

## A New, Pink-brown *Ophioglossum* (Ophioglossaceae) from India

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**Abstract** A new species of *Ophioglossum*, *O. indicum*, is described from Rajasthan, India. The plants are smaller than most congeners and have pinkish trophophylls and spike-stalks when young. The trophophylls become brownish green except the pinkish-brown margins at maturity, while the spike-stalks remain pink. The species is also characterized by the spore wall structure and stomatal distribution.

**Key words:** *Ophioglossum indicum*, Ophioglossaceae, India, spore.

### Introduction

The genus *Ophioglossum* L. is the most specialized in the eusporangiate fern family Ophioglossaceae. The family comprises three conventional genera, *Botrychium*, *Helminthostachys*, and *Ophioglossum* (Clausen, 1938; Wagner, 1990) and the recently discovered genus *Mankyua* (Sun *et al.*, 2001). *Ophioglossum* is characterized by the usually simple but rarely lobed trophophyll (vegetative leaf) with a spike (sporophyll) bearing two rows of sporangia. The lobed species are sometimes segregated in different genera, i.e., *Ophioderma* (*O. pendulum*) and *Cheiroglossa* (*O. palmatum*). *Ophioglossum palmatum* is also characterized by the multiple fertile spikes, and a few other species are devoid of the chlorophyllous trophophylls (Goswami, 2007). The cosmopolitan *Ophioglossum* includes about 45 or more species. In all species, like other plant groups, the trophophyll, if any, is green to dark or light green at maturity and produces a paler spike (Wieffering, 1964; Dixit, 1984; Khullar, 1994; Goswami, 1987, 2008; Sharma *et al.*, 2008). However, Goswami (1987, 2008) has mentioned the pink to brown basal part of the trophophore and spike-stalk in plants of *O. lusitanicum* L.

Burrows and Jones (2001) have also seen pink stipes in *O. polyphyllum* but as a rare feature.

