

Taxonomic Notes on New Record of *Zeylanidium lichenoides* Engl. (Podostemaceae) from West Bengal, India

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ABSTRACT

Zeylanidium lichenoides Engl. (Podostemaceae) is reported for the first time from the Rarh region (the area between the Chota Nagpur Plateau on the West and the Ganges Delta on the East) of West Bengal, India. Taxonomic description, SEM studies of plantparts (thallus, reproductive parts and pollen), phenology, distribution, ecological notes with illustrations of this species are provided.

Key words: New distributional record, thalloid anthophyta, SEM

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Introduction

Podostemaceae, a river weed family contains approximately 46 genera and 300 species which of them most species are thalloid aquatic herbs (Christenhusz & Byng, 2016). These river weeds are inundated when water levels are elevated. The species of the family depend on sticky biofilms for attachment to rocks in waterfalls (Jäger-Zürn & Grubert, 2000). They live as sunken haptophytes in these turbulent habitats throughout the rainy period of monsoon. After the monsoon period the water level reduces and the plants come out and flower, with anthesis generally above the water level. In the dry season they thrive on terrestrial surfaces, fixed to the rock in dry form projecting their fruits upwards. When they again get water logged, they resume their normal vegetative form (Koi et al., 2006).

Zeylanidium is a genus, under family Podostemaceae, and is distributed in different countries: Sri Lanka, northern Thailand, southern Myanmar and India (Cusset, 1992; Kato & Koi, 2009). Several species have been delineated and described under the genus, but generic delimitation is not well-established. Cook & Rutishauser (2001) transferred *Hydrobryopsis sessilis* to *Zeylanidium*.

The genus is categorized by the root being a ribbon-like or crustose thallus. The mature plant is largely composed of secondary or adventitious roots, which develop from different portions of the sapling.

The morphological character of the variously structured and organised roots is contentious, and they have been multifariously termed a thallus, root thallus or root, or a crust (Rutishauser and Huber, 1991). Based on molecular phylogenetic analysis it was shown that the genus *Zeylanidium* cannot be considered as monophyletic (Kato and Koi, 2018; Koi et al., 2012).

In India a total of nine *Zeylanidium* species are reported (Krishnan et al., 2019). Podostemads generally grow in well oxygenated, nonpollutant and nutrient poor habitats. The species *Zeylanidium lichenoides* Engl. is endemic to South and Southeast Asia (Cook, 1996). The Indian distribution of the species is in Tamil Nadu, Andhra Pradesh, Kerala, Karnataka, Maharashtra, Odisha, Assam and Meghalaya (Cook, 1996). It is an annual and occurs on smooth rocks in rapid currents (Cook, 1996). The thallus is completely appressed to rocks (Deshpande et al., 1995). The plant is highly variable (Kumar, 1987). The present study reveals that *Z. lichenoides* also occurs in West Bengal, which is a new distributional record for this plant.

Distribution in Purulia district, West Bengal

The study was conducted in the hilly region of the Dalma Hills an extension of the Eastern Ghats range in West Bengal, Purulia district (Fig. 1) *Z. lichenoides* was found near Ghageshwari water fall (23°25'60"N, 86°11'51"E) on Ajodhya hills (elevation: 855 meters) which is situated in Purulia district (Fig. 1). It was also found near Machkanda water fall (23°26'79"N,

