flowers more than 60L. praetermissa
_	Spathe small (up to 10 cm); pistillate flowers less than 40
4.	Spathe outside with few distinct irregular warts; leaves linear lanceolate to linear ovate
_	Spathe outside, rugose, not with distinct warts; leaves broadly elliptic or broadly lance-ovate
5.	Leaf-blade sublinear, c. 10 × longer than broad
_	Leaf-blade ovate-lanceolate, to 5 × longer than broad
6.	Leaf-blade to 50 cm long, margins smooth; inside of spathe limb strongly laterally ribbed, outside dark purpleL. koenigii
_	Leaf-blade to 20 cm long, margins erose; inside of spathe limb rugose spongy, outside greenL. erosa
7.	Spathe limb strongly twisted to one side, inflated and opening subhorizontally; outside of spathe limb whitish, inside black-purple
	and with tan, branched, hair-like protuberances
_	Spathe limb sub-erect, cylindrical and opening subvertically; outside of spathe limb purplish, inside with inconspicuous purplish
	protuberances
8.	Peduncle c. 2 cm; leaf blades often silver margined; stigma unequal; female flowers subscabrid on sidesL. thwaitesii
_	Peduncle 7-12 cm; leaf blades not silver margined; stigma dome-shaped; female flowers with long protuberances below stigma
	L. bogneri

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