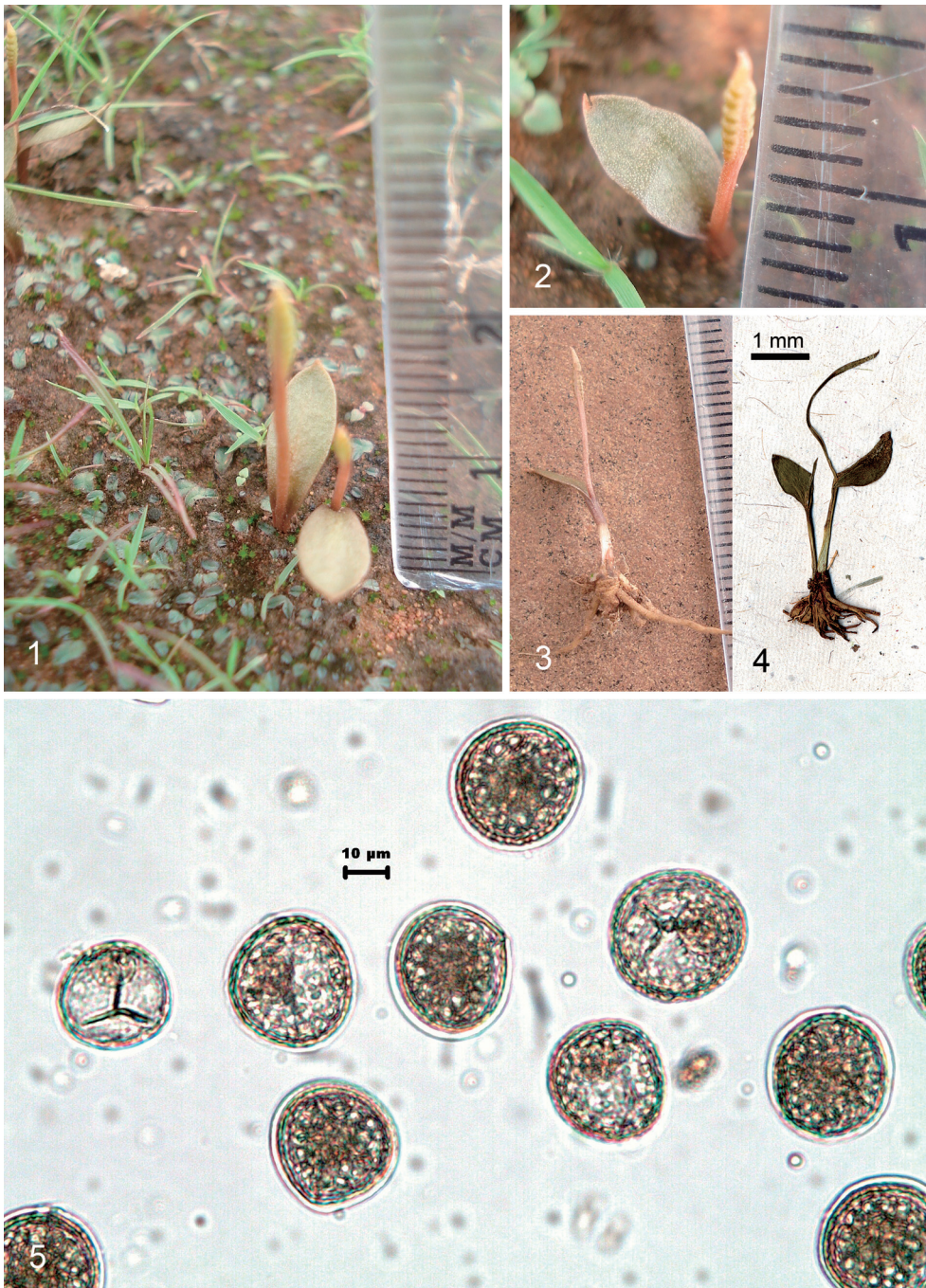
We have found a population of plants with pink to brown leaves in Mainal Chittorgarh, Rajasthan, India. No other pinkish plants are seen in *O. costatum* R.Br., *O. gramineum* Willd., *O. nudicaule* L., *O. petiolatum* Hook., *O. polyphyllum* A.Br. ex Seub., *O. reticulatum* L. and *O. vulgatum* L. occurring in Rajasthan, India (Gena, 1998; Yadav and Tripathi, 2002; Sharma *et al.*, 2008). From morphological comparison with these and other congeners, we conclude that this plant population is recognizable as a new species.

### Description and Comparison

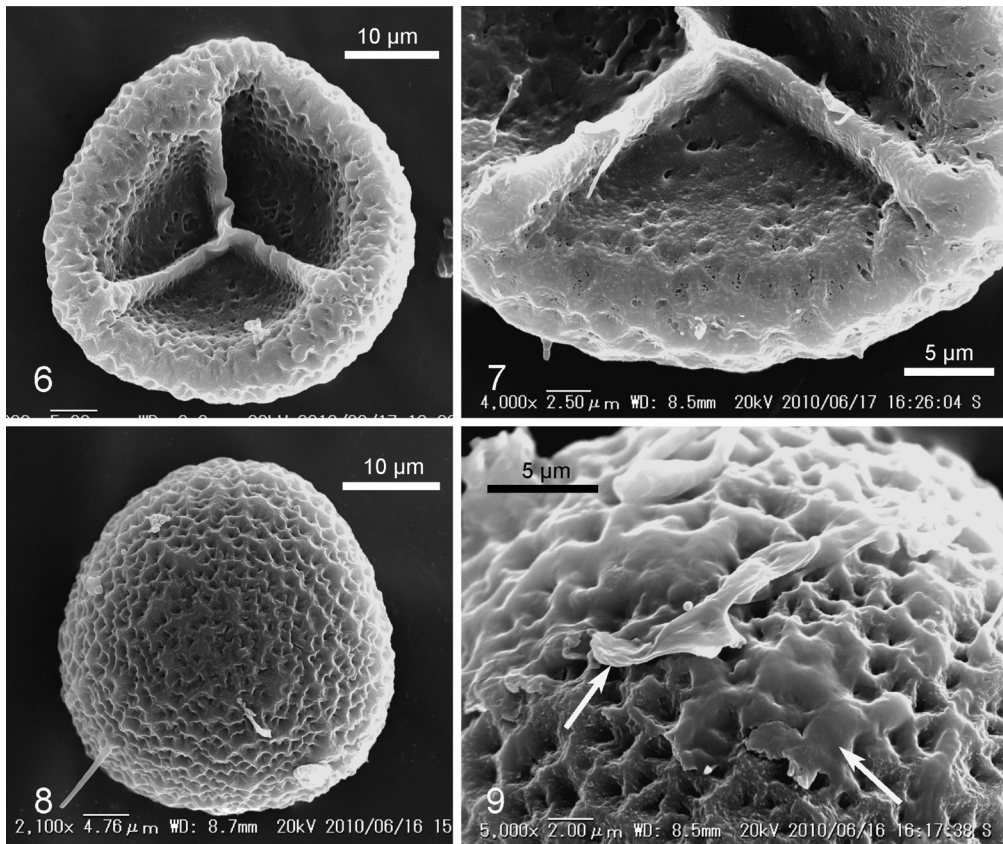
*Ophioglossum indicum* B. L. Yadav & H. K. Goswami, *sp. nov.*