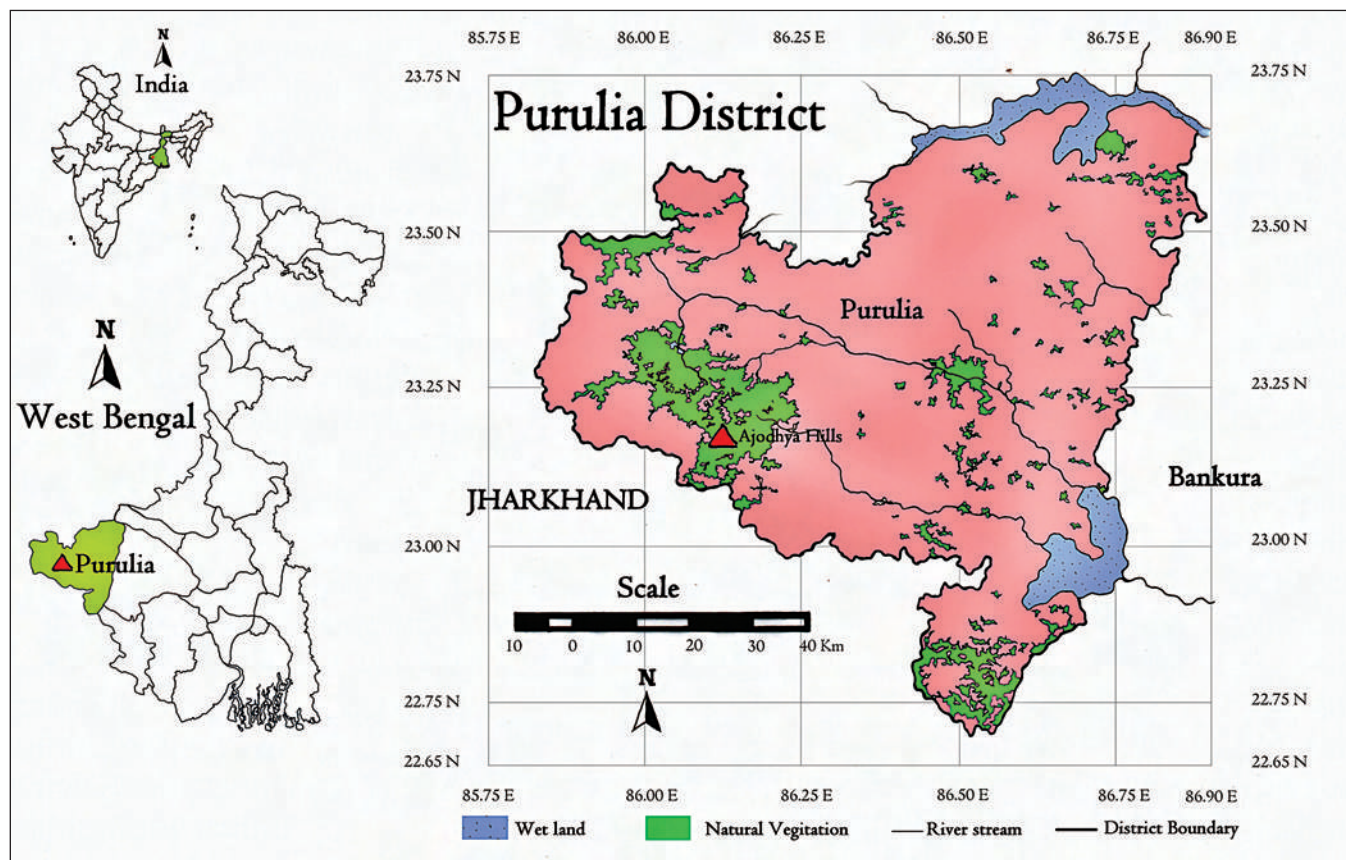


Figure 1. Map showing the study area where the investigated plant species was discovered.

86°04'17"E) in small patches most of which are desiccated. These waterfalls are suitable for the plant to flourish, as it requires low nutrient for their growth. The plants prefer sunshine and are noticeably absent from the permanently shaded areas of the river bank. Some algae belonging to families of Cyanophyceae, Chlorophyceae and Bacillariophyceae were found growing with the thallus. These areas of the forest mainly contain *Butea monosperma* (Lam.) Taub., *Erythrina variegata* L., *Evodia fraxinifolia* (Hook.) Benth., *Evodia roxburghiana* Benth., *Evodia triphylla* (Lam.) DC. and *Evodia meliifolia* (Hance ex Walp.) Benth.

