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COMMUNICATION

DIVERSITY, DISTRIBUTION AND CONSERVATION STATUS OF THE ADDER'S-TONGUE FERNS IN GOA, INDIA

Sachin M. Patil & Kishore Rajput

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Diversity, distribution and conservation status of the Adder's-tongue ferns in Goa, India

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Abstract: The cosmopolitan fern genus *Ophioglossum* (Ophioglossaceae) is distributed from low to high altitude plateaux, coastal plains and forest floors of India. This genus has received special attention from pteridologists worldwide since the discovery that *Ophioglossum reticulatum* possesses the largest number of chromosomes. There are, however, no reported studies of *Ophioglossum* in Goa, hence the present investigation was undertaken to study the diversity, distribution and conservation status of *Ophioglossum* in that state. A total of six species were collected from different localities, of which four (*O. nudicaule*, *O. lusitanicum*, *O. parvifolium*, and *O. reticulatum*) are reported as new distributional records for Goa State. A detailed morpho-taxonomy, illustration and photographs of all collected species are given, along with a key to the species.

Keywords: Illustration, morpho-taxonomy, new record, Western Ghats.

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Author contribution: SMP—collection & identification of *Ophioglossum* species and preliminary writing of present manuscript. KSR—confirmation of identity, proof reading, finalizing the current manuscript and administrative responsibilities.

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INTRODUCTION

The state of Goa is located on the western coast of India between Maharashtra and Karnataka states, with a geographical area of 3,702km². It lies on the coastal plains of the Western Ghats between 14.899–15.799 °N and 3.681–74.336 °E. The major rivers are Mandovi and Zuari (Meteorological Centre, Goa 2020), and the climatic features fall under the tropical monsoon climate, making the region generally warm and humid throughout the year. The average rainfall ranges between 2,500–4,500 mm/annum, and highest rainfall is observed during June–August. The average temperature ranges between 16.2°C–36.7°C, with maximum temperature during the month of April–May. The state has a national park (Molem) and six wildlife sanctuaries which covers an area of 755km² (Hiremath 2003; Jadhav & Patil 2012).

The genus *Ophioglossum* L. belongs to the primitive family Ophioglossaceae. About 50 species are accepted internationally (Hassler & Schmitt 2020), and 19 species are documented from India (Patil & Dongare 2014; Patil et al. 2018 & Kachhiyapatel et al. 2018), of which the status of a few were unresolved (Hassler & Schmitt 2020). All are terrestrial forms except the epiphytic *O. pendulum* L. The genus was studied in India for the first time by Beddome (1883). After his monumental contribution on the Indian ferns, the genus *Ophioglossum* L., received further attention from Blatter & d'Almedia (1922), Chakravarty (1951), Mahabale (1962), Panigrahi & Dixit (1969), Khandelwal (1987), Khullar (1994), and Goswami (2007), in their respective works. It is characterized by simple trophophyll with a spike (rarely bi or trifurcate) bearing two rows of sporangia. In all species the trophophyll is pale green, green, dark or light green at maturity, and produces a paler spike (Khullar 1994; Goswami 2007; Goswami et al. 2008). *Ophioglossum gomezianum* Welw. ex A.Braun, *O. indicum* B.L.Yadav & Goswami, *O. lusitanicum* L., and *O. rubellum* Welw. ex A.Braun, however, produce yellow, pink, reddish to brown tinge of trophophyll, respectively (Goswami 2007). Patil & Dongare (2014) studied the diversity and distribution of *Ophioglossum* from the Western Ghats and reported 06 species. Recently, Fraser-Jenkins et al. (2018) accepted only 12 species for India.

The diversity of pteridophytes in Goa is less understood, with few reports. Dalgado 1898; Blatter & d'Almedia 1922; Vartak 1966; Rao 1985–1986; Naithani et al. 1997, and Irudayaraj & Bir 1997. Manickam et al. (2004) studied the pteridophytes of the Western Ghats of Goa and recorded 51 species. Further, Kerkar & Shetkar (2009) studied the order Pteridales and recorded 16

species in Goa belonging to six genera from five families. In 2010, Datar & Lakshminarasimhan (2010) studied the pteridophyte flora of the Western Ghats of Goa and documented 47 species. These studies reported two species of *Ophioglossum*: *O. costatum* R.Br., and *O. gramineum* Willd., from the Western Ghats of Goa. While studying the pteridophytes of the Western Ghats, however, the authors visited different places in Goa and observed that the plateaux and coastal plains are favourable for *Ophioglossum* and earlier workers may have missed some species. Thus the present investigation was undertaken to study the morpho-taxonomy, species composition, distribution and conservation status of *Ophioglossum* from Goa.

MATERIALS AND METHODS

Field visits were carried out during 2014–2018 in different areas of Goa State. The collected specimens of *Ophioglossum* were processed in the laboratory. Pressed specimens were fixed with 4% formalin and affixed to herbarium sheets using synthetic gum (Fevicol). Specimens were identified using literature, including Blatter & d'Almedia (1922); Panigrahi & Dixit (1969); Fraser-Jenkins et al. (2017), and Patil & Dongare (2014). The voucher specimens are deposited in the herbarium of the Department of Botany, Maharaja Sayajirao University of Baroda, Vadodara, Gujarat (BARO).

RESULTS

During the present investigation authors collected six species of *Ophioglossum*: *O. costatum* R.Br., *O. gramineum* Willd., *O. lusitanicum* L., *O. nudicaule* L.f., *O. parvifolium* Grev. & Hook., and *O. reticulatum* L. The detailed morphology, diversity, distribution, illustrations, photographs, phenology, ecology, and conservation status of each species is given. An identification key for the taxa recorded from Goa State is given below.

