

## A NEW SPECIES OF PLECTOCARPON (ROCELLACEAE, LICHENISED ASCOMYCETES) FROM INDIA

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(Received 20 May, 2016; Accepted 15 June, 2016)

A new gall-inducing and lirellate lichenicolous fungus, *Plectocarpon diedertzianum* Y. Joshi, Upadhyay et Chandra, is described from Kumaun Himalayan regions of India colonising thallus of various parmelioid lichens (*Flavoparmelia caperata*, *Myelochroa aurulenta*, *Parmotrema crinitum*, *P. melanothrix*, *P. reticulatum*, *Punctelia subrudecta*). The new species is characterised by black, epruinose rounded to lirellate ascomata with a carbonised surface and a ±thalline pseudomargin, as well as a carbonised, sterile stromatic tissue, 4-spored asci and 3-septate hyaline ascospores.

Key words: Arthoniales, lichens, lichenicolous fungi, parmelioid, taxonomy

### INTRODUCTION

The widespread ascomycete's lichenicolous genus *Plectocarpon* Fée (Roccellaceae, Arthoniales) is mainly characterised by multilocular stromata, usually inducing gall-like structures on the host thalli, *Opegrapha*-type asci, usually 3-septate, rarely 1 or (4-)5-6(-7)-septate ascospores, which sometimes become brown at maturity. The genus has been well worked out across the globe (Aptroot *et al.* 1997, Cáceres *et al.* 2001, Diederich and Etayo 1994, Ertz and Diederich 2007, Ertz and van den Boom 2012, Ertz *et al.* 2003, 2005, Etayo 2007, Hafellner *et al.* 2002, Hawksworth and Galloway 1984, Kukwa *et al.* 2012, Lawrey and Diederich 2015, Santesson 1993, 1994, Scholz 1998, Wedin and Hafellner 1998) and is so far represented by 38 species (including *P. syncesioides* Cáceres et Lücking, a lichenised fungus) across the world.

Since the monograph of Ertz *et al.* (2005) six new species have been described in the genus *Plectocarpon*: five lichenicolous species on hosts belonging to *Dirinaria* (Ertz and van den Boom 2012), *Hypogymnia* (Zhurbenko *et al.* 2008), cf. *Siphula* (Etayo and Sancho 2008), *Stereocaulon* (Kukwa *et al.* 2012)

and *Usnea* (Etayo 2007), and one lichenised species, *P. syncesioides* Cáceres et Lücking (Cáceres 2007).

Generally most of the species of this genus parasitises members of Lobariaceae and Nephromataceae (Peltigerales; Kukwa *et al.* 2012), but members of Cladoniaceae, Ramalinaceae, Parmeliaceae, Physciaceae and Sphaerophoraceae (Lecanorales; Diederich and Etayo 1994, Ertz *et al.* 2005, Etayo 2007, Etayo and Sancho 2008, Ertz and van den Boom 2012, Zhurbenko *et al.* 2008) are also parasitised by species of this genus.

Till now only six species of this genus have been reported on members of Parmeliaceae: *Plectocarpon encausticum* (Nyl.) R. Sant. (on *Brodoa intestini-formis*), *P. hypogymniae* (on *Hypogymnia bitteri*), *P. melanohaleae* Christnach, Ertz et Diederich (on *Melanohalea ushuaiensis*), *P. usneae* Diederich et Etayo (on *Usnea exasperata*), *P. usneaustralis* Etayo (on *Usnea* sp.) and an undescribed species on *Usnea* (Ertz *et al.* 2005, Zhurbenko *et al.* 2008). In the present manuscript, we are describing a new species of *Plectocarpon* from India, apparently parasitising various species of parmelioid lichens, thus raising the number of *Plectocarpon* species to 39 and number of infected Parmeliaceae members to 7.

