

# New Distributional Records of Three Rare Ferns from Odisha, India

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## ABSTRACT

Niyamgiri and Kotgarh Wildlife Sanctuary are part of the Eastern Ghats located at Odisha. The altitude range of these mountain ranges between 400–1516 m shows the diversity of vegetation due to their undulating mountain peaks, deep gorges, valleys and numerous springs. Three species viz., *Amblovenatum opulentum* (Kaulf.) J. P. Roux, *Pronephrium articulatum* (Houlston & T. Moore) Holttum and *Sphaerostephanos hirtisorus* (C. Chr.) Holttum (Family: Thelypteridaceae) collected from Niyamgiri hill and Kotgarh Wildlife Sanctuary are recorded for the first time from Odisha state. The same are documented here with taxonomic details and photographs of herbaria.

**Keywords:** Ferns, addition, Pteridophyte flora, Odisha

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## INTRODUCTION

Three major mountain ecosystems are found in India viz., The Himalayas, Western Ghat and Eastern Ghat (Roy *et al.*, 2012). Among these, the Eastern Ghats comprise the mountain ranges extending along eastern coast of India. The state Odisha contributes to one-fourth of Eastern Ghat mountain, extending from Shimilipal in the Maurbhanj district of North Odisha to Malkangiri hills of Southern Odisha. The state harbors about 141 species of Pteridophytes (Odisha Biodiversity Board, 2019). The Kotgarh Wildlife Sanctuary and Niyamgiri hill of Odisha State falls under the range of Eastern Ghats and harbors the vegetation of moist deciduous forest. While studying the ferns and lycophytes of Niyamgiri, the authors came across three rare occurring ferns belonging to the family Thelypteridaceae. Thelypteridaceae is a large fern family of about 1000 different species distributed in tropical and subtropical areas (Smith and Cranfill, 2002). Its habitat ranges from moist to swampy or next to streams of water in ravines, exhibiting a versatile morphological, anatomical diversity and anomaly (Holttum, 1982; Schelpe and Anthony, 1986).

Thelypteridaceae's generic delimitation is still controversial (He & Zhang, 2012, Almeida *et al.*, 2016). Tagawa & Iwatsuki (1988) and Fraser-Jenkins *et al.* (2017) considered very few genera and grouped the majority of the species in *Thelypteris* Schmel. In contrast, Holttum (1982) and Smith (1992) identified and organized these sections/sub-genera into 30 genera. However, a recent study on molecular systematic supports for a large number of smaller genera (Almeida *et al.*, 2016) and this system has been accepted in PPG I (2016) globally and the same system has been adopted here.

The genus *Amblovenatum* is represented by 12-15 species found in India, Australia, Malesia, the Pacific islands and New Guinea (Holttum, 1971; Son *et al.*, 2022). In India, the genus is distributed with three species. The genus *Pronephrium* C. Presl belongs to the family Thelypteridaceae consists of 70 species worldwide and is mostly distributed in tropical regions of India, China, Japan, Malaysia, Sri Lanka, Fiji and Australia (Dixit and Vohra, 1984). In India, there are about 8 species of this genus has been reported (Dixit, 1984). The most important characteristics of this genus that isolates from other genus include slightly reduced or un-reduced basal pinnae, pinnae either superficially lobed or crenate, veins anastomosing with a few species with

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simple, entire lamina. The genus *Sphaerostephanos* consists of more than 150 species globally specifically distributed in Asia, Eastern Africa, Australia, and the Pacific (Holttum, 1982) while in India, 4 species was reported by Dixit (1984).

In the present study while exploring the Pteridophytes of Niyamgiri hill and Kotgarh Wildlife Sanctuary, the authors came across three rare occurring ferns belonging to the family Thelypteridaceae and the present record is new distributional record for Odisha.

