

A new species of *Parasopubia* (Orobanchaceae) from the southern Western Ghats, India

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Abstract. *Parasopubia raghavendrae*, a new species of Orobanchaceae is described from the southern Western Ghats of Kerala. It resembles *P. delphinifolia* and *P. hofmannii* var. *hofmannii* by its habit, shape, colour and hairiness of corolla lobes but differs by length of calyx tube, hairiness of staminal filaments and stomium, and shape and ornamentation of seeds. *Parasopubia raghavendrae* is hitherto known only from the type locality Mathikettan Shola National Park in Idukki district, Kerala. Detailed description of the new species along with colour photographs and comparison with its closely similar species are given. We also assessed provisionally the conservation status of the new species as Critically Endangered (CR) according to IUCN Red List Categories and Criteria.

Keywords. Critically Endangered, Idukki, Mathikettan Shola National Park, Orobanchaceae, *Parasopubia raghavendrae*.

Resumen. *Parasopubia raghavendrae*, una nueva especie de Orobanchaceae se describe para el sur del Ghats occidental de Kerala. Se asemeja a *P. delphinifolia* y *P. hofmannii* var. *hofmannii* por su hábito, forma, color e indumento de los lóbulos de la corola, y difiere de ellas por la longitud del tubo del cáliz, indumento del filamento estaminal y del estomio, y la forma y ornamentación de las semillas. Hasta ahora, *P. raghavendrae* solo se conoce para la localidad tipo del Parque Nacional de Mathikettan Shola, en el distrito de Idukki, Kerala. Se proporciona la descripción detallada de la nueva especie junto con fotografías en color y una comparativa con las especies más similares. Así mismo, se evalúa provisionalmente el estado de conservación de la nueva especie con la categoría en Peligro Crítico (CR) de acuerdo a los Criterios de la Lista Roja de la UICN.

Palabras clave. En Peligro Crítico, Idukki, Parque Nacional de Mathikettan Shola, Orobanchaceae, *Parasopubia raghavendrae*.

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INTRODUCTION

Orobanchaceae, commonly called ‘broomrapes’, is the largest parasitic angiosperm family with morphologically diverse herbaceous plants (Young & al. 1999). Most of the species are facultative or obligate root parasites which may be photosynthetic (hemiparasites) or totally depend on host plants (holoparasites). *Parasopubia* H.-P.Hofm. & Eb.Fisch., a genus of Orobanchaceae recently segregated from *Sopubia* Ham. ex D.Don (Hofmann & Fischer 2004), is characterized by slightly zygomorphic flowers, corolla tube much longer than lobes and acuminate reduced thecae. The genus comprises four taxa, including the new species here described, distributed in South East Asia. *Parasopubia bonatii* H.-P.Hofm. & Eb.Fisch. is distributed in Cambodia, Laos, Vietnam, Thailand and China

(Bonati 1927) while *P. delphinifolia* (L.) H.-P.Hofm. & Eb.Fisch., *P. hofmannii* Pradeep & Pramod var. *hofmannii* and *P. hofmannii* var. *albiflora* Pradeep & Pramod are found in India (Pradeep & Pramod 2013) (Fig. 1). Members of this genus are usually seen in grasslands, wet rocks, cultivated lands, marshy areas, lateritic hillocks and moist deciduous forests.

During our field work in Idukki district, Kerala, an interesting species of *Parasopubia* was collected from Mathikettan Shola National Park (MSNP). After careful comparison of *Parasopubia* specimens and consulting relevant literature, the authors found that it was quite distinct from other taxa in the genus and hence is described here as a new species.

