

## Three new *Diorygma* (*Graphidaceae*) species from Brazil, with a revised world key

Shirley Cunha FEUERSTEIN, Iane Paula Rego CUNHA-DIAS, André APTROOT,  
Sionara ELIASARO and Marcela Eugenia da Silva CÁCERES

**Abstract:** Three new corticolous *Diorygma* species are described from Brazil. *Diorygma incantatum* has transversely 29–31-septate, filiform ascospores  $105\text{--}108 \times 6 \mu\text{m}$ , and produces an unidentified substance with Rf 44 in solvent C. *Diorygma pauciseptatum* produces norstictic and connorstictic acids and has transversely 7–9-septate, I+ blue-violet, large ascospores  $28\text{--}32 \times 7 \mu\text{m}$ , surrounded by a gelatinous sheath *c.*  $2 \mu\text{m}$  wide that is often somewhat expanded at one end. *Diorygma tocantinese* contains protocetraric acid and has muriform, broadly fusiform ascospores with rounded ends,  $24\text{--}40 \times 10\text{--}15 \mu\text{m}$ , surrounded by an gelatinous sheath up to *c.*  $5 \mu\text{m}$  wide that is somewhat expanded at central parts of the ascospore. A revised world key is given to all currently known species of *Diorygma*.

**Key words:** corticolous, lichens, *Ostropales*, Paraná, taxonomy, Tocantins

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### Introduction

*Diorygma* is a common and sometimes abundant genus of the *Graphidaceae*, occurring chiefly in the tropics, often on the sheltered or overhanging side of trees. The genus is far more speciose in tropical Asia and Australia than in tropical America.

So far *c.* 50 species are known in the genus, half of which were treated in a preliminary monograph (Kalb *et al.* 2004), the other half in subsequent papers (Cáceres 2007; Archer 2009; Makhija *et al.* 2009; Sharma & Makhija 2009a, b; Lumbsch *et al.* 2011; Sharma & Khadilkar 2012; Lima *et al.* 2013).

During studies on *Graphidaceae* diversity by the first author in the states of Tocantins

in the north and Paraná in the south of Brazil, three undescribed *Diorygma* species were encountered. They are described below, and a world key to all 52 currently known species of *Diorygma* is provided.

The study in Tocantins was carried out on the farm São Paulo, located 5 km from the town of Itaguatins on TO 126 between km 39 and 40, north-east of the Parrot's Beak region, at an altitude of 161 m above sea level. The farm covers 174 acres, divided into pasture and native cerrado area. The cerrado vegetation is composed of tortuous, small, isolated or clustered trees with thick leaves such as *Aspidosperma macrocarpon* Mart., *Gochnatia polymorpha* (Less.) Cabrera and *Handroanthus impetiginosus* (Mart. ex DC.) Mattos. The climate of the state is tropical, with average annual temperatures of  $26^\circ\text{C}$  during the rainy season (October to March), and  $32^\circ\text{C}$  in the dry season (April to September) (Nascimento 2008).

The study in Paraná was conducted on the Ilha do Mel, located at the entrance of the Bay of Paranaguá, with an approximate area of 2760 acres. The island is composed of two well-defined areas in terms of geology and geomorphology, connected by a narrow

S. C. Feuerstein and S. Eliasaro: Universidade Federal do Paraná, Centro Politécnico, Setor Biológicas, Depto. Botânica, CEP 81531-980 – Curitiba, Paraná, Brazil.

I. P. R. Cunha-Dias: Instituto de Ensino Superior so Sul do Maranhão, Rua São Pedro, s/n, Jd. Cristo Rei, CEP: 65907-070 – Imperatriz, Maranhão, Brazil.

A. Aptroot (corresponding author): ABL Herbarium, G.v.d.Veenstraat 107, NL-3762 XK Soest, The Netherlands. Email: andreaptroot@gmail.com

M. E. S. Cáceres: Departamento de Biociências, Universidade Federal de Sergipe, CEP: 49500-000 – Itabaiana, Sergipe, Brazil.

sandy strip. The smaller southern area is formed of hills of crystalline rock and the northern area is a sedimentary plain, which originated mainly from marine deposits, with a small hill up to 80 m high (Silva *et al.* 1994). The Paranaguá region is wet tropical, without a dry season. The vegetation of the island is pioneer Restinga with marine influence (on sandbanks), with mangrove and swamps, and the dense rainforest, as well as areas with secondary vegetation in various stages of regeneration. The Ilha do Mel has two protected areas: the State Park of Ilha do Mel, corresponding to *c.* 5% of the surface area of the island, and the Ecological Station of Ilha do Mel, covering *c.* 95% of the surface.