## MATERIALS AND METHODS

The present work is based on the fieldwork undertaken in Niyamgiri Hill and Kotgarh Wildlife Sanctuary during 2017 to 2023. Some interesting ferns were collected during the survey and the collection of Pteridophytes from the different localities of the forest. The specimens were critically observed, and identified with the help of different literature (Borthakur *et al.*, 2000; Manickam and Irudayaraj, 1991) and consulting the e-flora of Ferns of Thailand, Laos and Cambodia. The identification of these specimens was confirmed to be *Amblovenatum opulentum*, *Pronephrium articulatum* and *Sphaerostephanos hirtisorus* all belonging to the family Thelypteridaceae. Observation on *Pronephrium articulatum* population from two different localities in Niyamgiri hill shows its extended range of distribution in southern regions of Odisha. On the other hand, *Sphaerostephanos*

*hirtisorus* and *Amblovenatum opulentum* are found in isolated populations at only one site, showing their narrow range of distribution and new records for Odisha state (Fig. 1). The present study provides a detailed taxonomic account, distinguishing characteristics to supplement other taxonomic traits and distribution of these three species. Specimens were sampled with the ecological data. SEM Images were captured by Scanning Electron Microscope FEI, Quanta 250, photographs were taken with camera CANON EOS 80D. Voucher specimens were processed and deposited in the Herbarium of CSIR-National Botanical Research Institute, Lucknow (LWG).

## RESULTS

### Taxonomic Descriptions

- ***Amblovenatum opulentum* (Kaulf.) J.P. Roux**, *Strelitzia* 23: 201. 2009. (Smith, 1992; Labiak and Prado, 2007; Lindsay and Middleton, 2012; Lin *et al.*, 2013).  
*Aspidium opulentum* Kaulf., *Enum. Filic.* 238. 1824.  
*Amphineuron opulentum* (Kaulf.) Holttum, *Blumea* 19: 45. 1971; Baishya & Rao, *Ferns & Fern-allies Meghalay*, 79.1982; Jamir & Rao, *Ferns Nagaland*, 252.1988.  
*Nephrodium extensum* Moore, *Ind. Fil.* 91.1858; Bedd. *Handb. ferns Brit. Indi.*, 269.1883.  
*Nephrodium punctatum* C. Parish ex Bedd., *Ferns Brit. India* t. 131. 1866.

*Nephrodium parasiticum* var. *multijugum* C.B. Clarke, *Trans. Linn. Soc. Lond.*, 2 Bot., 1: 533. 1880.

