



A new crustose species of *Zeylanidium* (Podostemaceae) from Kerala, India

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Abstract

Zeylanidium includes two crustose-rooted species from Kerala, South India and Sri Lanka. We describe a third species, *Zeylanidium crustaceum* (sp. nov.) from Kerala, which is similar to *Z. olivaceum* and *Z. maheshwarii*, but differs from them by the subulate stigma. Its crustose root is derived independently of that of *Z. olivaceum* and *Z. maheshwarii*.

Keywords: Podostemaceae, South India, *Zeylanidium crustaceum*

Introduction

Zeylanidium Engl. is a genus of Podostemaceae, a family of river-weeds, and is distributed in India, Sri Lanka, southern Myanmar, and northern Thailand (Cusset, 1992; Kato & Koi, 2009). Several species have been described under the genus, but the generic delimitation is not settled. Cook & Rutishauser (2001) transferred *Hydrobryopsis sessilis* (Willis) Engl. to *Zeylanidium*. The genus is variable and characterized by the root being ribbon-like or crustose; the tufts of leaves or flowering shoots borne at the sinus of root branches or scattered on the dorsal surface; the leaves filiform; the flowering shoot bearing bracts under a terminal flower; the bracts appressed to root or rock, different from the leaves, elliptic or base broadly sheath-like and distal part attenuate; the flower bud enclosed by a spathella (special envelope); the spathella ovate or elliptic, ruptured at anthesis; the pedicel long or short; the tepals 2 borne on either side of stamen (andropod); the stamens 1 in the proximal part (andropod), forked distally into two free filaments with anthers; the ovary 1, 2-locular; the stigma bifid at or above base; and the capsule stalked, slightly flattened, 8-ribbed or smooth, dehiscing by 2 unequal valves, the larger one persistent (Cusset, 1992; Cook & Rutishauser, 2007). A molecular phylogenetic analysis showed that *Zeylanidium* is not monophyletic (Koi *et al.*, 2012).

In recent field explorations in South India we collected plants with crustose roots. There are two species with similar roots, *Z. olivaceum* (Gardn.) Engl. and *Z. maheshwarii* Mathew & Satheesh, in South India and Sri Lanka (Mathew & Satheesh, 1997). In order to reveal their phylogenetic position and taxonomic definition, we made a *matK* analysis and morphological comparison of them and congeneric species. Results of the examinations (molecular data will be published elsewhere) show that the plants are not assignable to any known species. Hence it is described here as a new species.

Zeylanidium crustaceum M. Kato, sp. nov. **Figs. 1, 2**

Differs from *Zeylanidium olivaceum* (type species) and *Z. maheshwarii* in the subulate stigma, while similar to them in the crustose root.

Type: INDIA, Kerala Palakkad District, waterfalls in Padagiri SW of Nalliyampathy, 941 m alt., 76°40'13.1" E, 10°28'50.0" N, Feb. 4, 2014, M. Kato & S. Koi IND-1404 (holo-, TNS; iso-, CAL, CALI, K).

Other specimens examined: INDIA, Kerala Ernakuram District, Pooyam Kutty River near Kothamanglam, 140 m alt., Feb. 29, 2008, M. Kato & N. Katayama. KI-216 (TNS); Ernakulam District,

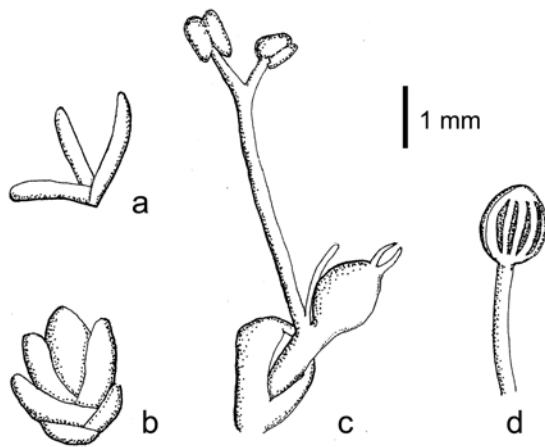


Fig. 1. *Zeylanidium crustaceum* M.Kato sp. nov.: **a.** Leaves; **b.** Young flowering shoot with bracts and spathe (middle); **c.** Flower extruding from ruptured spathe; **d.** Fruit with broad depressions and dehiscing line on capsule (All from M. Kato & Koi IND-1404).