## MATERIALS AND METHODS

The samples were collected from Binsar Wildlife Sanctuary, Dhaula Devi, Futsil and Tapogiri forests situated in Almora, Nainital and Pithoragarh districts of Kumaun Himalaya, Uttarakhand. The methods of study are same as those of Ertz *et al.* (2005). Morphological features of specimens were analysed by using a stereozoom dissecting microscope (Olympus SZ2-ILST), while anatomy was studied on hand-cut sections mounted in water, 10% KOH solution (K) and Lugol's solution without (I) or with (K/I) KOH pretreatment under Olympus CX21iLEDFS1 microscope. Spores were measured in water using Olympus CX21iLEDFS1 microscope. Measurements are given as follows: (minimum–) mean-standard deviation – mean – mean+standard deviation (–maximum) followed by the number of measurements (*n*). For other characters, the minimum and the maximum values are given.

## RESULTS AND DISCUSSION

*Plectocarpon diedertziaenum* Y. Joshi, Upadhyay et Chandra, *spec. nova*  
(Fig. 1A–G)

Mycobank no.: MB 817746

*Similar to Plectocarpon opegraphoideum, but differs in having 4-spored asci, narrower ascospores ((2.5–)3.0–3.5 μm) and different host.*

Type: India, Uttarakhand, Pithoragarh district, Gangolihat, Futsil Sacred forest, on *Myelochroa aurulenta* and *Parmotrema reticulatum* colonising *Quercus leucotrichophora*. Coll.: Upadhyay, S., Bisht, K. and Joshi, P. (LF-06/2015), 3 May 2015. Holotype: LWG; isotype: KU.

Ascomata "apothecia", gall-inducing, developing apically on upper surface of the thallus, dispersed to more often confluent, strongly convex, rounded to angular, prominent, blackish-brown, surface matt, cracked and epruinose, surface from the very beginning coarsely wrinkled, later with distinct labyrinth form or lirellate ornamentation (Fig. 1A–C), 42.5–62.5(–100)  $\mu\text{m}$  in diameter, thalline margin  $\pm$ restricted to the basal part. Stroma multilocular (Fig. 1D), globose, single to confluent, surrounded by orange-brown to black (in thick sections) sterile prosoplectenchymatous stromatic tissue, K+ olive-brownish, N+ reddish brown, without immersed crystals (pigment: Atra-brown, see Ertz *et al.* 2005, Meyer and Printzen 2000); (50–)66.81–75.50–84.18(–100)  $\times$  (62.5–)122.42–134–145.57(–212.5)  $\mu\text{m}$  ( $n = 50$ ), with carbonised surface (Fig. 1D–E). Hymenium not or slightly exposed, hyaline, I+ blue, K/I+ blue, entirely filling the loculi, 100–130  $\mu\text{m}$  high, usually divided in several loculi separated by sterile stromatic tissue (Fig. 1D); hymenial gel K/I+ blue. Epihymenium brownish, I+ blue, K/I+ blue. Paraphyses abundant, richly branched and anastomosing, septate, 1.5–3.0  $\mu\text{m}$  thick, apical cells slightly swollen. Asci *Opegrapha*-type, clavate, (2–)4-spored, (65–)70–90(–100)  $\times$  15–20  $\mu\text{m}$ , distinct apical K/I+ blue ring, wall K/I– (Fig. 1F). Ascospores overlapping in 2–3 rows in an ascus, hyaline, fusiform to narrowly skittle-shaped, smooth, (1–)3-septate, slightly constricted at the septa, all cells are more or less equal in length, (10–)10.88–14.72–18.55(–20)  $\times$  (1.5–)2.50–3.33–5.0(–5.15)  $\mu\text{m}$  ( $n = 50$ ), perispore distinct (especially in young ascospores), hyaline, up to 1  $\mu\text{m}$  thick (better seen in K), brown pigmentation not observed (Fig. 1F–G). Pycnidia not observed.

Distribution and habitat: The species is reported from temperate regions of Kumaun Himalaya, Uttarakhand, where it is growing in *Quercus*-dominated Binsar Wildlife Sanctuary, Dhaula Devi, Futsil and Tapogiri forests on thallus of *Flavoparmelia caperata*, *Myelochroa aurulenta*, *Parmotrema crinitum*, *P. melanothrix*, *P. reticulatum* and *Punctelia subrudecta*.