### Material and Methods

In Tocantins, the collections were made by opportunistic sampling in the study area, during six trips between September 2008 and August 2009. In Ilha do Mel, Paraná, four field trips were carried out (of two to four days each), also by means of opportunistic sampling, two in winter (June and August 2012) and two in summer (February and April 2013). All vegetation types occurring on the island were sampled. Descriptive work was partly carried out in Imperatriz, at the Instituto de Ensino Superior do Sul do Maranhão, and partly in Curitiba, at the Universidade Federal do Paraná. Morphological and anatomical characters were studied by dissecting and compound microscopes respectively. Sections were mounted in tap water, in which all measurements were also taken. The specimens from this study are preserved in UPGB. The chemistry of the type specimens was investigated by thin-layer chromatography (TLC) using solvent C (Orange *et al.* 2001).

### The New Species

#### *Diorygma incantatum* Feuerstein & Eliasaro sp. nov.

Mycobank No.: MB808554

*Diorygma* with transversely 29–31-septate, filiform ascospores  $105\text{--}108 \times 6 \mu\text{m}$ , and thallus with unidentified substance at Rf 44 in solvent C.

Type: Brazil, Paraná: Paranaguá, Ilha do Mel, Encantadas,  $25^{\circ}32'57.7''\text{S}$ ,  $48^{\circ}18'17.7''\text{W}$ , *c.* 8 m alt., on tree bark in Restinga forest, 24 August 2012, S. C. Feuerstein 1148 (UPCB—holotype).

(Fig. 1)

*Thallus* corticolous, continuous, without crystals, soredia and isidia absent; surface whitish grey, opaque, irregular, without cortex.

*Ascomata* circular to elongated, isolated, simple, with rounded ends, immersed to erumpent,  $0.6\text{--}1.6 \times 0.3\text{--}0.6 \text{ mm}$ , white; *disc* exposed, pinkish, white pruinose; margins entire, not corticate, divergent; *excipulum* hyaline. *Hymenium* not interspersed  $150\text{--}175 \mu\text{m}$ , I–; *epithecium* not differentiated; *hypothecium* hyaline; *paraphyses* simple, filiform,  $1.0\text{--}1.5 \mu\text{m}$  thick, periphysoids absent. *Ascospores* 8 per ascus, hyaline, transversely  $29\text{--}31$ -septate, filiform, I–,  $105\text{--}108 \times 6 \mu\text{m}$ , surrounded by a *c.*  $1 \mu\text{m}$  wide gelatinous sheath.

*Chemistry.* Thallus and ascomata K+ pale yellow. TLC: an unidentified compound forming a spot of purple colour, in UV fluorescent orange, at approximately Rf 44 in solvent system C.

*Ecology and distribution.* Known only from coastal Restinga forest in Brazil.

*Notes.* The species is named after the type locality Encantadas, meaning enchanted, which is an area located on the Ilha do Mel, Paraná. Only four other *Diorygma* species are known to have transversely septate ascospores, *viz.* *D. circumfusum* (Stirt.) Kalb, Staiger & Elix, *D. minisporum* Kalb *et al.*, *D. wallamanense* A.W. Archer & Elix, and *D. wilsonianum* (Müll. Arg.) A.W. Archer (Kalb *et al.* 2004; Archer 2009; Makhija *et al.* 2009; Sharma & Makhija 2009a, b; Sharma & Khadilkar 2012). *Diorygma circumfusum* is known only from Australia and can be distinguished by wider ascospores ( $8.5\text{--}16.0 \mu\text{m}$ ) with up to 22 septa, and by producing norstictic acid as the main secondary compound, while *D. minisporum* is distinguished by very small ascospores, not exceeding  $20 \mu\text{m}$  in length, and the presence of constictic, hypostictic, hypoconstictic and stictic acids (Kalb *et al.* 2004). *Diorygma wallamanense* and *D. wilsonianum* are differentiated mainly by smaller ascospores, which do not exceed  $55 \mu\text{m}$  in length and with a maximum of 15 septa, and in addition, the chemical compounds differ: the first has perstictic and stictic acids and