Z. lichenoides like other taxa in the family, is a thalloid angiosperm with no true leaf, stem or root. The plants grow attached to the surface of rocks. They also fix themselves to wooden pieces and fallen branches which are entrapped and wedged in the river. It was found that the *Zeylanidium* thallus has many lobes. The thallus consists of mainly parenchymatous ground tissue surrounded by an epidermal covering.

Critical study of the specimens collected was done with the help of relevant literature (Hooker, 1897;

Subramanyam, 1962; Prain, 1963; Saldanha, 1996; Sharma et al., 1984; Mathew and Satheesh, 1997; Jadhav, 2001; Sasidharan, 2004; Cook and Rutishauser, 2007; Kato & Koi, 2009; Kato & Koi, 2015) and consultation with experts at the Central National Herbarium, Shibpur, Howrah. It was identified as *Zeylanidium lichenoides* and this marks its first distributional record from West Bengal.

Taxonomic Notes

Zeylanidium lichenoides (Kurz) Engl., Pflanzenfam., ed. 2, 18a: 6 1928. Subramanyam, Aquat Angio 49 1962. *Hydrobryum lichenoides* Kurz, J. Asiat. Soc. Bengal 42: 103. 1873; Willis, Ann. Roy. Bot Gard. (Peradeniya) 1: 242 1902; Cooke, Fl. Bombay 2: 522. 1906 incl. vars. *khandalense* & *bhorensis*; Gamble, Fl. Madras 2: 1199. 1925. *Podostemon microcarpus* Wedd. in DC., Prodr. 17: 76. 1873. *Zeylanidium lichenoides* (Kurz) Engl. var. *bhorensis* (Willis) Santapau, 203 incomplete. *Hydrobryum lichenoides* Kurz var. *bhorensis* Willis, 245. incomplete

Local Name: Ojrani (santali)

Morphological Description: Thallus ribbon-like, green

irregularly branched, crustaceous, dorsiventral (Fig. 2), up to 115 cm long. Thallus attached to rocks via glandular rhizoids in fast flowing streams. Thallus ribbon-shaped, wide and flattened (0.6–1.75 mm wide, 0.2–0.4 mm thick), root branched alternately at distance of 0.5–1.8 mm. Adhesive rhizoids are densely formed on the ventral side of the thallus. Leaves tufted, 4 or 5(6) per tuft, thick, distichous, boat shaped narrowly imbricate, scattered on dorsal surface of thallus, appressed, subulate, linear-oblong, apex obtuse, up to c. 5.5×0.6 mm, flattened (ensiform). Flowering shoots come up on the thallus with the fall of water level in the streams. Each flowering shoots with three or four pairs of bracts. Flower bud positioned on the marginal side of the dorsal surface of thallus and is covered by spathe or spathe. Spathe ovoid, dehiscing by longitudinal, ventral slit. Pedicel lengthening to extrude flower from spathe after anthesis. Flower erect, reduced to a single pistil and 2 stamens. Tepals 2, linear. Androecium formed of 2 stamens with long andropod and with 2 short free filaments with anthers, (2.7–) 3–5.5 mm extended, up to 2 times or more as long as ovary. Anther tetrasporangiate, introrse and dorsifixed. Anther wall is composed of three layers of cells. The endothecium shows wall thickenings. Pollen grains are shaped as dyads. The gynoecium is bicarpellary and syncarpous. Ovary short-stalked, 1.3–1.9 \times 0.75–1.4 mm; ellipsoidal or subobovate, smooth, obtuse, anatropous, tenuinucellate and bitegmic with stigmas 2, conical forked at base, subulate at apex, equal, 0.4–0.75 mm. Lobes of the stigma short, close to each other in young bud, straighten when the buds are exposed to the air above the water. The ovary is superior and bilocular, placentation axile. Capsule 8 ribbed, stalked (stalk 0.9–2.7 mm), ellipsoidal or subobovate, slightly flattened, 1.2–1.65 \times 0.85–1.3 mm, dehiscent into 2 unequal valves, smaller caduceus (Figs. 4, 5, 6).