Key to the species for Goa state

- 1a. Trophophylls having costa or yellow band at centre *O. costatum*
- 1b. Trophophylls without costa or yellow band at centre 2
- 2a. Trophophylls base cordate, strobili having > 20 pairs of sporangia *O. reticulatum*
- 2b. Trophophylls base not cordate, strobili having

- < 20 pairs of sporangia 3
- 3a. Trophophylls attached to substratum *O. parvifolium*
- 3b. Trophophylls above the ground 4
- 4a. Trophophylls ovate-lanceolate, 1–2 cm above the ground *O. nudicaule*
- 4b. Trophophylls linear-lanceolate or spatulate not flat on ground 5
- 5a. Trophophylls linear-lanceolate or grass like *O. gramineum*
- 5b. Trophophylls spatulate-lanceolate not grass like *O. lusitanicum*

Ophioglossum costatum R. Br., Prod. Fl. Nov. Holl. 163. 1810. Panigrahi & Dixit, Proc. Nat. Inst. Sci. India 35: 249. 1969; Patil & Dongare, Indian Fern J., 31: 17–24. 2014.

Lectotype: from Australia, Queensland, Arnhem North Bay, R. Brown 118. 14.2.1803.

Ophioglossum pedunculatum Desv., Mag. Nat. Fr. Berlin 5: 306. 1811.

O. brevipes Bedd., Ferns. Southern India 23. t. 72. 1863.

O. bulbosum Bedd., Ferns. Brit. India Suppl. t. 28. 1876.

O. fibrosum Schum., Bedd., Handb. 465. t. 289. 1883.

Plant terrestrial, 12–25 cm in height, pale-green; rhizomorph 0.5–1 cm, subterranean, disc like or globose, bearing numerous yellow-brown, fleshy, unbranched, roots; common stalk 2–3 cm, subterranean-terrestrial; trophophylls 2–6 x 0.5–1 cm, 1–3 simple, elliptic-lanceolate, apex acute-apiculate or obtuse-round, base cuneate, margin entire, green-pale green, glabrous on both sides, coriaceous, costa present, prominent, yellow; texture coriaceous, thick; veins indistinct, simple reticulate, anastomosing; fertile segment 9–19 cm, unbranched, inserted on adaxial position of leaf; strobili 2–5 cm, linear-lanceolate, apex blunt-lanceolate, 20–55 pairs of sporangia, pale yellow, unbranched; spores 20–40 µm in diameter, trilete, foveolate.

Phenology: sterile phase – June–July; fertile phase: July–September (rarely in October)

Distribution: India (Andhra Pradesh, Assam, Chhattisgarh, Goa (Canacona, Dharbandora, Mapusa, Pernem, Phonda, Quepem, & Sattari), Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal), Bangladesh, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand, Africa, and Australia.

Ecology: Very common, collected from grassy plateau. The population size varies according to the water content of the soils. The population size is larger when water availability is more and vice-versa.

Conservation status: It is collected from throughout the Goa except seashore areas. Population comprises about 300–400 individuals per km² and the area of occupancy (AOO) is 50–60 km². Therefore, as per IUCN categories and criteria (IUCN red list of Threatened Species ver. 2017-1), it is assessed as Least Concerned (LR) species for Goa State.

Ophioglossum gramineum Willd. Nov. Act. Acad. Erfurt. 2: 18. t.f.1. 1802; Beddome, Handb. Suppl. Ferns Brit. India 108. 1892; Balakrishnan et al., Bull. Bot. Surv. India 2: 337. 1960; Panigrahi & Dixit, Proc. Nat. Inst. Sci. India 35: 250. 1969; Patil & Dongare, Indian Fern J. 31: 17–24. 2014.

Type: from West Africa, St. Thomae, De Friedland B. *Ophioglossum dietrichiae* Prantl, Ber. Deut. Bot. Ges. 1: 352. 1883.

O. gregarium Christ, Nova Guinea Bot. 8: 164. 1909;

O. inconspicuum (Racib.) Alderw., Bull. Dépt. Agric. Ind. Néerl. 21: 9. 1908.

O. prantlii C.Chr., Ind. Fil. 2: 471. 1906.

O. inconspicuum forma *majus* Alderw., Bull. Dépt. Agric. Ind. Néerl. 21: 9. 1908.

Ophioglossum gramineum var. *majus* (Alderw.) Wieff., Blumea 12(2): 324. 1964. *Ophioglossum gregarium* Christ, Nova Guinea, Bot., 8: 164. 1909.

Ophioglossum gracile Pocock ex J.E.Burrows, Bothalia 25(1): 61. 1995.

O. vulgatum var. *gramineum* (Willd.) Hook. f., Fl. Nov. Zel. 2: 50. 1854.

Plant terrestrial, 4–8 cm in height, green-pale green; rhizomorph sub-globose-tuberous, subterranean, bearing numerous, fleshy, fibrous roots; common stalk 0.5–2 cm, subterranean-terrestrial, flat; trophophylls 1–2 cm, 1–2, linear grass-like, apex acuminate, margin entire, soft, green-pale green; texture coriaceous, thin; veins parallel, anastomosing, forming parallel areoles; fertile segment 3.5–6 cm, unbranched, pale green, flat-round; strobili 0.5–1.5 cm, linear-lanceolate, apex pointed, 6–10 (rarely >10) pairs of sporangia, arranged in two alternate rows, pale green-yellow; spores 25–40 µm dia., trilete, exine reticulate.