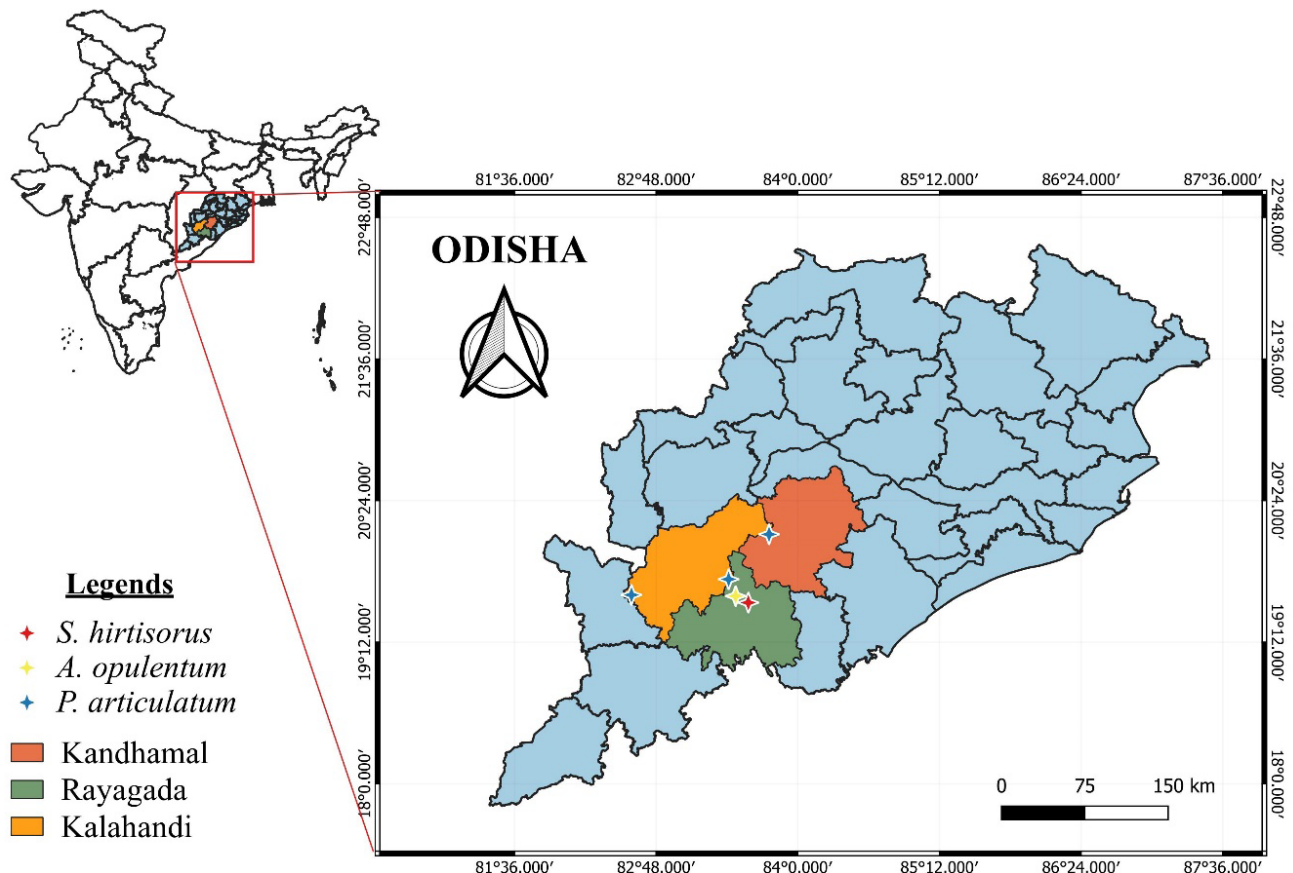
*Cyclosorus opulentus* (Kaulf.) Panigrahi, *Pl. Sci. Res. (Orissa)* 17(1-2): 52. 1995; 20(1 & 2): 25. 1998.

*Cyclosorus opulentus* (Kaulf.) Mazumdar and T. Mukhop., *Bionature (Bhopal)* 33(1): 27. 2013.

*Aspidium opulentum* Kaulfuss, *Enum. Filic.* 238. 1824.

*Thelypteris opulenta* (Kaulf.) Fosberg & Sachet, *Smithson. Contr. Bot.* 8: 3. 1972.

Rhizome short creeping, c. 1 cm thick, densely scaly, scales narrow, linear-lanceolate, tufted, slightly rufescent, brown. Stipes dark brownish, 30–65×0.65 cm, slender, grooved, hairs at grooves, base scaly. Lamina 80×30 cm, simple, pinnate, lanceolate, ovate-oblong, apex acuminate, glandular beneath, basal pinnae unreduced and much narrowed towards their bases, non-auricled, crenate, largest pinnae 30×3 cm, lanceolate, apex acuminate, glandular beneath; margin lobes  $\frac{3}{4}$  towards the costa, apex obtuse or rounded, margin wavy, spherical glands present on the ventral surfaces of pinnae and on sporangia, texture herbaceous to coriaceous; clothed with small yellowish glandular hairs, ventral surface of rachis, costae and costules covered by acicular hairs, dorsal surface necked with a few distant hairs. Veins 10–12 pairs in each lobe, the lower pair anastomosing with a free excurrent veinlet or sometimes meeting at the sinus without it, the other pairs of veins are free, region between veins in ventral surface often pustular when dry. Sori upto 8–10 pairs,



**Fig. 1:** Distribution of *Amblovenatum opulentum* (Kaulf.) J. P. Roux, *Pronephrium articulatum* (Houlston & T. Moore) Holttum and *Sphaerostephanos hirtisorus* (C. Chr.) Holttum in Odisha.

supra-median, confined to the margin of the pinnae lobes, upto 500 µm in diameter, globose, immersed and looks like punctated dots on the dorsal surface; indusia less hairy, margin with acicular hairs; sporangia stalked, hairy; spores dark brown, bilateral, 41×29 µm, perispore irregularly tuberculate (Fig. 2).