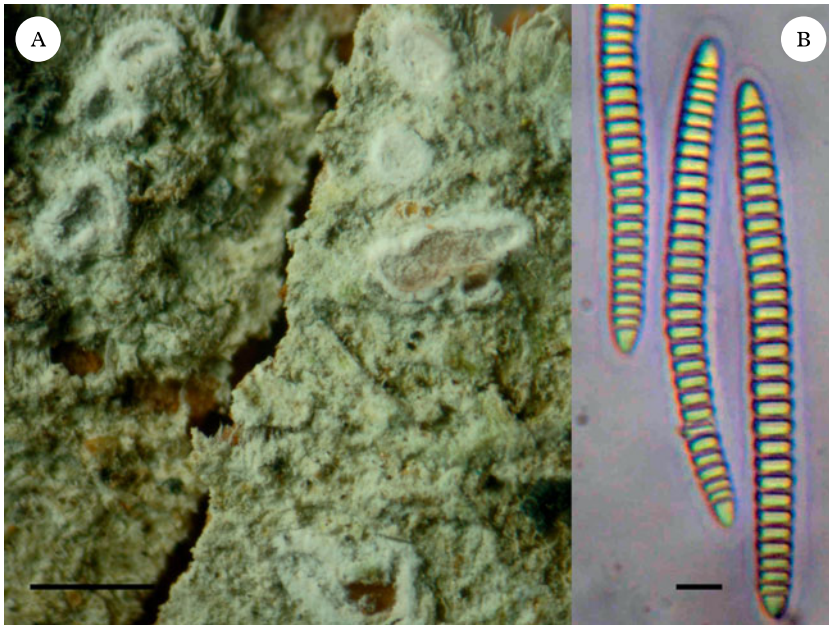


FIG. 1. *Diorygma incantatum*, holotype. A, habitus; B, ascospores. Scales: A = 1 mm; B = 10  $\mu$ m. In colour online.

the second contains norstictic acid (Archer 2009). The new species is somewhat reminiscent of *Chapsa indica* A. Massal., which differs by the presence of periphysoids and the absence of lichen substances (Cáceres 2007).

*Additional specimen seen.* **Brazil:** Paraná: Paranaguá, Ilha do Mel, Charmed, S. C. Feuerstein 1164, 1165 (UPCB).

***Diorygma pauciseptatum* Feuerstein,  
I. P. R. Cunha-Dias, Aptroot &  
M. Cáceres sp. nov.**

Mycobank No.: MB808555

*Diorygma* with norstictic and connorstictic acids and ascospores transversely 7–9-septate, I+ blue-violet, 28–32  $\times$  7  $\mu$ m, surrounded by a c. 2  $\mu$ m wide gelatinous sheath that is often somewhat expanded at one end.

Type: Brazil, Tocantins, Itaguatins, Fazenda São Paulo, 5°44'56.90"S, 47°32'25.00"W, c. 152 m alt., on bark of tree, 1 February 2009, S. C. Feuerstein 123 (UPCB—holotype).

(Fig. 2)

*Thallus* corticolous, continuous, with crystals, soredia and isidia absent; surface yellowish cream, opaque, irregular, without cortex.

*Ascomata* elongated, isolated, winding, simple to rarely branched, with pointed ends, immersed to erumpent, 0.3–1.1  $\times$  0.1 mm, of thallus colour; *disc* exposed, dark grey, thinly white pruinose; margins entire, not corticate, divergent; *excipulum* hyaline. *Hymenium* not interspersed 75–100  $\mu$ m, I–; *epithecium* consisting of brown and branched paraphysis apices; *hypothecium* hyaline; *paraphyses* branched at the tips, filiform, 1.5–2.0  $\mu$ m thick, periphysoids absent. *Ascospores* 8 per ascus, hyaline, transversely 7–9-septate, fusiform, I+ blue-violet, 28–32  $\times$  7  $\mu$ m, surrounded by a c. 2  $\mu$ m wide gelatinous sheath that is often somewhat expanded at one end.