Phenology: Sterile phase: Jun–July; fertile phase: July–August (rarely September–October)

Distribution: India (Andhra Pradesh, Chhattisgarh, Goa (Canacona, Dharbandora, Mapusa, Pernem, Phonda, Quepem, & Sattari), Gujarat, Karnataka, Kerala, Madhya

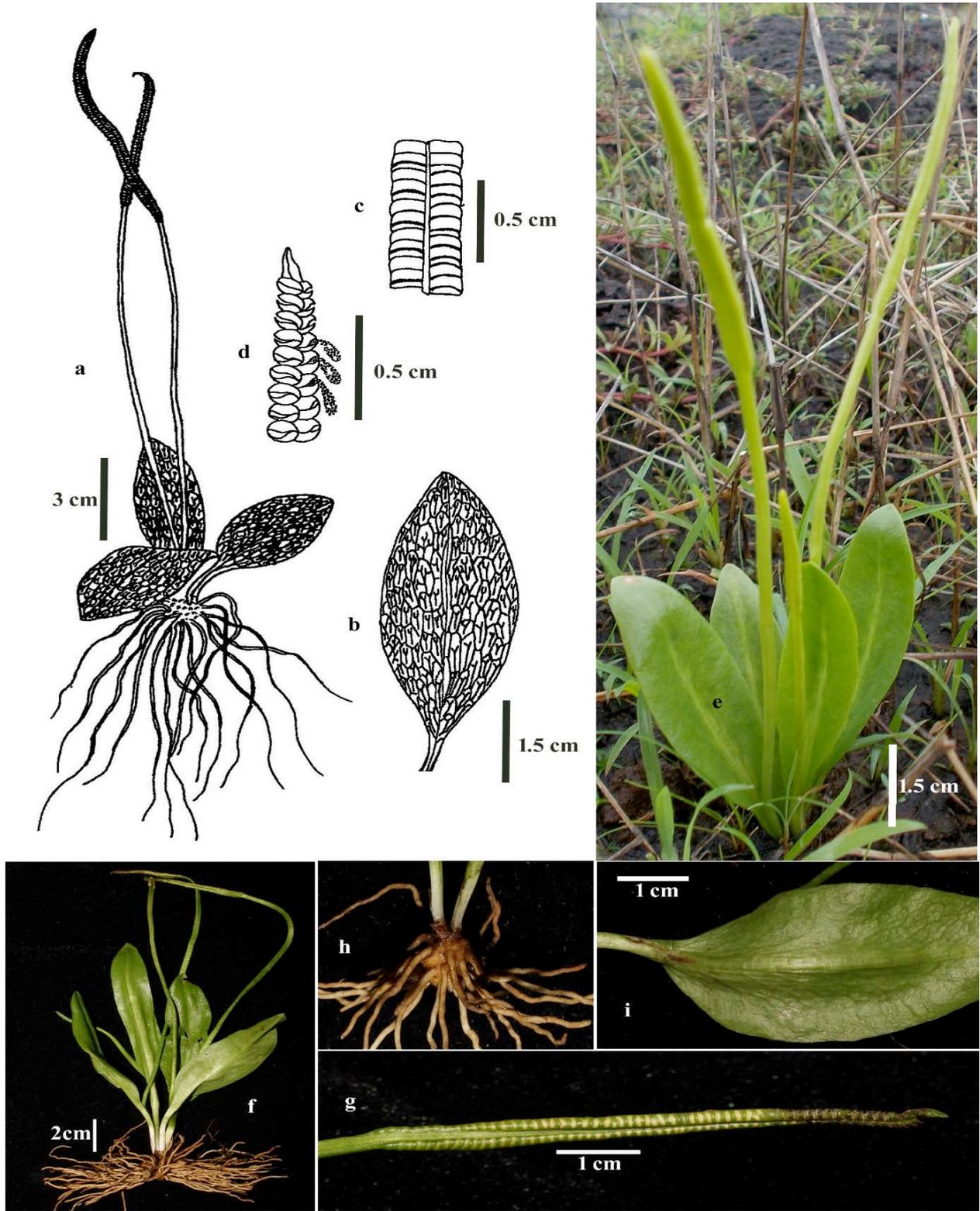


Image 1. *Ophioglossum costatum*: a, e-f—habit | b—enlarged trophophyll showing venation | c-d, g—enlarged strobilus | h—globous rhizomorph | i—trophophyll showing costa. © Sachin M. Patil