Remarks: The new species is mainly characterised by black coloured lirellate ascomata having carbonised stromatic tissue and narrow ascospores ((2.5–)3.22–3.42–4.07(–5.0)). *Plectocarpon opegraphoideum* Christnach, Ertz, Diederich et Wedin and *P. aff. pseudosticta* Fée, two closely related species differ from the new taxon in having I+ blue quickly turning red hymenium, (4–)6-spored asci, having broader ascospores ((4–)4.3–5.1(–5.5) and 5.1–5.9  $\mu\text{m}$ , respectively) and different hosts (*Pseudocyphellaria homoeophylla* and *P. multifida* for *Plectocarpus opegraphoideum*, while *Pseudocyphellaria intricata* and *P. thoursii* for *Plectocarpus aff. pseudosticta*).

In having rounded and warty ascomata, the new taxon resembles *Plectocarpon encausticum* (Nyl.) R. Sant., *P. latisporum* Ertz, Diederich et Wedin and *P. bunodophori* Wedin, Ertz et Diederich, but these species differ from the new taxon in having different hymenium I-test, number of spores in asci and ascospore size (see Ertz *et al.* 2005).

The six previously known lichenicolous species of this genus (*Plectocarpon encausticum*, *P. hypogymniae*, *P. melanohaleae*, *P. usneae*, *P. usneaustralis* and