#### Fertile

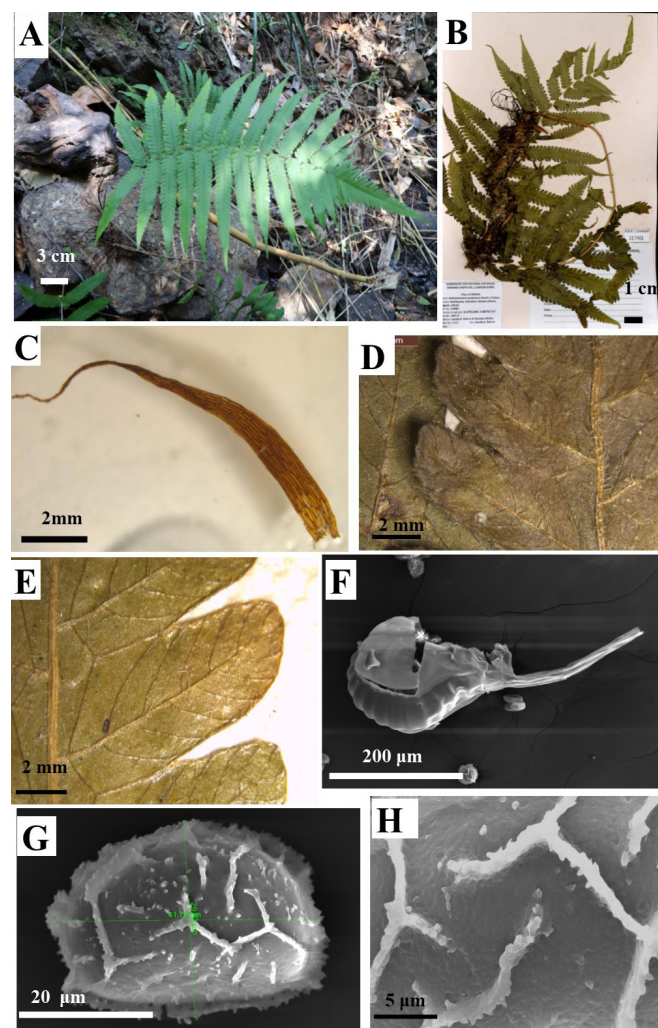
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#### Distribution

India (Andaman & Nicobar Islands, Karnataka, Meghalaya, Nagaland, Odisha and Tamil Nadu), China, Indonesia, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand; Australasia: Australia; Pacific Islands; Africa: Diego Garcia, Madagascar, Seychelles; North America (naturalized): Central America, United States of America; South America (naturalized).

#### Uses

Fronds are utilised as an alternative of tea and as a component in the fermentation of regional beverages (Jain, 1991).



**Fig. 2:** A-H: Illustration of *Amblovenatum opulentum* (Kaulf.) J.P.Roux. A. Terrestrial Habitat; B. Voucher specimen collected from Niyamgiri Hills; C. Rhizome scale; D. Dorsal view of Lamina; E. Ventral view of Lamina; F. SEM view of sporangia; G. SEM view of spore; H. SEM view of spore surface.

#### Specimens Examined

India, Odisha, Raigada, Niyamgiri Hill, Khambesi, Kothikucha, 19°31.066'N, 083°23.711'E, 1024m, 04.03.2021, S.K. Behera and N. Mishra, LWG 310981.

