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New distributional record of five pteridophytes from Angul District of Odisha: A report

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Abstract
During a recent field survey in the Angul district of Odisha state, five species of Pteridophytes were recorded for the first time, marking new additions to the botanical inventory of the Odisha state. These species are *Asplenium yoshinagae* Makino**,** *Dryopteris carthusiana* (Vill.) H.P.Fuchs, *Lygodium palmatum* (Bernh.)Sw., *Thelypteris kunthii* (Desv.) C.V.Morton, *Thelypteris palustris* Schott. The diagnostic features of each species are as follows: *Asplenium yoshinagae* is characterized by its small, brown, narrowly triangular and apically filiform scales on abaxial surface and pinna stalks. *Dryopteris carthusiana* is identified by its Veins that extend into each tooth are pinnate, simple, impressed adaxially, and elevated abaxially. *Lygodium palmatum* is characterized by its long, creeping, slender rhizome and the presence of glandular, colorless or brown-tinged hairs throughout the frond. *Thelypteris kunthii* is characterized by its veins which is adaxially with similar hairs but blade tissue usually without hairs. *Thelypteris palustris* is characterized by its glabrous rachises, costae, and veins. This communication includes the taxonomic descriptions, synonyms, ecological information, and photographs for each of these newly recorded species.

Keywords: Angul district, new record, pteridophytes, Odisha state

Introduction

Pteridophytes are a group of seedless, spore-producing plants that consist of two lineages: Lycophytes, which have fronds with no leaf gaps in the stem stele, and Monilophytes or Ferns, which have fronds with leaf gaps in the stem stele (Pryer *et al*. 2001, 2004 and Smith *et al*. 2006) [6, 7, 13]. They hold a unique position in the plant kingdom and are particularly fascinating due to their phylogenetic and morphological characteristics, as they bridge the gap between non-seed-bearing bryophytes and seed-bearing vascular plants. Pteridophytes constituted an important part of Earth's flora for millions of years (Pryer et al. 2001) [6] and are now widely distributed in tropical and temperate regions, especially at higher elevations.

It is estimated that there are around 15,000 species of Pteridophytes worldwide, with approximately 9,600 ferns and 1,400 Lycophytes described (Chapman 2006 and Smith *et al*. 2006, 2008) [1, 13, 14]. Among these species, the Indian subcontinent, recognized as one of the world's richest regions in terms of biological diversity and one of the 18 identified megadiversity countries, is home to about 1,100 species (Fraser-Jenkins 2012) [4]. The major centers of their distribution are the Himalayas and the Western Ghats, within the nine phytogeographical regions of India, as reported by Chatterjee (1939) [2].

Odisha State is an integral but geologically part of main Eastern Ghats. The range forms a discontinuous chain of mountains along the eastern edge of the Deccan Plateau, stretching from north of the Mahanadi River in Odisha to Vaigai River in Tamil Nadu at the southern end of the peninsula. The Eastern Ghats meet the Western Ghats at the Nilgiris. The average elevation is around 600 m (2,000 ft) and Arma Konda is the highest peak in the mountains at 1,680 m (5,510 ft). Because of topographical, altitudinal and geographical variation, the valley portrays great habitat diversity and harbors rich floristic diversity of immense scientific interest and economic potential.

Odisha itself is a rich biodiversity region with more than 194 species of pteridophytes. Earlier Saxena and Brahmam had reported a total of 141species belonging to 64 genera and 41 families of pteridophytes from Odisha (Flora of Orissa, 1994[10]-1996), later followed by addition of 33 new species by Prof. Panigrahi (Pteridophytic flora of Odisha, 1998). Rout *et al* (2009) [5, 9] added 18 species (2012) supplemented by two new records from Odisha namely *Pityrogramma calomelanos* (L.) Link (Das *et al.* 2017) [3] and a new species i.e. *Selaginella odishana from* Koraput (Singh *et al.* 2020) [12]. During last five decades studies of the Indian Pteridophytes have progressed, yet there are several virgin areas in India as well as in Odisha, which have remained unexplored till date. Hence, further exhaustive botanical exploration is required in the study area to enrich our knowledge of floristic diversity especially of these.