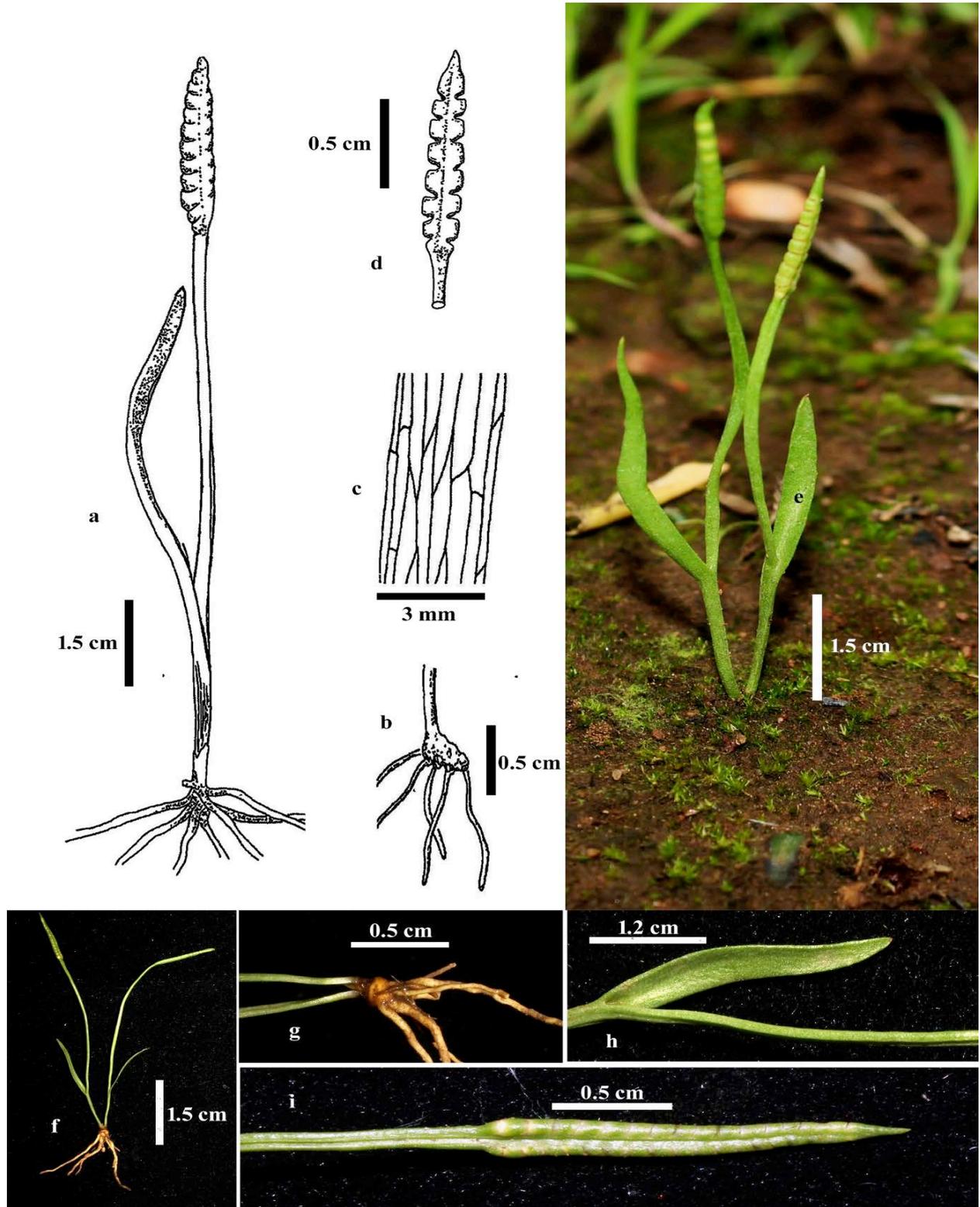


Image 2. *Ophioglossum gramineum*: a, e-f—Habit | b, g—enlarged rhizomorph | c—enlarged view of venation pattern | d, i—enlarged strobilus | h—enlarged trophophyll. © Sachin M. Patil

Pradesh, Maharashtra, Meghalaya, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, & West Bengal), Indonesia, Malaysia, Myanmar, Philippines, East Borneo, East Java, New Guinea, Vietnam, Africa, and Sri Lanka.

Ecology: Common fern collected from grassy plateaux associated with *O. nudicaule*, *O. parvifolium* and *O. costatum*.

Conservation status: It is collected from plateaux situated in Goa State. Population comprises about 300–400 individuals per km² and the area of occupancy (AOO) is 50–60 km². Therefore, as per IUCN categories and criteria (IUCN red list of Threatened Species ver. 2017-1), it is assessed as Least Concerned (LR) species for Goa State.

Ophioglossum lusitanicum L., Sp. Pl., 2: 1063. 1753; Clausen, Mem. Torrey Bot. Club, 19 (2): 159. 1938; Mahable, Bull. Bot. Surv. India, 4: 71. 1962; Panigrahi & Dixit, Proc. Nat. Inst. Sci. India 35: 251. 1969; Patil & Dongare, Indian Fern J., 31: 17-24. 2014.

Type: from Portugal, "Habitat in Lusitania", not designated.

Ophioglossum loureirianum C.Presl, Suppl. Tent. Pterid. 55. 1845.

O. braunii Prantl, Ber. Deutsch. Bot. Ges. 1: 351. 1883.

Plant terrestrial, 3–10 cm in height, small; rhizomorph 0.5–1 cm, subterranean, sub-globose-tuberous with or without stoloniferous fleshy roots; common stalk subterranean, white; trophophylls 1–2, erect, red-brown-green, spatulate, linear-lanceolate or elliptic-lanceolate, acute-acuminate apex, cuneate-attenuate base, entire margin; texture coriaceous, thin; veins indistinct, anastomosing, forming parallel areoles; fertile segment round, unbranched, green-yellow brown; strobili 1–2 cm, linear-lanceolate, 8–10 (rarely >10) sporangia in two rows, green-yellow; spores 20–25 µm dia., trilete, exine reticulate.

Phenology: sterile phase: June–July; fertile phase: August–September

Distribution: India (Andhra Pradesh, Assam, Bihar, Goa (Mapusa, Pernem, & Phonda), Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Tamil Nadu, & Uttar Pradesh), Algeria, Morocco, Portugal, Spain, Tanzania, Tunisia, and Uganda.

Ecology: Common species, collected from grassy plateaux of Goa, associated with *O. costatum*, *O. nudicaule*, *O. parvifolium* and *O. reticulatum*.