Specimens examined: West Bengal, Purulia (23°25'60"N, 86°11'51"E), 30.01.2017, Sayantan Tripathi & Amal Kumar Mondal 02458 (Vidyasagar University Herbarium); West Bengal, Purulia (23°26'79"N, 86°04'17"E), 31.01.2017, Sayantan Tripathi & Amal Kumar Mondal 02461 (Vidyasagar University Herbarium).

Pollen: About ~5000 pollen grains are produced from a single flower. Pollen grains are released in pairs (dyads). The pollen dyads have a depressed contact point (Fig. 3), are microechinate, dimensions - polar



Figure 2. Ribbon-like, green, irregularly branched, crustaceous thallus on wet rock.

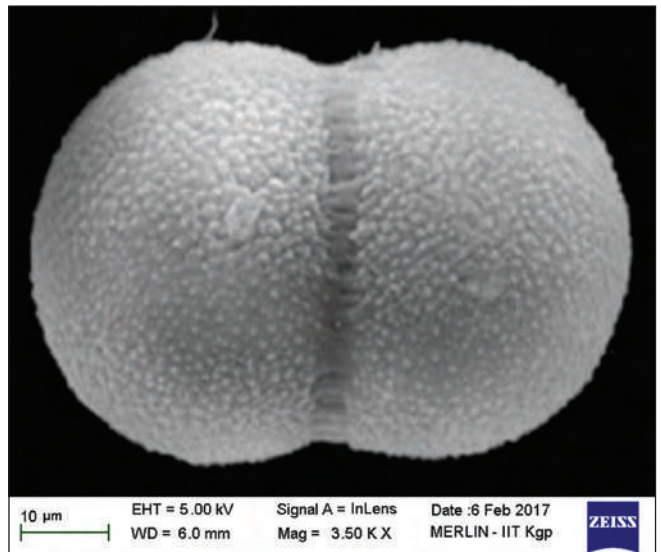


Figure 3. SEM of dyad pollen of *Z. lichenoides* Engl.

diameter 22.55–23.45 μ m, equatorial diameter 13.75–15.08 μ m, exine 0.03–0.05 μ m, intine 0.02–0.04 μ m.

Flowering and fruiting: August–November.

Distribution: This species is endemic to South and South East Asia.

Ecological notes: No threats have been reported although it is a habitat specialist which occurs only attached to rocks in rapidly flowing rivers/streams and therefore, sensitive to water quality and river flow alteration. The plant is listed as Least Concern based on wide geographic range and no threats currently impacting the global population.