Unfortunately, no detailed study on the Pteridophytes has so far been carried out neither for India nor for the Odisha State. The floristic works done so far in Odisha mainly deal with the angiosperms. Thus, pteridophytes growing naturally countrywide, including Odisha, remain as a group to be studied in a greater details.

Materials and Methods

Angul district is one of the interior districts of Odisha and surrounded on the east by Cuttack and Dhenkanal district, on the west by Sambalpur district, on the north by Sundargarh and Keonjhar district and on the south by Phulbani district. It covers a geographical area of 6232 sq. kms, the district lies between 20°31′ N and 20°40′ N latitudes and between 84°15′ E and 85°23′ E longitudes. The altitude of this place varies between 564 to 1187 mts.

The Administrative headquarters of the district is situated at Angul city. In the current situation of the administrative set up, there are four sub divisions, eight tehsils and eight blocks in the district. In total there are 1930 villages, 225 Gram Panchayats, two Municipalities, a single Notified Area Council (NAC), and twenty-three Police stations working in the district of Angul.

The major part of the area forms the plains of river Brahmani and its tributaries like Nandira Jhor, Singhara Jhor and Tikra River. The drainage network is controlled by river Brahmani. The rivulet Nandira, which flows centrally from west to east and meets Brahmani near the village Kamalanga. It is highly polluted carrying almost all the industrial effluents and also a sizeable load of domestic effluent from industrial townships, located on other sides of the river. Bangaru Nallah originates from Satyabadi Sagar situated within the lease hold area of Kalinga Open Cast mine project and carries the waste water of different coal mines of Mahanadi coalfields joins Brahmani from north-west. Deojhar nallah flowing to Nandira rivulet carries the run-offs of mining area as well as waste water of South Balanda colliery.

The present work is an outcome of rigorous and exhaustive explorations in the study area during three consecutive years between 2017 [3] -2020. This is an attempt to comprehensively study the ferns and fern allies of Angul district of Odisha. The study was undertaken with a view to enhancing our present day knowledge of diversity and distribution of pteridophytic flora and their ethnic uses in Angul district of Odisha, India, which may function as a basic source of data in various disciplines of Botany and related sciences.

The work on systematics of fern flora of Angul district was initiated in January 2017. The major part of the study area is hilly and characterised by hill ranges. After extensive field survey and collections of pteridophytic plant specimens for more than 3 years, a comprehensive list of pteridophytes in the study area has been prepared. A total list of pteridophytic species in the study area has been prepared. A complete list of pteridophytic species in the Angul district has been prepared based on personal collections. A comprehensive list of total 90 species belonging to 50 genera and 16 families has been presented

The present study is the outcome of the two years of exhaustive field survey in the different parts of Angul district during 2020-2021. All the voucher specimens collected during the field survey were deposited in the Herbarium of Post Graduate Department of Botany, Utkal University, Vani Vihar, Bhubaneswar. Identification of the plant specimens were done concerning "The Flora of Orissa" (Saxena and Brahmam, 1994[10]-1996) and in consultation with standard literature.