*Amblovenatum opulentum* is a rare species in India and prefers to grow near the water trenches of deep forests. Extensive surveys and research are needed to ascertain the status of this species in India, which can be used as an ornamental plant and can be cultivated for bioprospection before the species vanishes in India. The genus is characterized by basal pinnae abruptly reduced, anastomosing basal veins 1-2<sup>1/2</sup> pairs, sori and glands confined to the pinnae lobes.

- ***Pronephrium articulatum* (Houlston & T. Moore) Holttum**, Blumea 21 (1): 116. 1972; R.D. Dixit, Cens. Ind. Pterid. 111. (1984) *Nephrodium articulatum* Houlston & T. Moore, Gard. Mag. Bot. 3: 293. 1851.

*Nephrodium glandulosum* J.Sm. ex C.Presl var. *laetestrigosum* C.B. Clarke, Trans. Linn. Soc. Lond., 2 Bot., 1: 532, t. 74. 1880.

*Nephrodium abruptum* sensu Bedd, Ferns S. India 31. t 86.1863. not *Aspidium abruptum* Bl.

*Nephrodium glandulosum* var. *strigosum* C.B. Clarke, Trans. Linn. Soc. London, Bot. 1(8): 532, t. 74, f. 2. 1880.

*Cyclosorus laetestrigosus* (C.B. Clarke) Ching, Bull. Fan Mem. Inst. Biol., Bot., 8: 227. 1938.

*Nephrodium pennigerum* (Christ) Bedd., Handb. Ferns Brit. India 277. 1883.

*Thelypteris indica* (Alderw.) C.F. Reed, Phytologia 17: 284. 1968.

Rhizome erect, up to 5 cm thick, apex sparsely covered by scales; scales broadly ovate, 5×4 mm, pale brown, margin entire, apex acuminate. Stipes numerous, 36–64 cm long, up to 0.5 cm thick, minutely muricate at the base, glabrous above, grey-green when dry. Lamina 54×24 cm to 100×4 cm, lanceolate, simply pinnate; pinnae 23 pairs, up to 4 cm apart, sessile or subsessile, basal pinnae not reduced but slightly deflexed, pinnae of the basal part of the lamina are at right angles to the rachis; largest pinna 25×3.8 cm, apex acuminate, base of the upper ones truncate to broadly cuneate, margin lobed one-fourth towards the costa; lobes rounded or cuneate, marginally oblique; costa slightly raised above and below; veins distinct above and below, up to 13 pairs, basal 3 to 3<sup>1/2</sup> pairs anastomosing, next two to three and half pairs running to the side of the 3 mm long sinus membrane; veins in the terminal pinna often forked and anastomosing; upper surface of costa densely covered by 0.5 mm long, stiff hairs parallel to the costa; costules, veins and interveinal area sparsely covered by such hairs, lower interveinal area smooth, not pustular; fertile fronds contracted with narrowed pinnae; sori median on the veins, up to 10 pairs in two rows, up to 0.75 mm in diameter, indusial glabrous; spores monolet, 35×25 µm, dark brown, exine finely spinulose (Fig. 3).

#### Distribution

India (Arunachal Pradesh, Assam, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Odisha, Tamil Nadu, Tripura, West Bengal), Bangladesh, China, Indonesia, Malaysia, Myanmar, Nepal, Sri Lanka, Taiwan, Thailand, Tibet, Vietnam.

#### Specimens Examined

India: Odisha, Kalahandi, Niyamgiri, Meltola, 19°30.839' N, 083°22.170'E, 901m, 29.01.2019, S.K. Behera and N. Mishra, LWG 310684; Rayagada, Kinjamjodi, Pusipadar, 19°32.241'N,



082°27.507'E, 480 m, 02.02.2019, S.K. Behera and N. Mishra, LWG 310771; Kandhamal, Kotgarh, Belghar, 19°55.709' N, 083°34.683'E, 577m, 06.12.2022, S.K. Behera, S. Patra and N. Mishra, LWG 329828.