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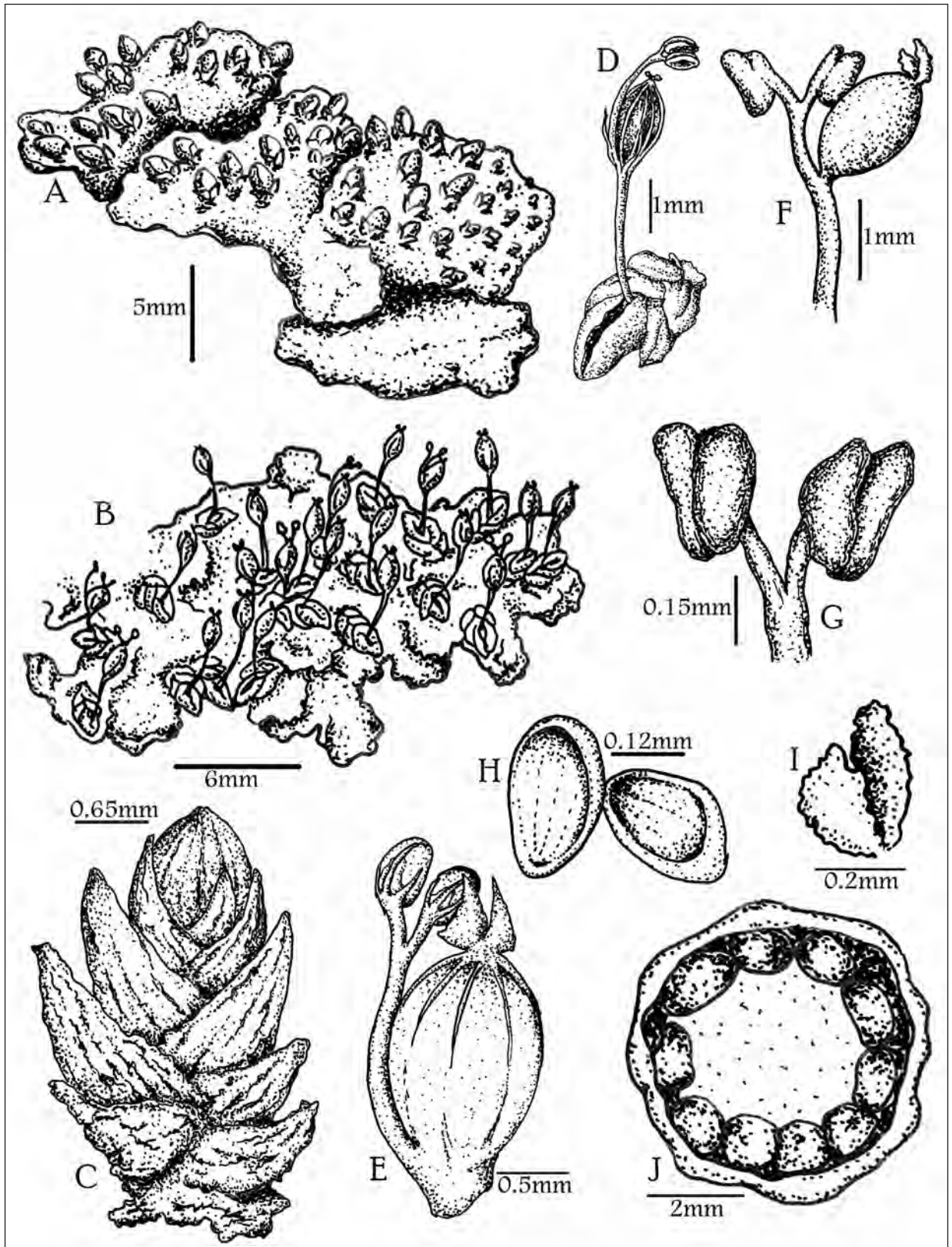


Figure 4. Illustrations of *Zeylanidium lichenoides* Engl.: (A) Flower buds on the thallus; (B) Thallus bearing flowers on rock surface; (C) Flower bud; (D) Thallus with elongated andropodium and the pedicel after anthesis; (E) A mature flower where the anther is intimately positioned to the stigma at time of pollination; (F) A flower with two stamens and stigma; (G) Stamens; (H) Fruit; (I) Bifid stigma; (J) Transverse section of ovary.