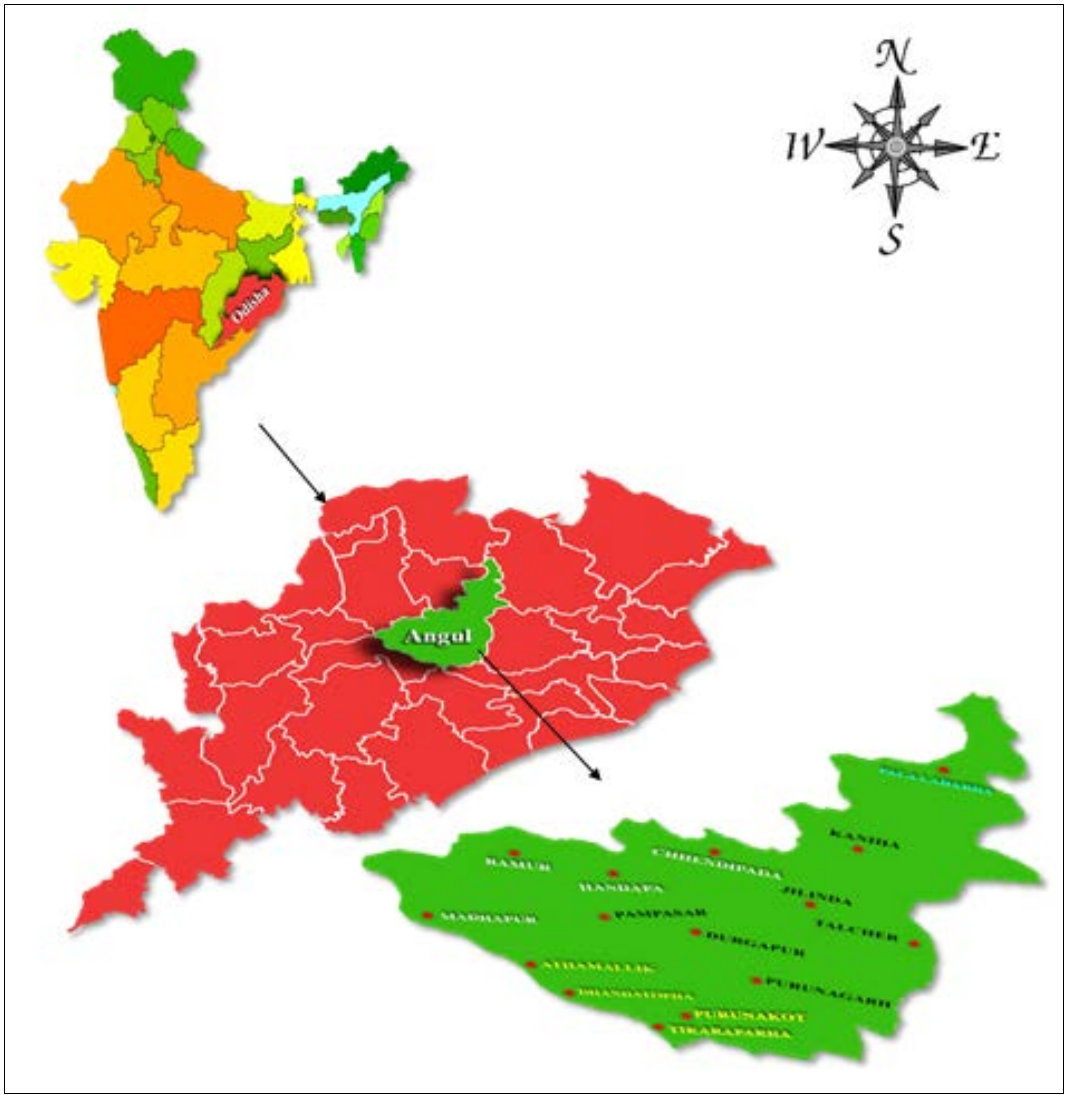

Fig 1: Locations of study sites of Angul district from Odisha State from India)

Results

A detailed account comprising taxonomic descriptions, synonyms, distributions and figures of these newly recorded species is provided hereunder:

Table 1: Names of the newly recorded species along with their families

Sl. No.	Species	Family
1.	*Asplenium yoshinagae* Makino	Aspleniaceae
2.	*Dryopteris carthusiana* (Vill.) H.P.Fuchs	Polypodiaceae
3.	*Lygodium palmatum* (Bernh.) Sw.	Schizaeaceae
4.	*Thelypteris kunthii* (Desv.) C.V.Morton	Aspleniaceae
5.	*Thelypteris palustris* Schott.	Aspleniaceae

Asplenium yoshinagae Makino, Phan. Pter. Jap. Icon. t. 64. 1900.