*Chemistry.* Thallus: K+ yellow, releasing orange-red, needle-shaped crystals in microscopic section. TLC: norstictic and connorstictic acids.

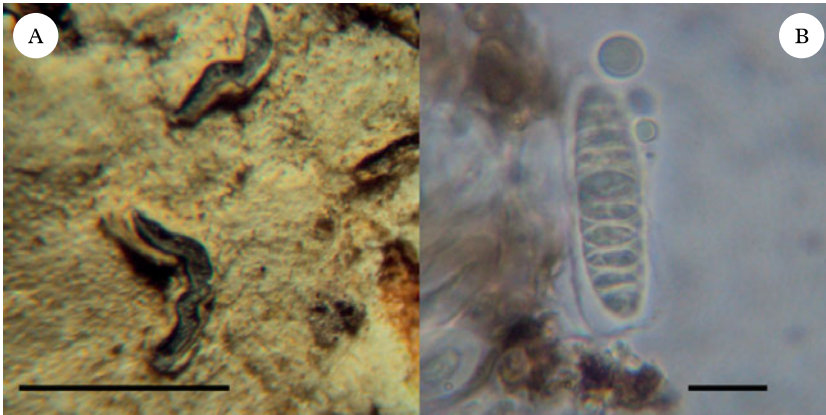


FIG. 2. *Diorygma pauciseptatum*, holotype. A, habitus; B, ascospore. Scales: A = 1 mm; B = 10  $\mu$ m. In colour online.

*Notes.* Within the genus *Diorygma*, only four species are known with transversely septate spores (see above). Among these species, *Diorygma wallamanense* and *D. circumfusum* also contain norstictic acid, but are differentiated by the longer ascospores, which always exceed 40  $\mu$ m in length. The new species has ascospores with the fewest septa in the genus. The dark grey apothecium discs are unusual in the genus, and are more common in *Graphidaceae* genera with carbonized apothecium margins. The new species is therefore at first glance more reminiscent of, for example, a *Platygramme* or even a *Graphis*.

***Diorygma tocantinense* Feuerstein,  
I. P. R. Cunha-Dias & Aptroot sp. nov.**

Mycobank No.: MB808556

*Diorygma* with protocetraric acid and ascospores that are muriform, broadly fusiform with rounded ends, 24–40  $\times$  10–15  $\mu$ m, surrounded by a gelatinous sheath up to c. 5  $\mu$ m wide that is somewhat expanded at central parts of the ascospore.

Type: Brazil, Tocantins: Itaguatins, Fazenda São Paulo, 5°44'56.90"S, 47°32'25.00"W, c. 152 m alt., on bark of tree, 9 August 2009, S. C. Feuerstein 447 (UPCB—holotype).

(Fig. 3)

*Thallus* corticolous, continuous, with crystals, soredia and isidia absent; surface whitish cream, opaque, irregular, without cortex.

*Ascomata* elongated, isolated, winding, simple to rarely branched, with pointed ends, immersed to erumpent, 0.5–6.0  $\times$  1.0 mm, of thallus colour; *disc* narrowly exposed, dark grey, cream pruinose; margins entire, not corticate, divergent, with dark grey line; *excipulum* hyaline. *Hymenium* not interspersed 85–100  $\mu$ m, I–; *epithecium* brown, 15–40  $\mu$ m; *hypothecium* hyaline; *paraphyses* branched at the tips, filiform, c. 1.0  $\mu$ m thick, periphysoids absent. *Ascospores* 8 per ascus, hyaline, muriform, broadly fusiform with rounded ends, I+ faintly blue, 24–40  $\times$  10–15  $\mu$ m, surrounded by up to c. 5  $\mu$ m wide gelatinous sheath that is somewhat expanded at central parts of the ascospore.

*Chemistry.* Thallus K+ deep yellow, P+ orange. TLC: protocetraric acid.

*Notes.* This new species of *Diorygma* is characterized by small muriform ascospores only 24–40  $\mu$ m long. The vast majority of *Diorygma* species have much larger ascospores. The species that most resemble it are *D. erythrellum* (Mont. & Bosch) Kalb *et al.* and *D. nothofagi* (A.W. Archer) A.W. Archer. *Diorygma erythrellum* differs by the corticate thallus and the norstictic acid chemistry, and *D. nothofagi* differs by having even shorter ascospores (18–23  $\mu$ m) and also by the norstictic acid chemistry.