Pooyamkutti, 50 m alt., 10°09'34.0" N, 76°47'13.6" E, 23 Jan., 2012, C. Tsutsumi & M. Kato IND-36 (TNS), *ibid.* IND-40-2A (TNS); Idukki District, Verala near Irumpupalam and Adimali, 493 m alt., 10°02'36.9" N, 76°50'21" E, 22 Dec., 2012, M. Kato IN-1206 (TNS); Palakkad District, waterfalls

in Padagiri SW of Nalliyampathy, 910 m alt., 76°38'53.4" E, 10°27'29.2" N, 4 Feb., 2014, M. Kato & S. Koi IND-1410 (140204-7) (TNS); Thrissur District, Athirappilly waterfalls, 120 m alt., 10°17'08.4" N, 76°34'21.7" E, 23 Jan., 2012, C. Tsutsumi & M. Kato IND-26 (TNS), *ibid.* IND-27-2B (TNS)

Root crustose, lobed, 0.2–0.4 mm thick, firm, adhering to rock surface by disc-like or columnar holdfasts scattered on ventral surface. Leaves tufted, 2 or 3(4) per tuft, scattered on dorsal surface of root, appressed, linear-oblong, apex obtuse, up to $c. 2.8 \times 0.2$ mm, flattened (ensiform); flowering shoots also scattered dorsally. Bracts $c. 4-6$ in two ranks, appressed, convex, elliptic, $1.4-2 \times 0.6-0.9$ mm, basal ones small; spathe (enclosing flower bud) 1–1.5 mm long, ruptured longitudinally or sometimes irregularly at maturity, smooth. Pedicel 1–2.5 mm long, tepals 2 on either side of stamen (andropod), on ventral side of flower facing rock surface, filiform, 1–1.5 mm long. Stamens 2 with long andropod (3–4 times as long as filament) and 2 short free filaments with anthers, (2.5–) 4–6 mm long, up to two times or more as long as ovary. Ovary 1, short-stalked, ellipsoidal or subobovate, smooth, 2-locular, $1.2-1.8 \times 0.8-1.3$ mm; stigmas 2, forked at base, subulate, equal, 0.5–0.8 mm long; ovules borne on whole surface of septum except for small sterile central area or on marginal



Fig. 2. Crustose roots (segments) of *Zeylanidium crustaceum*: **a.** Young flowering shoots dense and appressed on the dorsal surface and each having bracts subtending spathe (marked by asterisk); **b.** Stalked capsules ((M.Kato & S. Koi IND-1404; fixed specimen). Scale unit = 1 mm. Arrowheads indicate ruptured spathe.

surface of septum, 8–17 per locule. Capsule stalked (stalk 1–2.5 mm long), ellipsoidal or subobovate, slightly flattened, 1.2–1.5 × 0.9–1.2 mm, ribbed with 2 dehiscent lines and 8 broad, depressed ribs, dehiscing by 2 unequal valves, the larger one persistent, the smaller caducous.

Distribution: South India (Kerala).

Ecology: Lithophyte on rocks in rapids and waterfalls, which are submerged in rainy season and exposed in dry season.

Notes: A molecular (*matK*) phylogenetic data shows that *Zeylanidium crustaceum* is sister to *Z. sessile* (Willis) Cook & Rutish. and the two are sister to the *Z. lichenoides* (Kurz.) Engl. of north and south India (S. Koi & M. Kato, unpubl. data). *Zeylanidium crustaceum* is far from *Z. olivaceum* and *Z. maheshwarii*, although they share crustose roots. The former differs from the latter two in the subulate stigmas (*vs.* multilobed in *Z. maheshwarii* or bilobed with serrate margins in *Z. olivaceum*), the long stamen (*vs.* 2.7–3.2 mm or 3–3.5 mm), and the short stalk of capsule (*vs.* up to 10 mm or to 4 mm). It is suggested that the crustose root of *Z. crustaceum* is derived from a ribbon-like root of the ancestor similar to *Z. sessile* and *Z. lichenoides*, independently of that of *Z. olivaceum* and *Z. maheshwarii*.

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Literature cited

- Cook, C.D.M. & R. Rutishauser 2001. Name changes in Podostemaceae. *Taxon* **50**(4): 1163–1167.
- Cook, C.D.K. & R. Rutishauser 2007. Podostemaceae, In: Kubitzki, K. (Ed.), *The Families and Genera of Vascular Plants*. Vol. 9. Springer, Berlin, pp. 304–344.
- Cusset, C. 1992. Contribution à l'étude des Podostemaceae: 12. Les genres asiatiques. *Bul. Mus. Natl. Hist. Nat., Paris, 4^e Sér., Sect. B, Adansonia* **14**(1): 13–54.
- Kato, M. & S. Koi 2009. Taxonomic studies of Podostemaceae of Thailand. 3. Six new and a rediscovered species. *Gard. Bull. Singapore* **61**(1): 55–72.
- Koi, S., Y. Kita, Y. Hirayama, R. Rutishauser, K.A. Huber & M. Kato 2012. Molecular phylogenetic analysis of Podostemaceae: implications for taxonomy of major groups. *Bot. J. Linn. Soc.* **169**(3): 461–492.
- Mathew, C.J. & V.K. Satheesh 1997. Taxonomy and distribution of the Podostemaceae in Kerala, India. *Aquat. Bot.* **57**(1-4): 243–274.

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