Synonym(s): *Asplenium indicum* Sledge, Bull. Brit. Mus. Nat. Hist. 3:264.1965; Datta, Basu& Ghosh, J. Econ. Tax. Bot. 6:576.1985.

Local Name: Deshee Pliheeka

Description: Habit: Herb. Habitat: Lithophyte or epiphyte. Rhizome: short, erect; apex clothed with dark-brown tapering scales. Stipes: grey-green, upto 12 cm long, scaly when young as is the rachis with linear-lanceolate, entire brown scales. Lamina linear-oblong, upto 30 x 3-6 cm; pinnae 12-20 pairs, simple, shortly petiolate; pinna 1-4 x 1 cm, acute, base broadly cuneate to narrowly cuneate and entire to half or more the length from the base, the rest of the pinna above and below irregularly and shallowly lobed with dentate margins. Fronds: subleathery, grass-green to stramineous when dry, adaxially with wrinkles above veins, with small, brown, narrowly triangular and apically filiform scales on abaxial surface and pinna stalks, subglabrous when old; rachis: (when dry) abaxially greyish castaneous to green-stramineous for most of its length, with small, narrowly triangular and apically Sori: Distal sori close to rachis, linear, 3-7 mm, from near costa running almost to margin. Grayish brown, complete, and linolear indusia with an opening at the costa or first microscopic vein. Spores: typical exospore length is 31–36 micrometres, with a lophate (costate) perispore**.**

Fertile: Sept.

Ecology: Found on wet rocks or tree trunks in forests.

Specimens examined: Khuladi waterfall, 24.12.2018, SN-094 (Herbarium, Utkal University, Vani Vihar, and Bhubaneswar).

Associated Species: *Tortulamuralis*, *Barbulacalycina*, *Funaria* sp. etc.

Note: New record for Odisha Flora

Dryopteris carthusiana (Villars) H. P. Fuchs, Bull. Soc. Bot. France. 105: 339. 1959.

Synonym: *Polypodium carthusianum* Villars, Hist. Pl. Dauphiné 1: 292. 1786.

Local Name: Peeta Kasthapakhi

Description: Habit: Herb. Habitat: Terrestrial. Rhizome: Short, sturdy, erect or obliquely ascending, scaly; scales pale brown, elliptical or oval-lanceolate, membranous, dentate. Fronds: oblong, dentate, stipe stramineous, caespitose, as long as lamina, longitudinally grooved. Lamina: bipinnate-pinnatifid, deltoid or ovate-oblong, 20–30 cm wide at the lowest half. Pinnae: 12 or 13 pairs, oblique, basal pair largest, shortly stalked, upper ones gradually shortened, connected by wing at base, lowest ones deltoid, 9-10 4-5 cm, base subtruncate, shortly stalked, apex acuminate; pinnules: 8 or 9 pairs, basal pair largest, upper ones gradually shortened, connected by broad wing, basal pair opposite or subopposite, deltoi Veins that extend into each tooth are pinnate, simple, impressed adaxially, and elevated abaxially. Sori: terminal along main vein of pinnules, in 2 rows, at apex of lateral veins. Indusia is a light brown, membranous plant that often becomes deciduous as it ages.

Fertile: Sept-Jan.

Ecology: Frequently found in shady places in valleys.

Specimens examined: Deulajhari, 14.12.2019, SN-127 (Herbarium, Utkal University, Vani Vihar, Bhubaneswar).

Associated Species: *Arachinoides aristata*, *Pteris biaurita*, *Dryopteris sparsa*, *Macrothelypteris torresiana* etc.