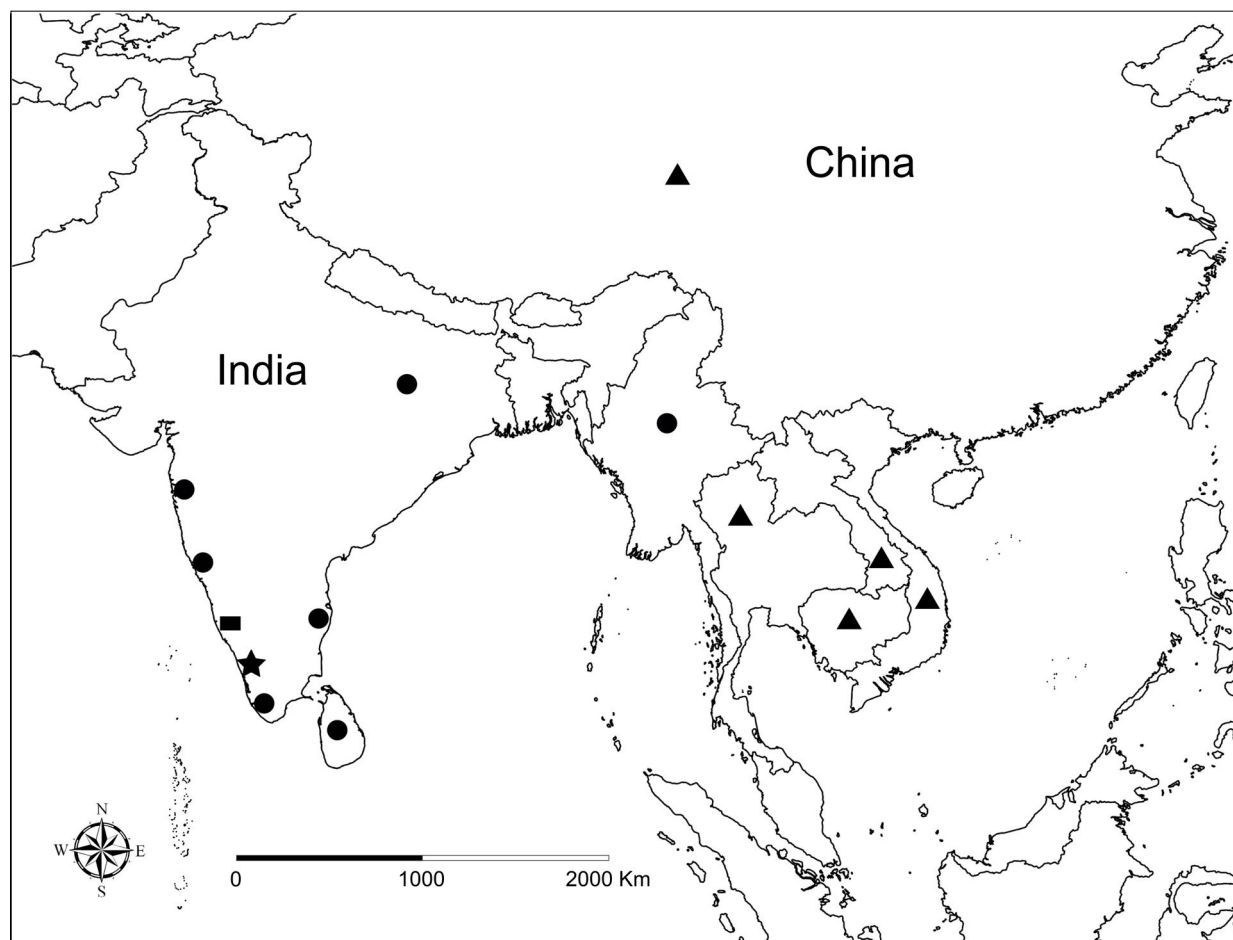


Fig. 1. Map showing the approximate location of the known herbarium records of *Parasopubia* species: *P. delphinifolia* (circle), *P. bonatii* (triangle), *P. hofmannii* (square), *P. raghavendrae* (star). Base map modified from version available at <https://d-maps.com>.

MATERIALS AND METHODS

Fresh specimens were collected from Mathikettan Shola National Park of Idukki district. Protologues and relevant literature (Bonati 1927; Hofmann & Fischer 2004; Pradeep & Pramod 2013) were examined for confirming the identity of the specimens and detailed descriptions were made. The following virtual herbaria were also searched for confirming the identity of the specimens: K, M and S (acronyms according to Thiers 2021, continuously updated). Herbarium sheets were prepared as per Bridson and Forman (1991). Conservation assessment was done using IUCN standards and petition committee criteria (IUCN 2019). The photographs of floral parts were taken with a Stemi 508 Stereomicroscope attached to an Axiocam 105 colour Camera (Zeiss, Germany). The ultra-morphological analysis of seeds was done using DM6 B Phase Contrast Microscope fitted with a DFC450 Camera (Leica, Switzerland) and Gemini 300 Scanning Electron Microscope (Zeiss, Germany).

RESULTS AND DISCUSSION

Taxonomic treatment

Parasopubia raghavendrae Divya & Nampy, sp. nov.
 Type: India, Kerala: Idukki district, Mathikettan Shola National Park (MSNP), Sivanpara, ± 1610 m, 11 Dec. 2016, D.K. Venugopal & S. Nampy 151405 (holotype: CALI!; isotypes: CALI!, CAL!). Fig. 2.