*Additional specimen seen.* **Brazil:** Tocantins: Itaguatins, Fazenda São Paulo, S. C. Feuerstein 412 (UPCB).



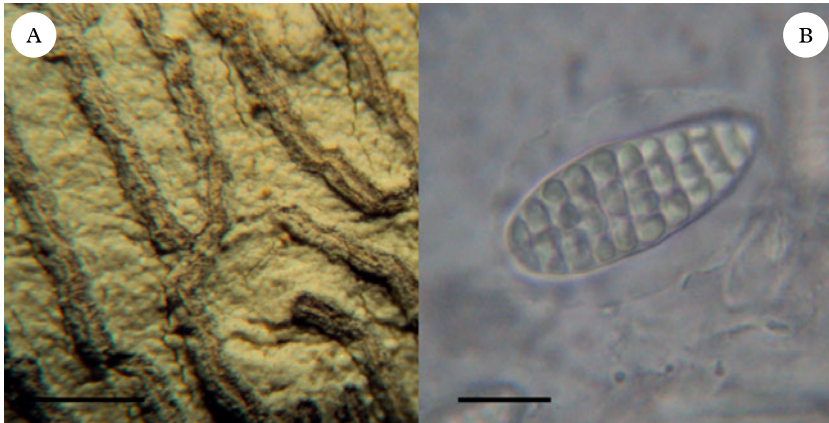


FIG. 3. *Diorygma tocantinense*, holotype. A, habitus; B, ascospore. Scales: A = 1 mm; B = 10 µm. In colour online.

### World key to the species of *Diorygma*

- 1 Thallus with isidia; ascomata as yet unknown . . . . . 2  
 Thallus without isidia; ascomata present . . . . . 3
- 2(1) Protocetraric acid present as major substance, norstictic and salazinic acids minor or absent; no black hypothallus present . . . . . **D. australasicum** (Elix) Lücking *et al.*  
 Norstictic and salazinic acids present as major substances, protocetraric acid minor or absent; with a black, brittle hypothallus . . . . . **D. antillarum** (Vain.) Nelsen *et al.*
- 3(1) Ascospores only transversely septate . . . . . 4  
 Ascospores muriform or submuriform . . . . . 9
- 4(3) Ascospores more than 60 µm long . . . . . 5  
 Ascospores less than 55 µm long . . . . . 6
- 5(4) Ascospores 60–100 × 8.5–16.0 µm, 12–22-septate; norstictic acid present; thallus K+ yellow > red (crystals formed in microscopic section) . . . . .  
 . . . . . **D. circumfusum** (Stirt.) Kalb, *et al.*  
 Ascospores 105–108 × 6 µm, 29–31-septate; norstictic acid absent; unknown substance present; thallus K+ pale yellow . . . . .  
 . . . . . **D. incantatum** Feuerstein & Eliasaro
- 6(4) Ascospores up to 35 µm long . . . . . 7  
 Ascospores 40–55 µm long . . . . . 8
- 7(6) Hypostictic, hypoconstictic, stictic and constictic acids present; ascospores 17–20 × 5.0–6.5 µm . . . . . **D. minisporum** Kalb *et al.*  
 Norstictic acid present; ascospores 28–32 × 7 µm . . . . .  
 . . . . . **D. pauciseptatum** Feuerstein *et al.*
- 8(6) Perstictic and stictic acids present; ascospores 40–50 × 8–10 µm . . . . .  
 . . . . . **D. wallamanense** A. W. Archer & Elix  
 Norstictic acid present; ascospores 45–50(–54) × (6–)8–9 µm . . . . .  
 . . . . . **D. wilsonianum** (Müll. Arg.) A. W. Archer
- 9(3) Protocetraric acid present (thallus P+ orange-red; no crystals formed with K) . . . 10  
 Protocetraric acid absent (thallus not P+ red, if P+ yellow-orange, then K+ yellow > red, with crystals formed which are visible in microscopic section). . . 16