Conservation status: It is collected from plateaux situated at Mapusa, Pernem, and Phonda. A population of about 100–200 individuals was found. The area of

occupancy (AOO) is 10–20 km² per locality and considered as Data Deficient (DD) because the explorations in the state are not completed and there is a possibility of more locations of occurrence.

Ophioglossum nudicaule L.f., Suppl. Pl. Syst. 443. 1781; Beddome, Handb. Ferns Br. India, 464, t. 228. 1883; Panigrahi & Dixit, Proc. Nat. Inst. Sci. India 35: 252. 1969; Manickam & Irudayaraj, Pterid. Fl. West Ghats 48-49. t. 27. 1992; Patil & Dongare, Indian Fern J. 31: 17-24. 2014.

Type: South Africa: Cape of Good Hope.

Ophioglossum capense Sw., Schard. Journ. 1801(2): 308. 1803.

Ophioglossum capense Schlech. var. *nudicaule* (L.) Schlech., Fil. Prom. Bonae Sp.: 9. 1825.

Ophioglossum ellipticum Hook. & Grev., Icon. Filic. t. 40 A. 1828.

Ophioglossum lineare Schlechter & Brause, Bot. Jerb., 49: 59, fig. 3F. 1912.

Ophioglossum luersseni Prantl, Ber. Deut. Bot. Ger. 1: 352. 1883.

Plant 4–12 cm height, green, terrestrial herb; rhizomorphs subterranean, sub-globose (at young)-tuberous (at maturity), bearing many soft, pale brown, unbranched, fleshy, fibrous, stoloniferous roots; common stalk 1–3 cm, subterranean-terrestrial, white (subterranean), green (terrestrial); trophophylls 0.5–2 x 1–2 cm, 1–2 (rarely 3), green, tuft ovate-elliptic, apex acute-obtuse, base cuneate, margin entire, glabrous; veins indistinct, simple reticulate, anastomosing, with or without included veinlets; fertile segment 2–8 cm, unbranched (rarely branched), green at young, yellow at maturity; strobili 1.5–2.5 cm long, with 10–20 sporangia per strobilus, arranged in two alternate rows, linear-lanceolate, apex pointed; spores 30–40 µm dia., trilate, with reticulate ornamentation.

Distribution: India (Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Goa (Phonda & Canacona), Gujarat, Jharkand, Karnataka, Kerala, Maharashtra, Sikkim, Tamil Nadu, & West Bengal), China, Indonesia, Malaysia, and Thailand.

Phenology: sterile phase: July–August; fertile phase: August–September.

Ecology: The species is growing in patches on fully exposed plateaux or open grassland, associated with *O. costatum*, *O. gramineum* and *O. parvifolium*.

Conservation status: It is collected from open grasslands on plateaux situated in Phonda and Canacora. The area of occupancy (AOO) is 10–20 km² per locality and considered as Data Deficient (DD) because the explorations in the state are not completed and there is



Image 3. *Ophioglossum lusitanicum*: a, e–g—Habit | b, i—enlarged rhizomorph | c—enlarged trophophyll showing venation | d, j—enlarged strobilus | h—enlarged trophophyll. © Sachin M. Patil