Diagnosis.—It is similar to *Parasopubia delphinifolia* and *P. hofmannii* var. *hofmannii* but can be easily distinguished by the calyx with tube exceeding lobes (4–4.5 mm against 3.5–3.8 mm long), the glandular hairy staminal filaments and stomium, the oblong capsules and seeds in contrast with the calyx tube less long than calyx lobes (2–2.5 mm against 4 mm long in *P. hofmannii* var. *hofmannii*; 4 mm against 7 mm long in *P. delphinifolia*), and glabrous staminal filaments and stomium. The capsules are elliptic and the seeds obovate in *P. delphinifolia* while obovoid and obovate, respectively in *P. hofmannii* var. *hofmannii*. The



Fig. 2. *Parasopubia raghavendrae* Divya & Nampy sp. nov.: **a**, habit; **b**, flowering twig with leaves; **c**, flower; **d**, didynamous stamens; **e**, glandular hairs on filaments; **f**, illustration of filament with glandular hairs; **g**, calyx tube and lobes; **h**, capsule; **i-j**, SEM images of seeds; **k**, phase contrast image of seed [from: MSNP 151405; photos: Divya K. Venugopal; scale: c = 1 cm; d = 1 mm; e = 1 mm; f = 2 mm; g = 1 mm; h = 5 mm; i = 100 μ m; j = 20 μ m, k = 25 μ m].

testa is uniformly ribbed and parallelly reticulate with wide testa cells in *P. raghavendrae* while non-uniformly ribbed and obliquely reticulate in *P. hofmannii* var. *hofmannii* and *P. delphinifolia*. However, the testa cells are narrow in the former and wide in the latter.

Annual herbs up to 50 cm tall. Stems terete at base, 4-angular above, densely branched (branches 6–30), green. Leaves opposite, 2–5 cm long, sessile; lower leaves 5–7 segmented; segments linear-lanceolate to filiform; upper leaves entire; midrib prominent abaxially, strigose on

margins, green. Flowers axillary, solitary, bisexual, zygomorphic, 1–1.5 × 0.5–1 cm. Pedicels 1–1.5 cm long, tomentose, green; bracteoles 2, linear, 2–2.3 × 0.5–1 mm, glabrous, green. Calyx 5-lobed, persistent in fruit; tube 4–4.5 mm long, longer than lobes, glabrous; lobes linear, 3.5–3.8 × 1–1.1 mm, acute at apex, glabrous, green. Corolla campanulate, puberulent on outer surface, glabrous on inner surface, pink; tube 6.8–7 × 1–1.5 mm; lobes nearly sub-rotund, 3–3.2 × 4–4.1 mm. Stamens 4, unequal, inserted on corolla tube; filaments deep pink, 2 longer (6 mm long), 2 shorter (5 mm long), glandular hairy; anthers 2, pendent, thecae pale brown, one fertile and one sterile, unequal; fertile thecae 2 × 1 mm; sterile thecae 1 × 1 mm; stomium hairy, opening whole length. Ovary superior, 1 × 1 mm, ellipsoid, 2-celled, glabrous, green; ovules many in each cell; style slender, 8–8.2 × 1–1.1 mm, puberulent distally, pale pink; stigma globose, glabrous. Capsules oblong, erect, 5–5.3 mm long, glabrous; ¾ portion enclosed in calyx tube; fruiting calyx lobes erect. Seeds numerous, oblong, 0.57 mm long, brown; testa uniformly ribbed and parallelly reticulate with wide testa cells.

Distribution and habitat.—The new species is hitherto known only from the type locality. It grows in wet humus-rich rock crevices at an elevation of c. 1610 m along with *Murdannia satheeshiana* Joby, Nisha & Unni, *Cyanotis* sp. (both Commelinaceae), *Eriocaulon* sp. (Eriocaulaceae), *Polycarpaea corymbosa* (L.) Lam. (Caryophyllaceae), etc.

Phenology.—Flowering and fruiting from early December to late January.

Etymology.—The new species is named in honour of Dr. R. Raghavendra Rao, for his contributions in Indian botany.

Provisional conservation status.—The new species is currently known only from the type locality in the Mathikettan Shola National Park. Two populations with approximately 15 mature individuals were observed in two successive years (2017–2019) and the populations were separated by a distance of around 300 m. There is no possible threat as the area falls under a National Park. On the basis of available data, this species is categorized provisionally as Critically Endangered (CR) (by considering area of occupancy < 10 km² [B₂]; number of mature individuals in each population ≤ 50 [C₂a]; very small or restricted population with number of mature individuals < 50 [D]) as per IUCN Red List Categories and Criteria (IUCN, 2019).