Note: New record for Odisha flora.

Lygodium palmatum (Bernhardi) Swartz, Syn. Fil. 154. 1806.

Synonym(s): *Gisopteris palmata* Bernhardi, J. Bot. (Schrader) 1800(2): 129, 1801.

LocalName: AnguMahajala

Description: Habit: Perennial climber. Habitat: Land plants growing in average supply of water. Stems: long-creeping. Leaves: not pointed or rounded; having small hairy, upper surface with transparent hairs. Fertile pinnae: periodically lobed, small in size than sterile pinnules, 2-4 × 2-6 cm, otherwise similar; ultimate segments narrowly triangular. Sporangia: There is usually no leaf lamina on the fertile portions at all – just sporangia covered by the leaf out growth, these are covered by an outgrowth of the leaf lamina that looks like an indusium. There are generally 6-10 sporangia to a pinnule segment.

Fertile: Nov-Dec.

Ecology: Among shrubs near streams; low elevations.

Specimens examined: Satkosia hill Range, 20.07.2017, SN-034 (Herbarium, Utkal University, Vani Vihar, and Bhubaneswar).

Associated Species: No

Note: New Record for Odisha flora.

Thelypteris kunthii (Desvaux) C. V. Morton, Contr. U.S. Natl. Herb. 38: 53. 1967.

Synonym(s): *Nephrodiumkunthii* Desvaux, Mém. Soc. Linn. Paris 6: 258. 1827; *Christellanormalis* (C. Christensen) Holttum; *Dryopteris normalis* C. Christensen; *Thelypterismacrorhizoma* R. P. St. John; *T. normalis* (C. Christensen) Moxley; *T. saxatilis* R. P. St. John; *T. unca* R. P. St. John.

Local Name: ShilaaJoshikaa

Description: Habit: Herb. Habitat: Terrestrial or lithophyte. Stems: “long-creepingto short, 4-8 mm diam. Leaves evergreen, monomorphic, up to 2(-3) cm apart, (15-)50-160 cm. Petiole: straw-coloured, at base with brown, (5-)20-80 × (1-)3-6 mm, hairy scales, linear-lanceolate. Blade (9-) 30-80 cm, gradually tapered to pinnatifid apex, broadest at base. Pinnae: (2-) 8-15(-20) × (0.6-)1-2.5 cm, incised 3/5-4/5 of width; segments oblong, rounded to acute at apex; proximal pair of veins from adjacent segments running to sinus, or nearly so. Veins: adaxially with similar hairs but blade tissue usually without hairs, indument abaxially of hairs mostly 0.3-1 mm on costae, veins, and blade tissue; often with scattered yellowish, stalked glands 0.1 mm. Sori: round, medial to supramedial; indusia tan, hairs 0.2-0.4 mm, hairy; sporangial glands obscure, stalked, yellowish, arising from sporangial stalks”.

Fertile: Nov-March
Ecology: Grows near damp, shady places, chiefly near streams.
Specimens examined: MalyaGiri, 06.02.2018, SN-081 (Herbarium, Utkal University, Vani Vihar, Bhubaneswar).
Associated Species: This species is specially found among other pteridophytes like *Sphenomeris chinensis*, *Pterisbiaurita*, *Dryopteris concholor*, *Macrothelypteris torresiana*etc.
Thelypteris palustris Schott. Gen. Fil. t. 10. 1834.
Local Name: Joshika
Description: "Plants 35-65 cm tall. Long creeping rhizomes with ovate-lanceolate scales, either glabrous or sparsely covered in reddish brown. Fronds roughly; stipes 20–40 cm, distally dark stramineous; bases black; typically white or glabrous; pubescent when young; 22–28× 6–9 cm or occasionally slightly wider; laminae lanceolate; bases practically tapering; apices shortly acuminate and pinnatifid; pinnate–pinnatifid; pinnae ca. 20 pairs, subopposite; middle pinnae lanceolate; flat or obliquely spreading; typically slightly reflexed; proximal pair slightly shortened; 4-5× 1-1.2 cm; bases truncate; pinnatifid nearly to costae; apices shortly acuminate; segments 5-7 ×3-5 mm; obtuse-pointed or rounded-obtuse at apices; fertile segments typically recurved to Segmented veins are pinnate, with the proximal pair emerging from the base of the costa and the lateral veins (usually 4-6 pairs), either simple or forked, reaching the margins. Papery, glabrous on both surfaces, rachises and costae grooved adaxially, elevated abaxially, and glabrous on both surfaces or with acicular long hairs abaxially are the characteristics of the laminae when they are dry. Between the costa and the margins, the sori is orbicular, dorsifixed at the middle of the veinlets, and the mature indusia are small, orbicular-reniform, deciduous, and membranous. Smooth spores on exospore surfaces, translucent perispores, and echinate" [PLATE-4.23 (C, D)].