- 10(9) Asci 2–8-spored . . . . . 11  
 Asci 1(–2)-spored . . . . . 13
- 11(10) Stictic acid present (in addition to protostictic and cryptostictic acids); thallus K+ yellow in section; ascospores  $87\text{--}125 \times 20\text{--}37 \mu\text{m}$  . . . . .  
 . . . . . **D. agumbense** B.O. Sharma & Khadilkar  
 Stictic acid absent (only protocetraric acid present); thallus not clearly K+ yellow in section . . . . . 12
- 12(11) Ascospores  $24\text{--}40 \times 10\text{--}15 \mu\text{m}$  . . . . . **D. tocaninense** Feuerstein *et al.*  
 Ascospores  $125\text{--}250 \times 30\text{--}40\text{--}50 \mu\text{m}$  . . . . . **D. hololeucum** (Mont.) Kalb *et al.*
- 13(10) Norstictic acid present in addition to protocetraric acid; thallus K+ yellow → red, with crystals formed which are visible in microscopic section . . . . . 14  
 Norstictic acid absent; only protocetraric acid present; thallus K– . . . . . 15
- 14(13) Exciple partly carbonized; ascospores  $110\text{--}230 \times 35\text{--}80 \mu\text{m}$  . . . . .  
 . . . . . **D. reniforme** (Fée) Kalb *et al.*  
 Exciple not carbonized; ascospores  $120\text{--}215 \times 30\text{--}45\text{--}63 \mu\text{m}$  . . . . .  
 . . . . . **D. rufopruinosum** (A. W. Archer) Kalb, *et al.*
- 15(13) Ascospores up to  $150 \mu\text{m}$  long (or very rarely to  $170 \mu\text{m}$  long),  $95\text{--}150\text{--}170 \times 19\text{--}50 \mu\text{m}$ ; peripheral and central ascospore locules of more or less equal size . . . . .  
 . . . . . **D. pruinoseum** (Eschw.) Kalb *et al.*  
 Ascospores mostly over  $150 \mu\text{m}$  long,  $140\text{--}200 \times 40\text{--}65 \mu\text{m}$ ; peripheral ascospore locules distinctly smaller than central ones . . . . . **D. africanum** Kalb *et al.*
- 16(9) Lichexanthone present (thallus UV+ yellow) . . . . . 17  
 Lichexanthone absent (thallus not UV+ yellow) . . . . . 19
- 17(16) Asci 6–8-spored; ascospores  $40\text{--}60 \times 10\text{--}14 \mu\text{m}$ ; apothecia short, often aggregate; without black hypothallus . . . . . **D. alagoense** M. Cáceres & Lücking  
 Asci 1(–2)-spored; apothecia longer, distinctly lirelliform and never aggregate; thallus with brittle black hypothallus . . . . . 18
- 18(17) Ascospores up to  $135 \mu\text{m}$  long (or very rarely to  $145 \mu\text{m}$  long),  $80\text{--}135\text{--}145 \times 25\text{--}45\text{--}50 \mu\text{m}$ ; peripheral and central ascospore locules of more or less equal size . . . . .  
 . . . . . **D. confluens** (Fée) Kalb *et al.*  
 Ascospores mostly  $>135 \mu\text{m}$  long,  $(120\text{--})135\text{--}203 \times 35\text{--}70 \mu\text{m}$ ; peripheral ascospore locules distinctly smaller than central ones . . . . .  
 . . . . . **D. epiglaucum** (Müll. Arg.) Kalb *et al.*
- 19(16) Norstictic acid present as major substance . . . . . 20  
 Norstictic acid absent or only present as trace accompanying other major substances . . . . . 42
- 20(19) Asci (4–)6–8-spored . . . . . 21  
 Asci 1–2(–4)-spored . . . . . 24
- 21(20) Ascospores up to  $65 \mu\text{m}$  long . . . . . 22  
 Ascospores over  $75 \mu\text{m}$  long . . . . . 23
- 22(21) Ascospores  $18\text{--}23\text{--}25 \times 6\text{--}8 \mu\text{m}$ ; thallus without cortex . . . . .  
 . . . . . **D. nothofagi** (A. W. Archer) A. W. Archer  
 Ascospores  $30\text{--}65 \times 12\text{--}20 \mu\text{m}$ ; thallus with smooth cortex . . . . .  
 . . . . . **D. erythrellum** (Mont. & Bosch) Kalb *et al.*