A congenris plantis subroseis differt; *O. lusitanici* plantis parvis simile, sed spora lata differt; ab *O. costatis* costa vix visibili; ab *O. vultatis* trophophyllo basi cuneato differt.

*Typus.* Village area Mainal (Chittorgarh), Rajasthan, India, B. L. Yadav 3011, 14 Aug 2009 (holotype, Herbarium of MLV Government College, Bhilwara, Rajasthan; isotypes, Bionature



Figs. 1–5. *Ophioglossum indicum* and spores. Figs. 1–3. Plants of *O. indicum* in nature. The mature fertile spike, trophophyll margin, and trophophyll stalk are tinted pink. Fig. 4. Herbarium specimen (*B. L. Yadav 3011* in TNS). Fig. 5. Spores in light microscopy. Spores were released and mounted in glycerin jelly. Spores have triradiate mark, and verrucose exine is covered by distinct perine.



Figs. 6–9. SEM images of *O. indicum* spores. Spores were attached to specimen stubs, ion-sputtered with gold, and observed using a Keyence VE-7800 microscope at 20 kV. Figs. 6, 7. Polar views of proximal face of exine: spores artificially crashed. Fig. 6. Whole spores with long and thickened laesurae on verrucose surface. Fig. 7. Numerous depressed areoles are united into negative reticulation. Figs. 8, 9. Polar views of distal face of exine. A. Whole spore. B. Part of spore showing cracked perine (marked by right arrow) and tapetal residue (left arrow).

herbarium, Bhopal, and National Museum of Nature and Science Herbarium [TNS]).

Plants 2.5–3.6 cm in height; rhizome subglobose or knob-shaped, 0.4–0.6 cm tall, produced adventitiously from creeping roots, resulting in a colony; trophophyll generally single, sometimes two per rhizome per season, elliptic or elliptic-lanceolate, thick, entire, acute, without midrib, pink in color at youth and green-brownish except at margin at maturity; fertile spike inserted on adaxial side of trophophyll under trophophyll-lamina, pink in color throughout, sterile stalk 1.1–1.2 cm long, distal fertile part of stalk 0.4–0.6 cm long, ending with minute sterile tip,

sporangia 7–10 on either side, globose, embedded. Spores in LM globose, trilete, 16–28  $\mu\text{m}$  in equatorial diameter with four layers; perine (perispore) distinct covering all over spore surface, exine (exospore) well defined, thick with verruca-like sculpture, endexine (mesospore) thick, but intine (endspore) smooth, simple; in SEM, exine surface proximally verrucose with many minute pits, distally with many depressed areoles united into negative reticulation (Figs. 1–10).

*Reproductive period:* July–August.

*Locality:* Mainal, Chittorgarh, Rajasthan, India.