The genus characterised by slightly reduced or un-reduced basal pinnae, pinnae either superficially lobed or crenate, veins anastomosing with a few species with simple entire lamina.

- ***Sphaerostephanos hirtisorus* (C. Chr.) Holttum**, Blumea 19(1): 40. 1971.

*Dryopteris hirtisora* C.Ch.in Contr. U.S. Natl. Herb.26 (6): 277. 1931.

*Cyclosorus hirtisorous* (C.Chr.) Ching, Bull.Fan Mem. Inst.Biol., Bot. 8(4): 221- 223. 1938.

*Cyclosorus hirtisorus* (C.Chr.) Ching, Bull. Fan Mem. Inst. Biol., Bot., 8(4): 1938.

*Thelypteris hirtisora* (C.Chr.) K.Iwats., J. Jap. Bot. 38(10): 314. 1963

Rhizome creeping, 5-6 mm in diameter. Stipe length 45-70 cm, stramineous above the dark base. Lamina 60-70 cm long, texture firm; pinnae 15 pairs, terminal lamina mostly pinna-like, basal 3-5 pairs of pinnae gradually more widely spaced and

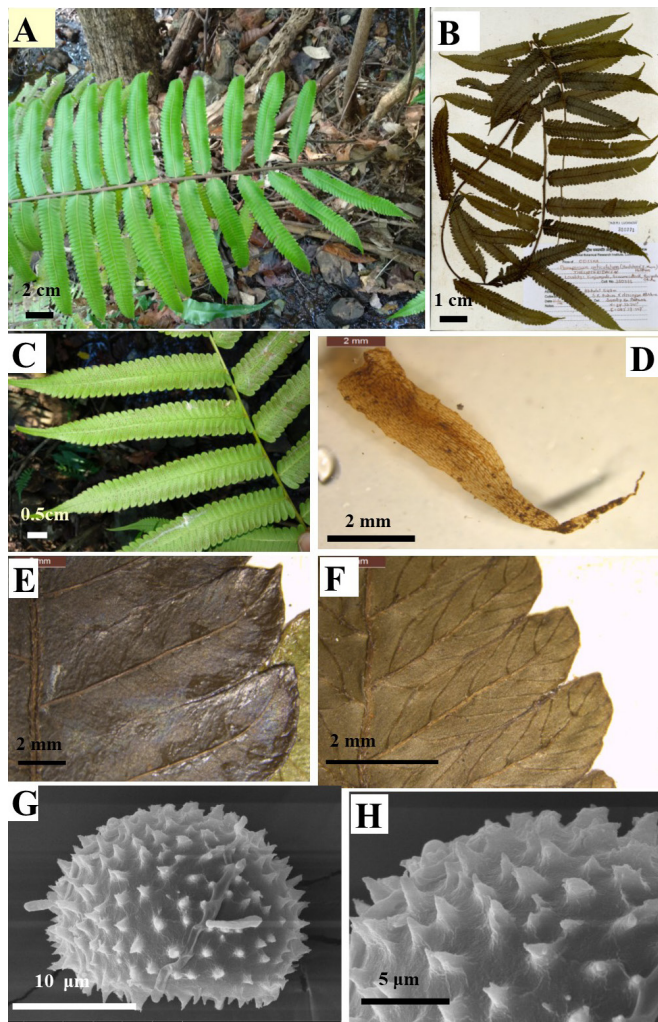
reduced, lowest not more than 2.5 cm long; lower large pinnae narrowed a little at their bases. Rachis bearing short, acicular hairs 0.5-1 mm long on both surfaces, those on the abaxial surface erect. Largest pinnae of 21×2.3 cm with stalk 2 mm long; base subequally broadly cuneate, apex short-acuminate, edges lobed 1/3 around costa, lobes falcate, ±triangular, apiculate; veinlets 8-10 pairs, basal 1 and ½ pairs anastomosing, next pair opens to sides of sinus; hairs on both ventral and dorsal surfaces confined to costae, costules and veins. Sori medial; indusia copiously long hairy; sporangia bearing 3-8 slender setae; spores 49×34 µm with wing and cross-wings (Fig. 4).