- 23(21) Ascospores up to 20  $\mu\text{m}$  wide, long ellipsoid, 100–115  $\times$  15–18(–20)  $\mu\text{m}$ . . . . .  
 . . . . . **D. longisporum** E. L. Lima *et al.*  
 Ascospores over 24  $\mu\text{m}$  wide, broad ellipsoid, 75–145  $\times$  24–34  $\mu\text{m}$ . . . . .  
 . . . . . **D. subalbatum** (Patw. & Makhija) B. O. Sharma & Makhija
- 24(20) Salazinic acid present. . . . . 25  
 Salazinic acid absent or only present as trace accompanying other major substances  
 . . . . . 34
- 25(24) Asci always only 1-spored. . . . . 26  
 Asci variably 1–2(–4)-spored . . . . . 30
- 26(25) Ascospores 79–96  $\times$  29.5–33.5  $\mu\text{m}$ . . . . . **D. inaequale** B. O. Sharma & Makhija  
 Ascospores over 96  $\mu\text{m}$  long . . . . . 27
- 27(26) Ascospores > 50  $\mu\text{m}$  wide, 150–200(–230)  $\times$  50–75  $\mu\text{m}$  . . . . .  
 . . . . . **D. salvadoriense** Kalb *et al.*  
 Ascospores up to 40  $\mu\text{m}$  wide . . . . . 28
- 28(27) Exciple distinctly convergent, disc mostly concealed; ascospores 125–175  $\times$  27–35  $\mu\text{m}$   
 . . . . . **D. dandeliense** B. O. Sharma & Khadilkar  
 Exciple divergent, disc wide open . . . . . 29
- 29(28) Thallus verrucose; ascospores 97–126  $\times$  25–33  $\mu\text{m}$ . . . . .  
 . . . . . **D. verrucirimosum** B. O. Sharma & Makhija  
 Thallus smooth; ascospores 105–147  $\times$  33–37  $\mu\text{m}$ . . . . .  
 . . . . . **D. dealbatum** B. O. Sharma & Makhija
- 30(25) Ascospores up to 100  $\mu\text{m}$  long . . . . . 31  
 Ascospores > 130  $\mu\text{m}$  long . . . . . 32
- 31(30) Methylstictic acid present in addition to salazinic and norstictic acids; ascospores  
 75–99  $\times$  24–30  $\mu\text{m}$  . . . . . **D. panchganiense** Makhija *et al.*  
 Methylstictic acid absent, only salazinic and norstictic acids present; ascospores  
 76–92  $\times$  21–25  $\mu\text{m}$  . . . . . **D. manipurensis** B. O. Sharma & Makhija
- 32(30) Methylstictic and cryptostictic acids (and sometimes also constictic acid) present in  
 addition to salazinic and norstictic acids . . . . . 33  
 Methylstictic acid absent, only salazinic and norstictic acids present; ascospores 130–  
 200  $\times$  32–42  $\mu\text{m}$  . . . . . **D. karnatakense** B. O. Sharma & Khadilkar
- 33(32) Ascospores 135–150  $\times$  18–27  $\mu\text{m}$ . . . . . **D. albocinerascens** Makhija *et al.*  
 Ascospores 147–273  $\times$  34–67  $\mu\text{m}$ . . . . . **D. excipuloconvergentum** Makhija *et al.*
- 34(24) Asci 2–8-spored . . . . . 35  
 Asci 1-spored . . . . . 36
- 35(34) Asci 8-spored; ascospores submuriform, 12–15  $\times$  6–7  $\mu\text{m}$ . . . . .  
 . . . . . **D. microsporum** M. Cáceres & Lücking  
 Asci 2–4-spored; ascospores muriform, 151–294  $\times$  38–63(–84)  $\mu\text{m}$  . . . . .  
 . . . . . **D. megistosporum** Makhija *et al.*
- 36(34) Stictic acid present in addition to norstictic acid; ascospores 95–150(–170)  $\times$  30–45  $\mu\text{m}$   
 . . . . . **D. hieroglyphicum** (Pers.) Staiger & Kalb  
 Stictic acid absent, only norstictic and often connorstictic acids present . . . . . 37
- 37(36) Lirellae long and curved; exciple distinctly convergent; ascospores 105–113  $\times$  33–42  $\mu\text{m}$   
 . . . . . **D. longilirellatum** B. O. Sharma & Makhija  
 Lirellae shortened; exciple divergent . . . . . 38