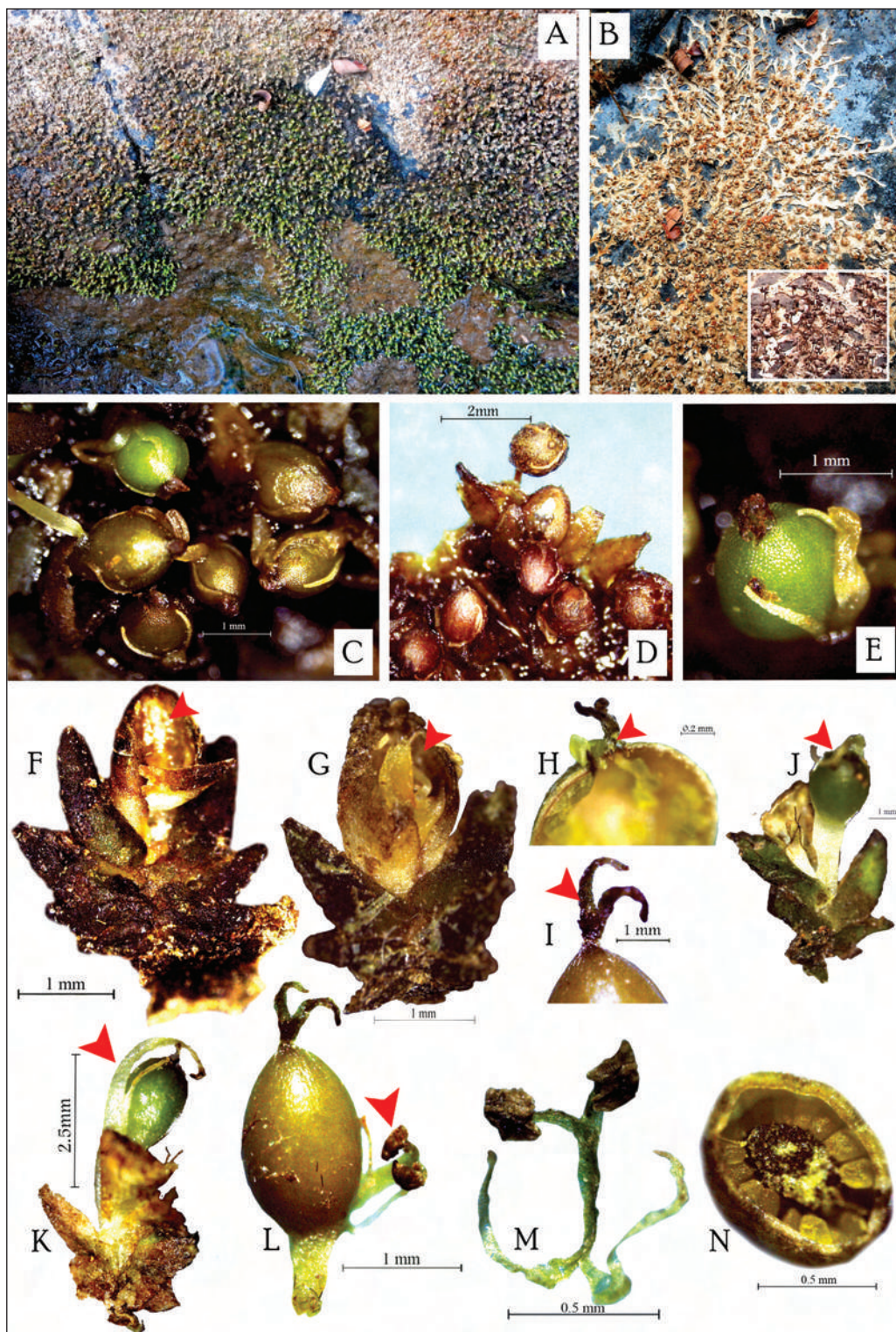


Figure 5. Photographs of *Zeylanidium lichenoides* Engl.: (A) Habitat showing a patch of *Z. lichenoides* growing attached to partly submerged rocks; (B) Dry thallus bearing fruits on rock surface [inset: A close up of dry thallus with fruits]; (C & D) Young flowers in close up view; (E) Young flower showing stigma; (F-K) Stages of flower development; (F) Flower bud in thallus (arrow head); (G) Flower at anthesis (arrow head); (H) A part of mature flower where the anther is closely appressed to the stigma at time of pollination (arrow head); (I) Bifid stigma (arrow head); (J) Thallus showing anthers in contact with an interlocking bifid stigma (arrow head); (K) Maturation of the flower after pollination showing the elongated pedicel and the andropodium which is far above the stigma (arrow head indicating the elongated andropodium); (L) A flower with the two stamens and bifid stigma (arrow head indicating the anthers); (M) Stamen; (N) Longitudinal section of fruit.