Notes.—It is worth mentioning that *Parasopubia raghavendrae* shares the habit and hairiness of corolla lobes with other taxa of *Parasopubia* in India. *Parasopubia raghavendrae* is peculiar by its hairy staminal filaments and stomium, uniformly ribbed testa and parallelly reticulate wide testa cells. It grows in wet, humus rich non-lateritic rocks, while *P. hofmannii* var. *hofmannii* grows in lateritic rocks and *P. delphinifolia* in almost all habitats (in grasslands, cultivated lands, marshes, lateritic rocks and non-lateritic rocks, etc.). The flowering period of the three taxa are: *P. delphinifolia* from August to February, *P. hofmannii* var. *hofmannii* from July to September while *P. raghavendrae* from December to January. A comparison of diagnostic characters between *P. delphinifolia*, *P. hofmannii* var. *hofmannii* and *P. raghavendrae* is given in Table 1.

Table 1. Diagnostic morphological characters of *Parasopubia raghavendrae* Divya & Nampy sp. nov. and comparison with morphologically similar species.

Character	<i>P. delphinifolia</i>	<i>P. hofmannii</i> var. <i>hofmannii</i>	<i>P. raghavendrae</i>
Calyx tube length	4 mm; shorter than calyx lobes	2–2.5 mm; shorter than calyx lobes	4–4.5 mm; longer than calyx lobes
Calyx lobes length, shape	7 mm, lanceolate	4 mm, linear	3.5–3.8 mm, linear
Staminal filaments indument and length	Glabrous Longer filaments 5 mm Shorter filaments 4 mm	Glabrous Longer filaments 5 mm Shorter filaments 3 mm	Glandular hairy Longer filaments 6 mm Shorter filaments 5 mm
Fertile and sterile thecae	Equal, 2 mm long	Equal, 1.5 mm long	Unequal Fertile thecae > 2 mm long Sterile thecae 1 mm long
Stomium	Glabrous Opening from apex	Glabrous Opening from base	Hairy Opening whole length
Fruiting calyx lobes	Erect	Divergent from capsule	Erect
Capsules	Elliptic Slightly pubescent Enclosed in calyx tube	Obovoid Glabrous ½ of the capsule enclosed in calyx tube	Oblong Glabrous ¾ of the capsule enclosed in calyx tube
Seeds	Obovate Non-uniformly ribbed with wide oblique reticulate cells	Obovate Non-uniformly ribbed with narrow oblique reticulate cells	Oblong Uniformly ribbed with wide parallel reticulate cells

Key to the species of genus Parasopubia including the new species

1. Plants stout; calyx lobes broadly triangular, without linear extension *P. bonatii*
- Plants slender; calyx lobes linear or lanceolate, with linear extension 2
2. Fruiting calyx lobes erect 3
- Fruiting calyx lobes divergent 4
3. Calyx with tube shorter than lobes; calyx lobes lanceolate; stomium opening from apex; capsules elliptic, slightly pubescent *P. delphinifolia*
- Calyx with tube longer than lobes; calyx lobes linear; stomium opening whole length; capsules oblong, glabrous *P. raghavendrae*
4. Corolla pale pink; plant parts often purplish; testa cells narrow *P. hofmannii* var. *hofmannii*
- Corolla white; plant parts without purplish tinge; testa cells wide *P. hofmannii* var. *albiflora*

Additional specimens examined.—*Parasopubia delphinifolia*. INDIA. **Kerala**: Malappuram district, Kozhippara, 21 Oct. 2009, A.K. Pradeep 90072 (CALI 152574); C U Campus, 22 Nov. 1989, Ushakumari V.N. 4878 (CALI 152663); *ibid.*, 02 Sep. 1990, Solly George 3238 (CALI 152665). **Tamil Nadu**: Coimbatore district, Mount Stouert, 27 Oct. 1961, J. Joseph 13377 (MH 00125774, MH 00125773); Dharmapuri district, Dhoddikere, 22 Dec. 1990, T. Ravishankar 95524 (MH 00125763, MH 00125762). s.d., s.coll., s.n. (M 0188641 digital image); s.loc., 1 Jan. 1777, Johann G. König s.n. (S 09-26708 digital image); s.loc., 1831, N. Wallich 3890 (K 000999981 digital image).—*Parasopubia hofmannii* var. *hofmannii*. INDIA. **Kerala**: Kannur district, Madayippara, 27 Nov. 2011, Pramod CU 151405 (holotype CALI); *ibid.*, 11 Sep. 2009, Pramod CU 123592 (CALI);

ibid., 01 Aug. 2010, Pramod CU 126510 (CALI); *ibid.*, 20 Aug. 2010, Pramod CU 126555 (CALI).

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