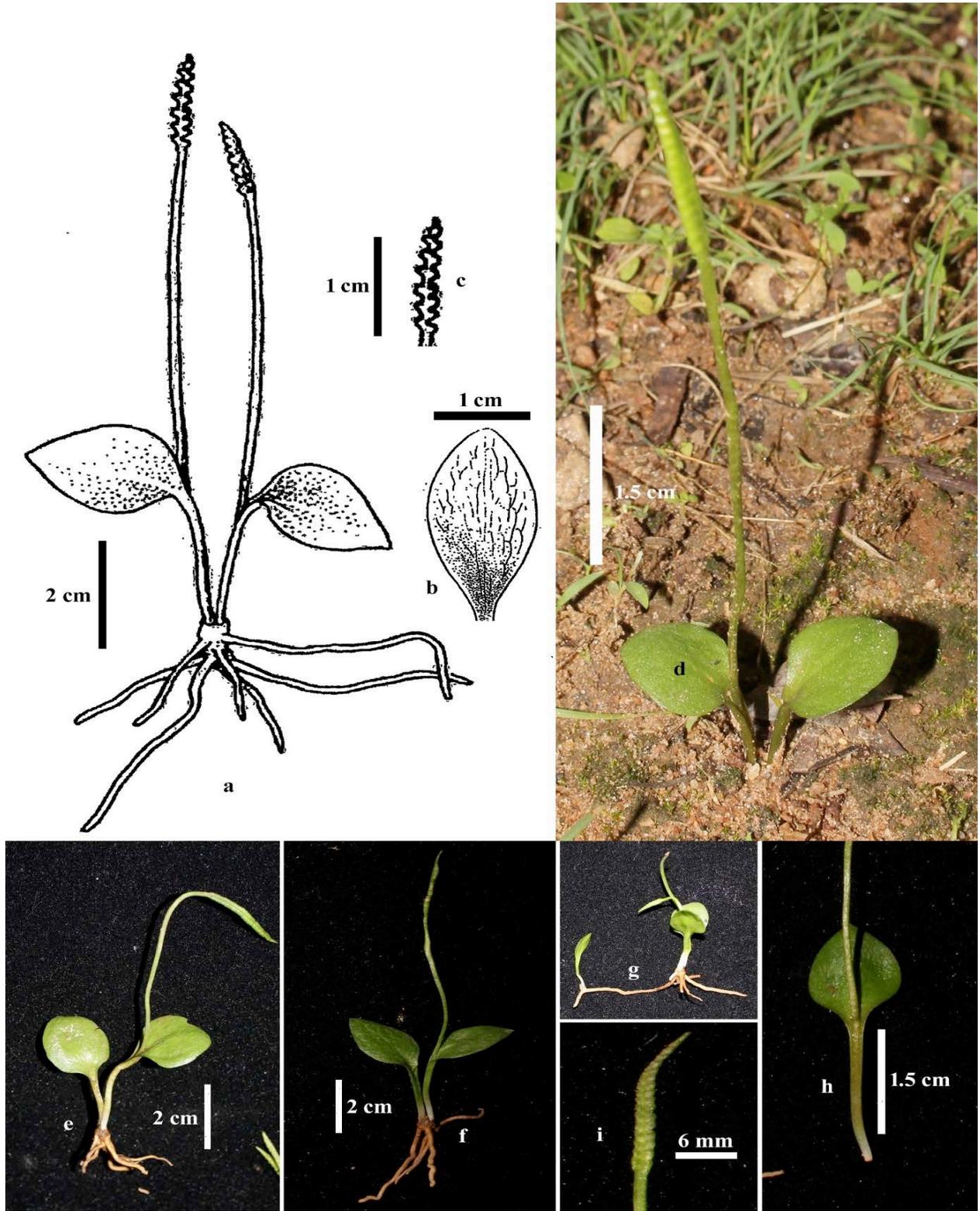


Image 4. *Ophioglossum nudicaule*: a, d-f—Habit | b, h—enlarged trophophylls | c—enlarged strobilus | g—stoloniferous roots. © Sachin M. Patil

possibility of more locations of occurrence.

Ophioglossum parvifolium Grev. & Hook., Bot. Misc. 3: 218. 1833; Patil & Dongare, Indian Fern J. 31: 17–24. 2014.

O. macrorrhizum Kunze Analecta Pteridogr.: 2. 1837.

O. schmidii Kunze in Linnaea 24: 246. 1851.

O. luerssenii Prantl Ber. Deutsch. Bot. Ges. 1: 352. 1883.

O. pumilum (Racib.) Alderw. Malayan Ferns: 774. 1909.

Type: India, Gujarat, Valsad District, Wilson Hills, 24 Aug 2014, Patil & Kachhiyapatel 38 (BARO No. 1234500700). *typ. cons. prop.* (Mazumdar et al. 2018)

Plant 4–8 cm, terrestrial herbs; rhizomorph subterranean, sub-globose-tuberous, pale brown, bearing many soft, fleshy, unbranched, fibrous, stoloniferous roots; common stalk subterranean, white, round, glabrous; trophophylls 0.4–1 cm, 1–2 (rarely 3–4), pale green-green, ovate-lanceolate, apex acute-apiculate, margin entire, base cordate; texture coriaceous, thin; *veins* indistinct, simple reticulate, four or five veins passing up through the stalk of the blade; fertile segment 2–6 cm long, unbranched, green-pale green; strobili 0.5–1 cm long, 5–7 (rarely >10) pairs of sporangia, arranged in two alternate rows; *spores* 25–45 µm dia., trilete, exine reticulate.

Distribution: India (Madhya Pradesh, Goa (Canacona, Dharbandora, Mapusa, Pernem, Phonda, Quepem, & Sattari), Gujarat, Maharashtra, Karnataka, Rajasthan, Kerala, & Tamil Nadu), China, South America, Sumatra, Malaysia, and Thailand.

Ecology: Common species grows in patches on fully exposed areas from low land to high land areas.

Conservation status: It is collected from different plateaux of Goa state. Population comprises about 300–400 individuals per km². The area of occupancy (AOO) is 50–60 km². Therefore, as per IUCN categories and criteria (IUCN ver. 2017-1), it is assessed as Least Concerned (LC) species for Goa state.

Ophioglossum reticulatum L. Sp. Pl. 2: 1063. 1753; Beddome, Ferns. Southern India 23. t. 70. 1863; Beddome, Handb. Ferns. Bri. India, 465. t. 290. 1883; Panigrahi & Dixit, Proc. Nat. Inst. Sci. India 35. 257. 1969; R.D. Dixit, Cens. Ind. Pterid. 24. 1984; Manickam & Irudayaraj, Pterid. Fl. West Ghats: 51. t. 29. 1992; Patil & Dongare, Indian Fern J. 31: 17–24. 2014.

Lectotype: (Tardieu Blot, in Aubreville, Flor. Gabon 8: 30. 1964): from C. America, "*Ophioglossum cordatum* et *reticulatum*" in Plumier, Traité Foug. Amér., 141, t. 164,

1705.

Ophioglossum peruvianum Presl, Suppl. Tent. Pterid 52. 1845.

Ophioglossum petiolatum sensu Wieffering, Blumea, 12: 327. 1964.

Ophioglossum cordifolium Roxb., Hort. Bengal. 75. 1814;

Plant 15–25 cm, terrestrial herb; rhizomorph 3–7 mm long, subterranean, tuberous, bearing few long, thick fleshy unbranched, pale brown roots, with 1–2 trophophylls; common stalk 2–5 cm, terranean, white at base, green above; trophophylls 1, 2–5 x 1–3 cm, cordate-broadly ovate, rarely elliptic-oblong, apex rounded or acute, base cordate; veins reticulate, areoles with or without included free veinlets; fertile segment 12–18 cm long, round; strobili 1–5 cm, 20–45 pairs of sporangia, apex pointed, sporangia arranged in two alternate compact rows; spores 30–45 µm dia., spherical, trilete, exine hemispherical.