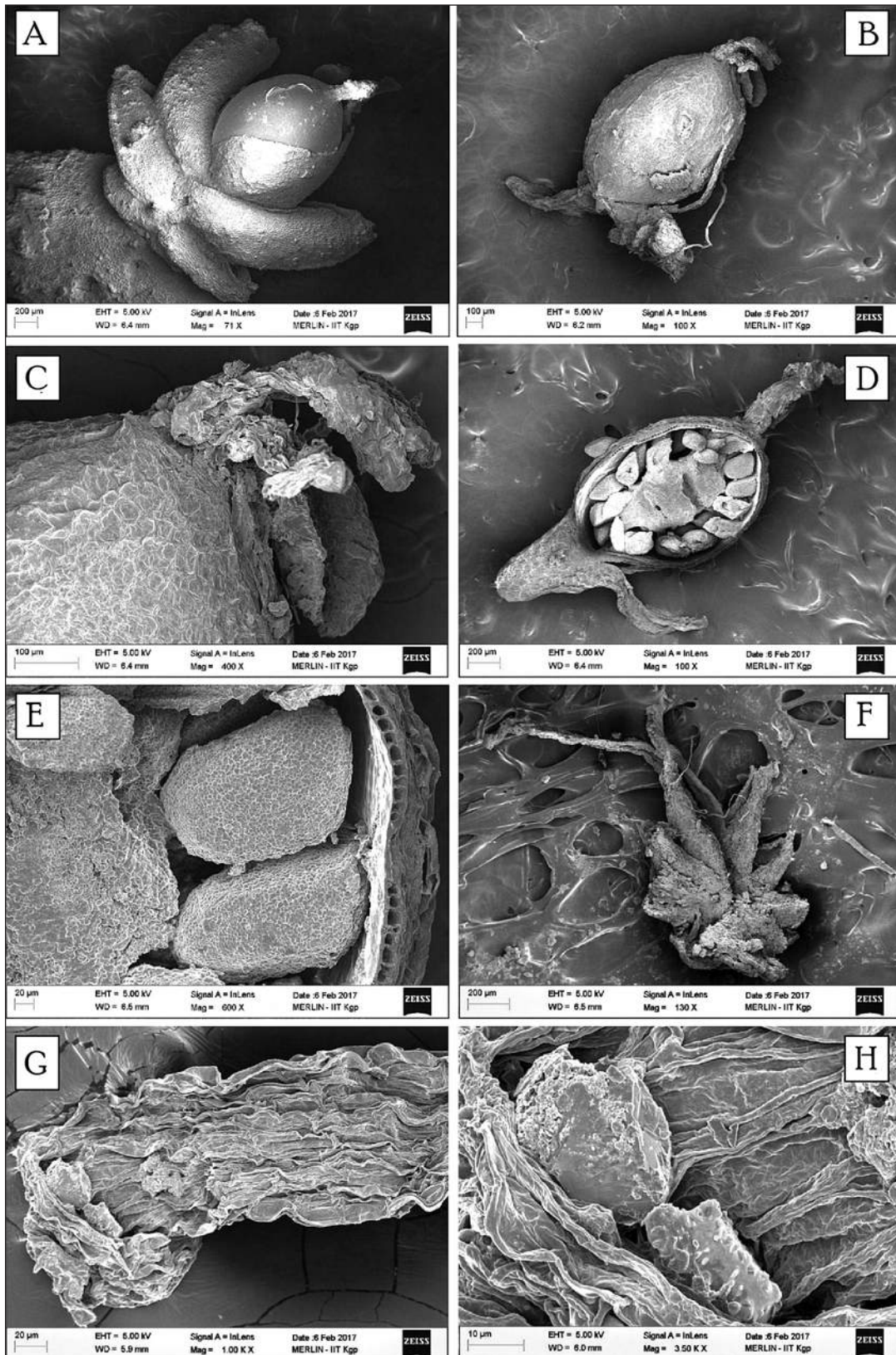


Figure 6. Scanning Electron Microscopic pictures of *Zeylanidium lichenoides* (A) Thallus with flower; (B) Mature flower where the anther is closely attached to the stigma at time of pollination; (C) Part of mature flower showing bifid stigma; (D) Longitudinal section of ovary; (E) Part of ovary showing ovules and ovary wall; (F) Thallus showing androecium after removing gynoecium; (G) Anther; (H) Ruptured anther showing anther wall and the pollens.

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