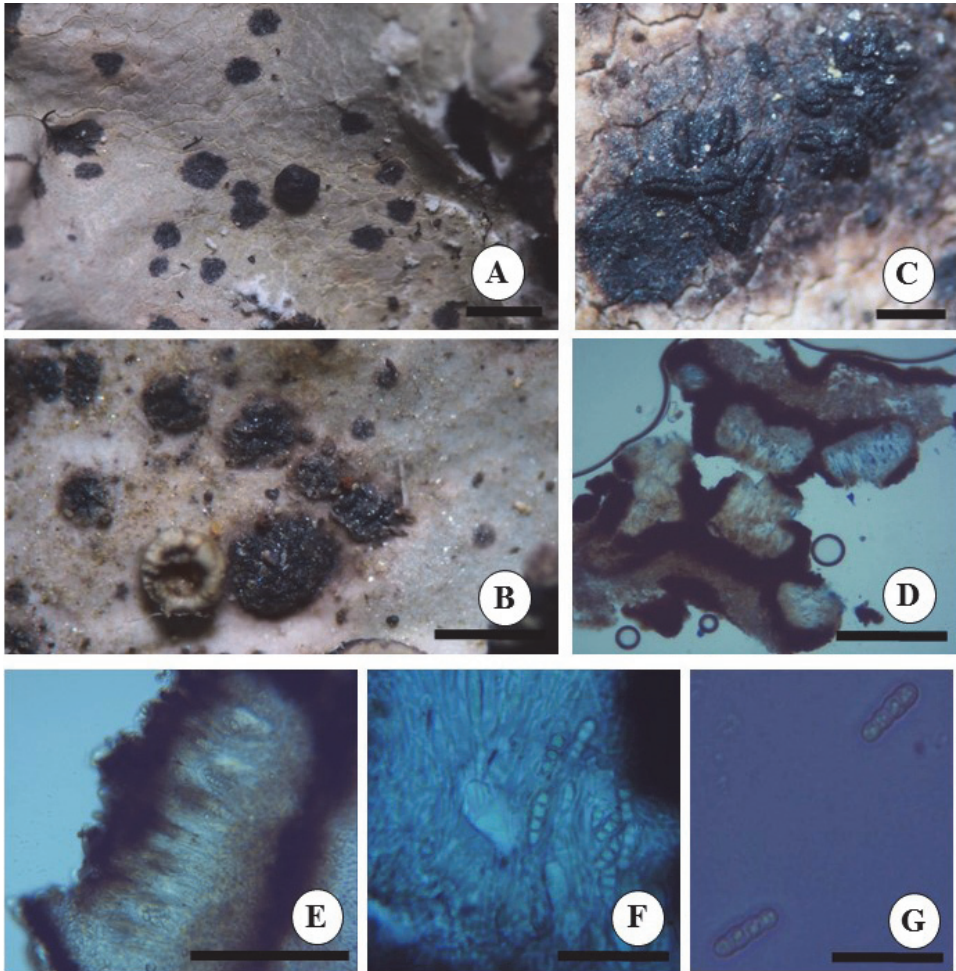


Fig. 1. *Plectocarpon diedertsonianum* holotype. A = Thallus with gall (scale bar = 1 mm), B = enlarged view of gall (scale bar = 1 mm), C = lirellate apothecia (scale bar = 1 mm), D = transverse section of stroma (scale bar = 50 µm), E = enlarged view, vertical section through apothecium (scale bar = 100 µm), F = spores in ascus (scale bar = 10 µm), G = spores (scale bar = 10 µm)

Table 1  
A comparative analysis of seven *Plectocarpion* species colonising parmelioid lichens

Characteristic features	<i>P. dider-tzianum</i>	<i>P. encausticum</i>	<i>P. hypogymniae</i>	<i>P. melanohaleae</i>	<i>P. usneae</i>	<i>P. usneustralis</i>	<i>P. sp.</i>
Gall-forming	yes	yes	no	yes	no	yes	yes
Thalline pseudomargin	±present	present (thick)	absent	no	absent	±present	present
Ascomatal surface	warted to lirellate	warted	warted to lirellate	smooth to rarely warted	smooth	warty	smooth
I reaction of hymenium	blue	red	red	blue	red	red	red
I reaction of epihymenium	blue	blue	blue	blue turning red	red	–	–
Atra-brown pigment	present	present	present	present	absent	present	present
Number of spores per ascus	4	6	(5–)8	(6–)8	4–8	6–8	8
Number of septa	3	3	3	3	(5–)6(–7)	3	3
Pigmentation in perispore	hyaline	±brown	hyaline	hyaline	hyaline	hyaline to brown (at maturity)	brown
Spore size (µm)	(12.5–)15.2–17.2(–20.0) × (2.5–)3.0–3.5	20.0–29.0 × 4.5–6.0	(12.0–)13.0–15.5(–17.0) × (3.0–)3.5–4.0 (–4.5)	15.0–21.5 × 4.5–6.0	26.0–30.0 × 4.0–5.0	18.0–26.0 × 6.0–8.0	20.0–27.5 × 5.0–6.0
Host genus	<i>Flavoparmelia</i> , <i>Myelochroa</i> , <i>Parmotrema</i> , <i>Punctelia</i>	<i>Brodoa</i>	<i>Hypogymnia</i>	<i>Melanohalea</i>	<i>Usnea</i>	<i>Usnea</i>	<i>Usnea</i>
Distribution	India	France, Norway, Russia, Sweden, Switzerland	Russia	Chile	Rwanda	Chile	Papua New Guinea

*Plectocarpon* sp.) colonising members of Parmeliaceae, differ from the new taxon in several characters (Table 1).

**Etymology:** The species is named in honour of Drs Paul Diederich and Damien Ertz for their monographic work on *Plectocarpon* and describing several new species belonging to this genus. Four initials of both Diederich and Ertz were combined to form *diedertzianum*.