Distribution: India (Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Goa (Sattari & Canacona), Gujarat, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Mizoram, Odisha, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, & West Bengal), Malay Peninsula, tropical America, Africa, Philippines, and Sri Lanka.

Phenology: sterile phase: July–August; fertile phase: August–October

Ecology: Very common, found beneath trees in the forest along with *Ophioglossum costatum*, *O. gramineum* and *O. parvifolium*.

Conservation Status: It is collected from forest regions at Sattari and Canacona. The area of occupancy (AOO) is 10–20 km² per locality and considered as Data Deficient (DD) because the explorations in the state are not completed and there is possibility of more locations of occurrence.

DISCUSSION

Earlier only two species, *Ophioglossum costatum* and *O. gramineum* were reported from Goa (Manikam et al. 2004; Datar & Lakshminarsimhan 2010). During the present investigation six species were collected, of which *O. lusitanicum*, *O. nudicaule*, *O. parvifolium*, and *O. reticulatum* have been added to the flora of Goa. *O. costatum*, *O. gramineum*, and *O. parvifolium* are considered least concerned (LC) species, while *O. lusitanicum*, *O. nudicaule*, and *O. reticulatum* are

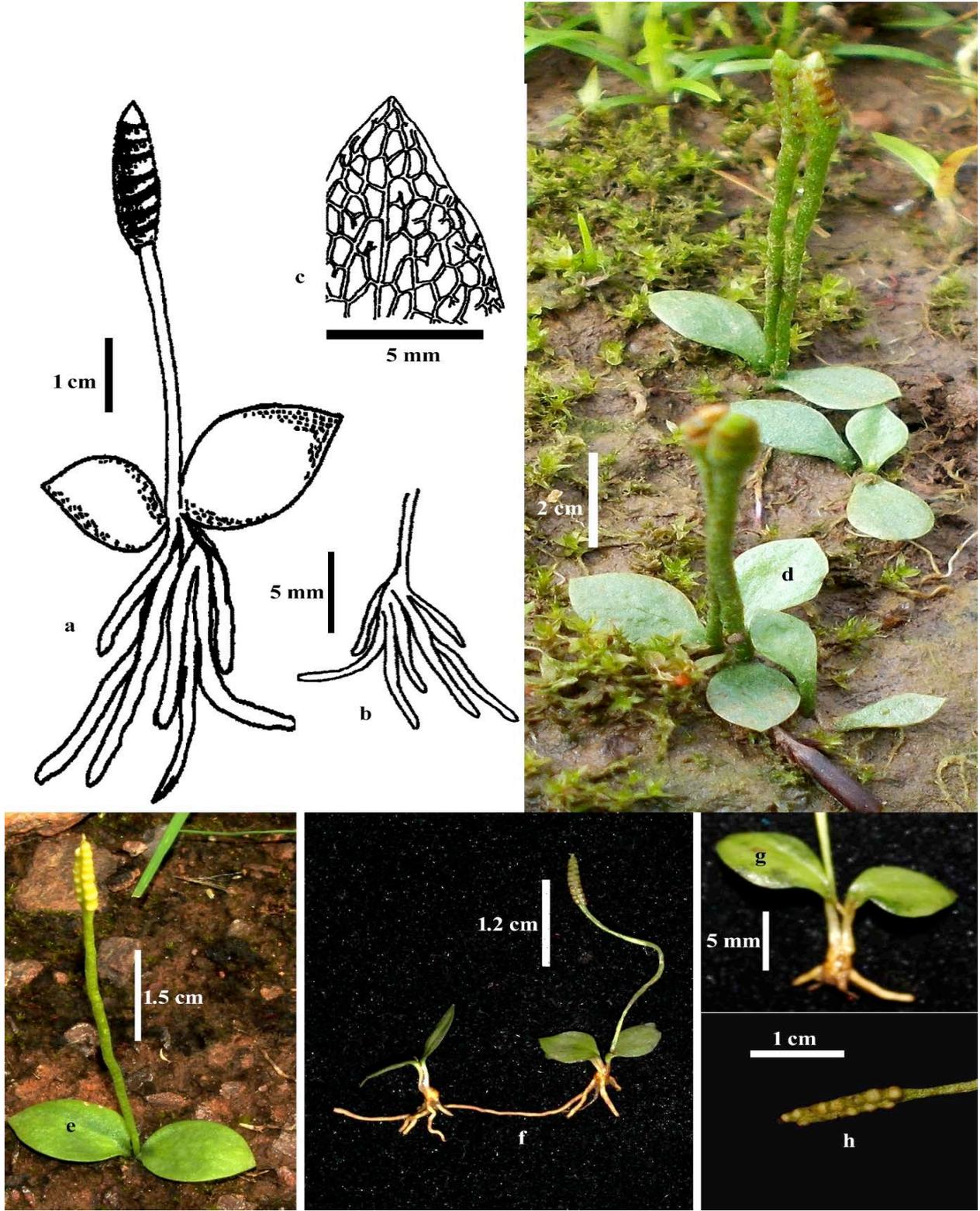


Image 5. *Ophioglossum parvifolium*: a, d-e—Habit | b, g—enlarged rhizomorph | c—enlarged trophophylls showing venation | f—stoloniferous roots | h—enlarged strobilus. © Sachin M. Patil