#### Distribution

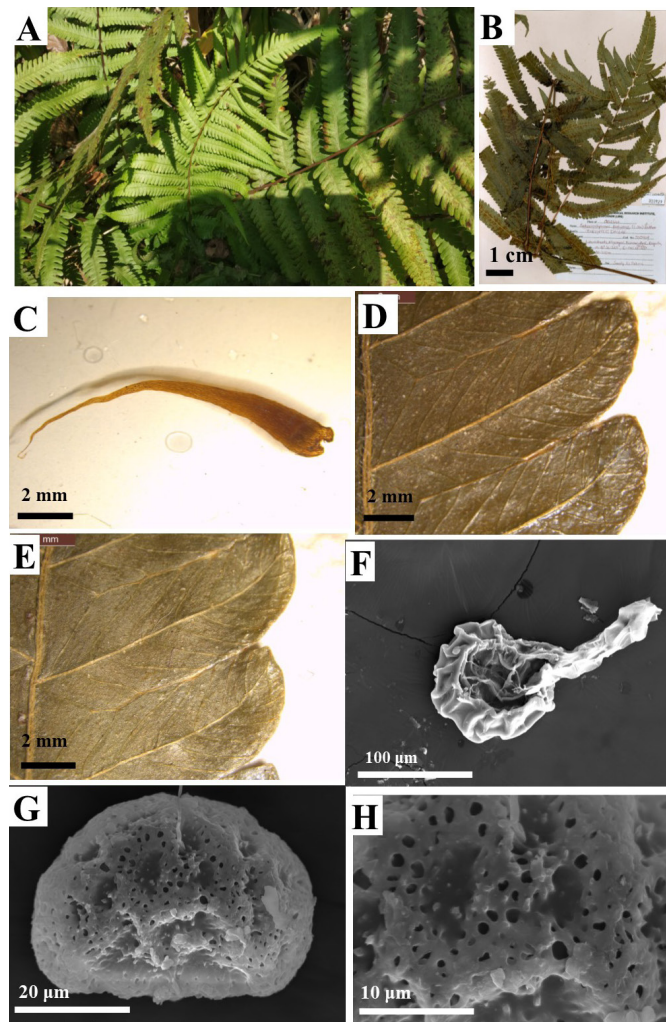
India (Assam, Meghalaya, Mizoram, Nagaland, Tripura) China, Laos, Myanmar, Nepal, Thailand, Yunnan.

#### Specimens Examined

India: Odisha, Rayagada, Bissamcuttack, Niyamgiri, Lahunikhunti, 19°31.267' N, 083°27.083'E, 567 m, 20.03.2020, S.K. Behera and N. Mishra, LWG 310929.



**Fig. 3:** A-H: Illustration of *Pronephrium articulatum* (Houlston & T.Moore) Holttum A. Terrestrial Habitat; B. Voucher specimen collected from Niyamgiri Hills; C. Lamina with pinnae; D. Rhizome scale; E. Dorsal view of Lamina, F. Ventral view of Lamina; G. SEM view of spore; H. SEM view of spore surface.



**Fig. 4:** A-H: Illustration of *Sphaerostephanos hirtisorus* (C.Chr.) Holttum A. Terrestrial Habitat; B. Voucher specimen collected from Niyamgiri Hills; C. Rhizome scale; D. Dorsal view of Lamina; E. Posterior view of Lamina; F. SEM view of sporangia; G. SEM view of spore; H. SEM view of spore surface.

The species *S. hirtisorus* has a long-creeping rhizome, clearly differing from most other species of *Sphaerostephanos*. This species differs from *S. invisus* (Forst. f.) Holttum in pinna-like apical lamina stalked lower pinnae, and medial (not supramedial) sori.