Representative specimens examined: India, Uttarakhand, Almora District, Banari Devi Sacred forest, on *Myelochroa aurulenta* colonising *Quercus leucotrichophora*, Joshi, Y. and party (LF-01/2013), 8 December 2013 (KU); on way to Danya, Dhaula Devi forest, on *Parmotrema reticulatum* colonising rock, 16 May 2015, Shashi Upadhyay, Krishna Chandra and Kapil Bisht, LF-24/2015 (KU); *ibid.*, on *Parmotrema reticulatum* colonising rock, Shashi Upadhyay, Krishna Chandra and Kapil Bisht, LF-33/2015 (KU); *ibid.*, on *P. crinitum* colonising *Q. leucotrichophora*, Upadhyay, S., Chandra, K. and Bisht, K. (LF-32/2015) (KU); *ibid.*, on *P. reticulatum* colonising *Q. leucotrichophora*, Upadhyay, S., Chandra, K. and Bisht, K. (LF-30/2015) (KU); *ibid.*, on *M. aurulenta* colonising *Q. leucotrichophora*, Upadhyay, S., Chandra, K. and Bisht, K. (LF-31/2015) (KU); Binsar Wild life Sanctuary, on *P. melanothrix* colonising *Q. leucotrichophora*, Joshi, Y. (LF-36/2015), 9 August 2015 (KU); Nainital District, Ramgarh, Talla Ramgarh, Tapogiri forest, on *Punctelia rudecta* and *Flavoparmelia caperata* colonising *Q. leucotrichophora*, Bisht, A. and Joshi, P. (LF-38/2015), 30 September 2015 (KU); Pithoragarh District, Gangolihat, Chamunda Devi forest, on *F. caperata*, Bisht, K., Bisht, P. and Bankoti, D. (LF-06/2014), 4 April 2014 (KU); Badabe Village, Thal Ke Dhar forest, on *M. aurulenta* colonising *Q. leucotrichophora*, Upadhyay, S. (LF-01/2015), 16 January 2015 (KU); Gangolihat, Jadapani forest, on *M. aurulenta* and *Parmotrema reticulatum* colonising *Q. leucotrichophora*, Chandra, K. and party (LF-04/2015), 2 May 2015 (KU); *ibid.*, on *P. crinitum* colonising *Q. leucotrichophora*, Chandra, K. and party (LF-05/2015) (KU); Futsil Sacred forest, near Himalayan Gramya Vikas Samiti, on *M. aurulenta* colonising *Q. leucotrichophora*, Upadhyay, S., Bisht, K. and Joshi, P. (LF-21/2015), 3 May 2015 (KU); *ibid.*, on *Punctelia subrudecta* colonising *Q. leucotrichophora*, Upadhyay, S., Bisht, K. and Joshi, P. (LF-19/2015) (KU); *ibid.*, on *M. aurulenta*, Upadhyay, S., Bisht, K. and Joshi, P. (LF-11/2015) (KU); *ibid.*, on *P. subrudecta*, Upadhyay, S., Bisht, K. and Joshi, P. (LF-18/2015) (KU); *ibid.*, on *P. reticulatum* colonising *Q. leucotrichophora*, Chandra, K. and Kumar, N. (LF-08/2015, LF-20/2015) (KU); *ibid.*, on *P. crinitum* colonising *Q. leucotrichophora*, Chandra, K. and Kumar, N. (LF-12/2015, LF-13/2015, LF-14/2015, LF-15/2015) (KU); *ibid.*, on *P. tinctorum* colonising *Q. leucotrichophora*, Chandra, K. and Kumar, N. (LF-10/2015) (KU); *ibid.*, on *M. aurulenta* colonising *Q. leucotrichophora*, Chandra, K. and Kumar, N. (LF-09/2015) (KU); *ibid.*, on *M. aurulenta* colonising *Pyrus pashia*, Chandra, K. and Kumar, N. (LF-17/2015) (KU); Guptadi forest, on *M. aurulenta* and *Flavoparmelia caperata* colonising *Q. leucotrichophora*, Chandra, K. and party (LF-07/2015), 3 May 2015 (KU).

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**Acknowledgements** – One of the authors (YJ) would like to thank Scientific and Engineering Research Board (SB/FT/LS-313/2012) and University Grants Commission (41-488/2012(SR) & 20-1/2012(BSR)/20-2(16)/2012(BSR) for financial assistance, and to Dr Paul Diederich for his expert opinion and providing valuable literature. Thanks are extended to Director, Kerala Forest Research Institute and Head, Department of Botany, S. S. J. Campus, Almora for providing laboratory facilities.

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