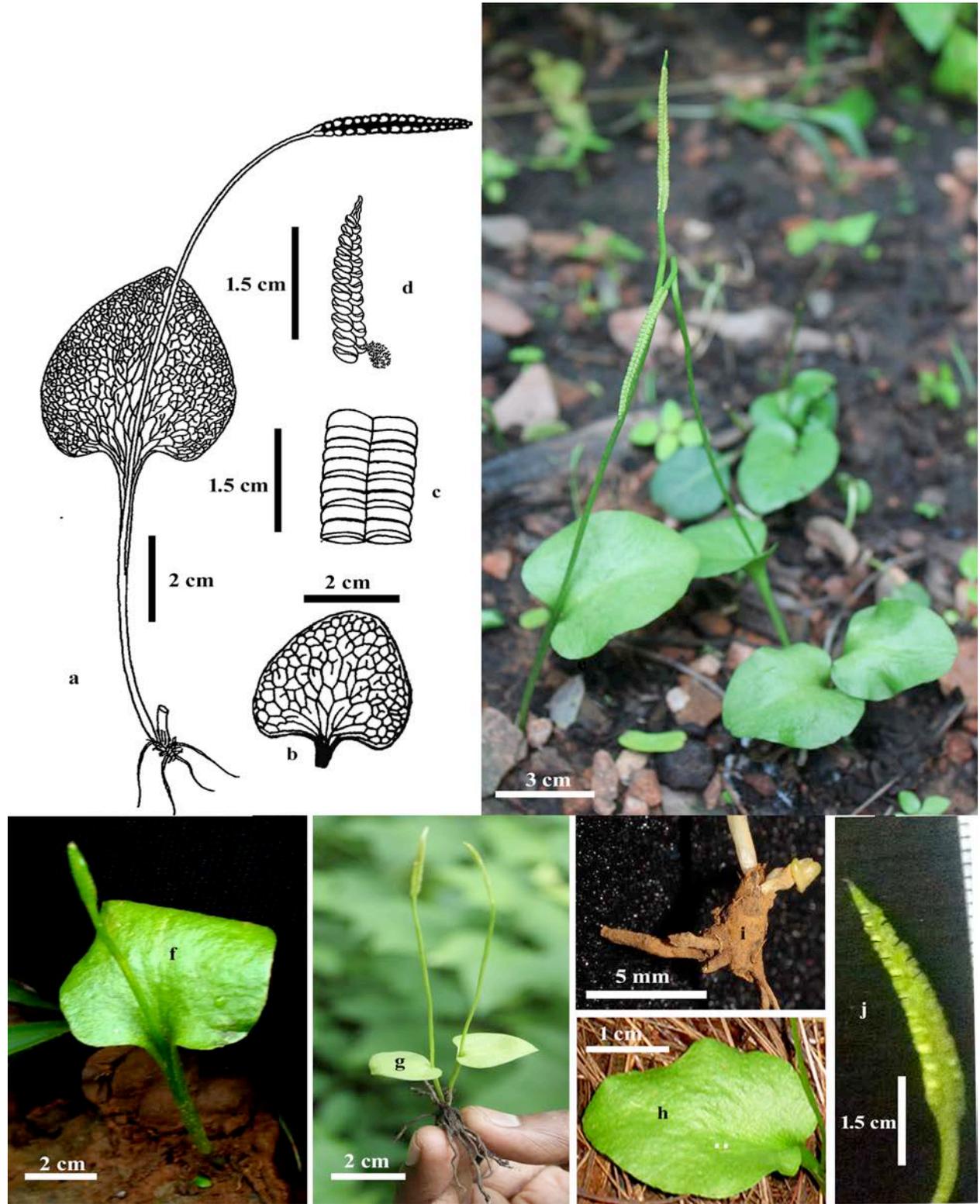


Image 6. *Ophioglossum reticulatum*: a, e–g—Habit | b—enlarged trophophyll showing venation | c–d, j—enlarged strobilus | h—enlarged trophophyll | i—rhizomorph. © Sachin M. Patil

considered data deficient (DD) species. The maximum diversity was observed in open grassy habitat and plateaux, where we collected *O. costatum*, *O. gramineum*, *O. lusitanicum*, *O. nudicaule*, and *O. parvifolium*. Coastal plains contained *O. costatum* and *O. gramineum*, and on forest floors we collected *O. nudicaule* and *O. reticulatum*.

In *Ophioglossum costatum* the trophophylls (leaf-like segment) have a central yellow band (i.e. costa), hence the specific epithet is *O. costatum*. Amongst the taxa reported from India, *O. costatum* is only one with a costa (Image 1), thus it can be easily differentiated from other Indian residents. In the field it is difficult to locate *O. gramineum* because this species is found on grassy plateaux and its appearance is similar to a grass (hence specific epithet *O. gramineum*). Generally the trophophylls are linear-lanceolate like grass, and are part underground and part above ground with a common stalk (Image 2). A species similar to *O. gramineum* is *O. lusitanicum*, however, the latter has green-brown, spatulate-lanceolate trophophylls and a subterranean common stalk (Image 3). *Ophioglossum nudicaule* and *O. parvifolium* are closely allied and commonly confused species. *O. nudicaule* is smaller in size, hence the specific epithet is *parvifolium* (*parvum* = small and *folium* = trophophylls). *Ophioglossum nudicaule* has trophophylls that are ovate-obovate, 1–2 cm above the ground, common stalk subterranean-terrestrial, whereas in *O. parvifolium* the trophophylls are ovate-broadly lanceolate, attached or flat on the ground, common stalk subterranean only (Image 4–5). *Ophioglossum reticulatum* is well-known and popular in biological world because it has the highest number of chromosomes ($n=740$). It is allied and confused with *O. petiolatum*, however, *O. reticulatum* has cordate trophophylls, 2–5 cm above ground, petiolate, common stalk subterranean-terrestrial, having maximum number of sporangia (Image 6).

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