## DISCUSSION

In India, *Amblovenatum* is distributed with three species. *A. immersum* (Blume) Mazumdar, *A. opulentum* (Kaulf.) J. P. Roux and *A. terminans* (J.Sm. ex Hook.) Roux (Dixit, 1984). *A. opulentum* is a perennial fern, native to tropics of Asia and Africa (Lindsay & Middleton, 2012; Lin *et al.*, 2013). Baishya & Rao (1982) listed this plant from North East India and then by Jamir & Rao (1988). The systematics of the taxa *A. opulentum* is still in ambiguity. According to some authors, the species *A. opulentum* belongs to the genus *Cyclosorus* and they named it as *Cyclosorus opulentus* (Kaulf.) Nakaike. Further, some researcher considered *C. opulentus* is a synonym of *A. opulentum* (Smith, 1992; Labiak and Prado, 2007; Lindsay & Middleton, 2012; Lin *et al.*, 2013). Holttum (1971) proposed the genus *Amphineuron*, but it was later replaced with the genus *Amblovenatum* by J.P. Roux (Roux, 2009) as it was a homonym of *Amphineuron* in the Angiosperm family Apocyanaceae (Brummitt, 2007).

The genus *Pronephrium* C. Presl belongs to the family Thelypteridaceae consists of 70 species worldwide and is mostly distributed in tropical regions of India, China, Japan, Malaysia, Sri Lanka, Fiji and Australia (Dixit and Vohra, 1984). There are about 8 species of *Pronephrium* in India (Dixit, 1984). The genus characterised by slightly reduced or un-reduced basal pinnae, pinnae either superficially lobed or crenate, veins anastomosing with a few species with simple entire lamina.

The genus *Sphaerostephanos*, established by John Smith in Genera Filicum in 1839 was based on a single species characterized by elongate sori, the structure of which was wrongly observed. Later, Holttum (1971), while proposing a new system of genera in the family Thelypteridaceae, redefined *Sphaerostephanos*, as it was the oldest generic name for a considerable group of Malesian species, the majority of which had circular sori rather than elongate ones. It consists of more than 150 species globally specifically distributed in Asia, Eastern Africa, Australia, and the Pacific (Holttum, 1982). One of the important characteristics of this genus, except a few species, is the small sessile spherical yellow glands present on the adaxial or abaxial surface of pinnae (Holttum 1979, Sano 2008). Additionally, most species have erect or short-creeping rhizomes, and a few species, e.g., *S. invisus* (Forster, 1786; Holttum, 1976), *S. validus* (Christ, 1908; Holttum, 1979) and *S. unitus* (Holttum, 1974), have long-creeping rhizomes (Holttum 1979, 1982). The distinctive field character of the genus *Sphaerostephanos* which is common with *Pneumatopteris*, is the presence of much-reduced basal pinnae, usually with a sudden transition from normal to reduced form but the latter have no spherical sessile glands. Other distinctive characteristics of the genus *Sphaerostephanos* are; groove on the adaxial surface on costae and many yellow sessile glands on the abaxial surface of lamina.

## CONCLUSION

During our present study we came across three rare ferns belonging to the family Thelypteridaceae, viz., *Amblovenatum*

*opulentum* (Kaulf.) J. P. Roux, *Pronephrium articulatum* (Houlston & T. Moore) Holttum and *Sphaerostephanos hirtisorus* (C. Chr.) Holttum. These three plants are being reported as new distributional record to the fern flora of Odisha. The occurrence of *A. opulentum* and *S. hirtisorus* from single locality each and *Pronephrium articulatum* from three localities with very few individuals indicates that the populations are in threat.

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## AUTHOR CONTRIBUTION

Niranjan Mishra: Collection of plant, manuscript preparation, preparation of photo plates. Suman Patra: Collection of plant, manuscript preparation, Babita Kumari: preparation of photo plates, manuscript preparation, Neelu Lodhiyal: Finalisation of the manuscript, Sandip Kumar Behera: Identification of the plants, Manuscript preparation and validation and the submission of manuscript.

## CONFLICT OF INTEREST

None

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