Fertile: June-Aug
Ecology: Meadows, reed marshes, wet shaded places in forests.
Specimens examined: MalyaGiri, 06.02.2018, SN-079 (Herbarium, Utkal University, Vani Vihar, Bhubaneswar).
Associated Species: *Sphenomeris chinensis*, *Pterisbiaurita*, *Dryopteris concholor*, *Macrothelypteristorresiana*etc.
Note: New record for Odisha flora.There are two varieties found in Odisha. This species is IUCN Red list of Threatened species (https://www.iucnredlist.org/species/164136/42331187)

Fig 2: Showing different parts of the newly recorded species

Discussion

This study revealed that Angul district has great variety of pteridophytes due to its diverse geography and vegetation. This group of plants constitutes a conspicuous element in the flora of the district and flourishes well during rainy season and is at their best from August to November. The present study resulted in collection and identification of 90 species (8 Lycophytes and 82 ferns) belonging to 50 genera under 16 families. During the current extensive field surveys carried out in different regions of district Angul, a good number Pteridophytes species were collected, out of which five species have been reported for the first time from the study area that makes up new records for the Angul district as well as Odisha State. There are no earlier reports of their collection from the state. However, these species have been reported from other parts of the world and also from different regions of India. Five new records were added to the flora of Odisha namely *Asplenium yoshinagae* Makino, *Dryopteris carthusiana* (Vill.) H.P.Fuchs, *Lygodium palmatum* (Bernh.) Sw., *Thelypteris kunthii* (Desv.) C.V. Morton and *Thelypteris palustris* Schott. As noted, PPG (2016) system of classification was followed with some modifications for the present treatment. However, these species have been reported from other parts of the world and also from different regions of India. The distinguishing features of six new records are: *Asplenium yoshinagae* is characterized by its small, brown, narrowly triangular and apically filiform scales on abaxial surface and pinna stalks. *Dryopteris carthusiana* is identified by its Veins that extend into each tooth are pinnate, simple, impressed adaxially, and elevated abaxially. *Lygodium palmatum* is characterized by its long, creeping, slender rhizome and the presence of glandular, colorless or brown-tinged hairs throughout the frond. *Thelypteris kunthii* is characterized by its veins which is adaxially with similar hairs but blade tissue usually without hairs. *Thelypteris palustris* is characterized by its glabrous rachises, costae, and veins.

Conclusion

In addition to a good number of species, five number of species of pteridophytes namely; *Asplenium yoshinagae*, *Dryopteris carthusiana*, *Lygodium palmatum*, *Thelypteris kunthii*, *Thelypteris palustris* were collected for the first time from Angul district of Odisha state, which are discussed in the present communication. This study is expected to act as a stepping stone for further floristic studies and their need for studying the Pteridophyte diversity in other parts of State. In addition, field survey is a primary methodology to assess plant communities that furnish the basic information required for conservation of biodiversity.

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