*Ecology:* Grows in dense colony in flat damp

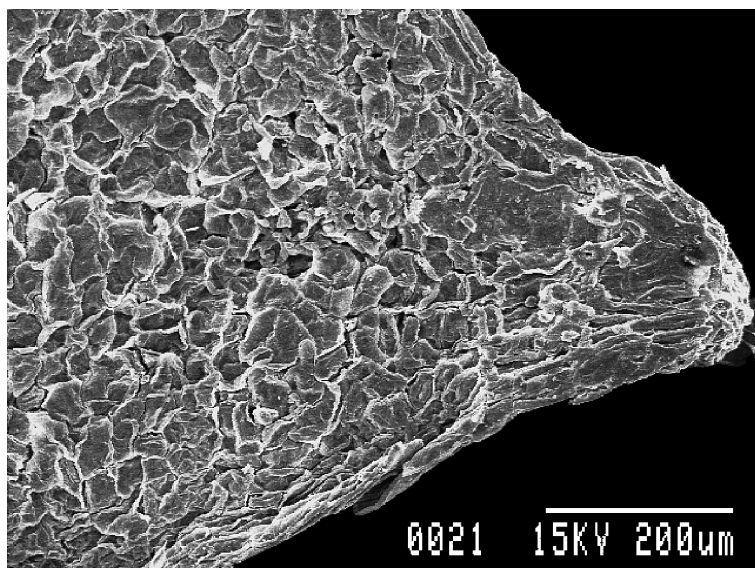


Fig. 10. SEM image of *O. indicum* ventral mesophyll near tip of trophophyll with epidermis peeled off, showing isodiametric irregular cells with small pedunculate hair-like structures.

grassy area, along with *O. costatum*, *O. nudicaule*, *O. eliminatum*, and *O. lusitanicum* (Fig. 1). The *O. indicum* plants, which can be easily identified by the leaf color, grow intermixed with green congeners, e.g., *O. lusitanicum*, *O. costatum* and *O. eliminatum* in Mainal locality (District Chittorgarh).

*Status*: Exclusively restricted to Mainal area, Chittorgarh.

*Notes*: *Ophioglossum indicum* is remarkable in the pink leaf (Figs. 1–3). The young pink trophophyll-lamina except at the margin and sterile stalk gradually turns brownish green toward maturity, associated with increased photosynthetic activity. In other species, color change is complete.

In light microscopy (LM, see figure legend for method), the spores are globose and trilete with a small triradiate mark (laesurae) not extending to the margins (Fig. 5), sometimes divided (Goswami, 2007). In scanning microscopy (SEM, see figure legend for methods), the laesural arms are crassimarginate, like in *O. lusitanicum* but also sometimes sinuous, like in *O. costatum* (Goswami and Khandelwal, 1973; Pant *et al.*, 1995; Goswami, 2007). The proximal surface is verru-

cose and has many minute depressions (Figs. 6 and 7). The distal face is granulose to verrucate (verrucose) in light microscopy, but in SEM the depressed areoles are united into negative reticulation (Figs. 8 and 9). In LM, the perine (perispore) is thick and covers the exine, which is thick and verrucose (Fig. 5), like in *O. costatum*, but the latter species does not have a distinct perine.

*Ophioglossum eliminatum* Khandelwal & Goswami incidentally occurs together with *O. indicum*. However, the spores of *O. eliminatum* show a thick apex of triradiate mark sometimes looking like a raised knob, and the exine is very thick and warty (verruca-like sculpture). By contrast, such a thick perine around every spore as in *O. indicum* is not found in any other congeners except in some spores of *O. eliminatum*.

*Ophioglossum indicum* resembles *O. lusitanicum* and *O. nudicaule* in the size range of small plants and *O. costatum* in having spores with thick exine, but differs in having a very widely covering perine. Also, *O. indicum* has no obvious midvein in the trophophyll, while *O. costatum* always has an obvious midvein. The *O. indicum* spores show many depressed areoles united into

negative reticulation on the distal face. Furthermore, *O. indicum* totally differs from *O. vulgatum* in the shape and size of trophophyll and color of plants.

The ventral mesophyll of the trophophyll is composed of irregularly packed rectangular to isodiametric cells with hair-like pedunculate outgrowths. There are only a few stomata in the ventral epidermis, but stomata are numerous in the dorsal epidermis (Fig. 10). In the mesophyll histology *O. indicum* is distinct in the genus.

In summary, *O. indicum* is characterized by the pink plant and the spores with thick exine widely covered by thick perine.

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