- 38(37) Thallus with carbonaceous basal layer; ascospores  $90\text{--}115 \times 30\text{--}40 \mu\text{m}$  . . . . .  
 . . . . . **D. tinctorium** Eschw.  
 Thallus without carbonaceous layer . . . . . 39
- 39(38) Ascospores up to  $145 \mu\text{m}$  long . . . . . 40  
 Ascospores  $170\text{--}250 \times 42\text{--}58 \mu\text{m}$  . . . . . **D. pachygraphum** (Nyl.) Kalb *et al.*
- 40(39) Peripheral and central ascospore locules of more or less equal size . . . . . 41  
 Peripheral ascospore locules distinctly smaller than central ones; ascospores  $100\text{--}130 \times 44\text{--}48 \mu\text{m}$ . . . . . **D. tuberculosum** (Stirt.) Kalb *et al.*
- 41(40) Hymenium completely I+ blue-violet; ascospores  $(60\text{--})80\text{--}125 \times 21\text{--}42 \mu\text{m}$  . . . . .  
 . . . . . **D. junghuhnii** (Mont. & Bosch) Kalb *et al.*  
 Hymenium weakly I+ blue-violet (mostly laterally); ascospores  $110\text{--}145 \times 36\text{--}45 \mu\text{m}$   
 . . . . . **D. soozanum** (Zahlbr.) Nakan. & Kashiw.
- 42(19) Asci (2–)4–8-spored . . . . . 43  
 Asci 1(–2)-spored . . . . . 48
- 43(42) Hypostictic and hypoconstictic acids present, stictic acid absent or minor . . . . . 44  
 Hypostictic and hypoconstictic acids absent, stictic acid present (sometimes with other  
 major substances) . . . . . 46
- 44(43) Hymenium completely I+ blue-violet . . . . . 45  
 Hymenium I– or weakly I+ blue-violet; ascospores  $45\text{--}100 \times 14\text{--}30\text{--}(40) \mu\text{m}$  . . . . .  
 . . . . . **D. sipmanii** Kalb *et al.*
- 45(44) Ascospores  $40\text{--}65 \times 10\text{--}18 \mu\text{m}$  . . . . . **D. poitaei** (Fée) Kalb *et al.*  
 Ascospores  $(60\text{--})70\text{--}115 \times 16\text{--}22 \mu\text{m}$  . . . . . **D. intermedium** Kalb *et al.*
- 46(43) Ascospores submuriform,  $10\text{--}13 \times 6\text{--}8 \mu\text{m}$  . . . . . **D. sticticum** Sutjaritturakan *et al.*  
 Ascospores muriform, over  $65 \mu\text{m}$  long . . . . . 47
- 47(46) Ascospores  $66\text{--}99 \times 12\text{--}36 \mu\text{m}$ ; thallus corticolous . . . . .  
 . . . . . **D. albovirescens** Makhija *et al.*  
 Ascospores  $143\text{--}172 \times 29\text{--}34 \mu\text{m}$ ; thallus saxicolous . . . . .  
 . . . . . **D. saxicola** B. O. Sharma & Makhija
- 48(42) Hypostictic and hypoconstictic acids present, stictic acid absent; ascospores  $105\text{--}165 \times 35\text{--}60 \mu\text{m}$ . . . . . **D. monophorum** (Nyl.) Kalb *et al.*  
 Hypostictic and hypoconstictic acids absent, stictic acid present (sometimes with  
 several other major substances) . . . . . 49
- 49(48) Ascospores up to  $205 \mu\text{m}$  long . . . . . 50  
 Ascospores  $231\text{--}244 \times 59\text{--}76 \mu\text{m}$  . . . . . **D. megasperum** Makhija *et al.*
- 50(49) Ascospores up to  $145 \mu\text{m}$  long . . . . . 51  
 Ascospores usually  $> 145 \mu\text{m}$  long,  $(135\text{--})168\text{--}205 \times 54\text{--}96 \mu\text{m}$  . . . . .  
 . . . . . **D. rufosporum** (Patw. & C. R. Kulk.) B. O. Sharma & Makhija
- 51(50) Stictic acid present alone; thallus corticolous; ascospores  $90\text{--}136 \times 30\text{--}44 \mu\text{m}$ . . . . .  
 . . . . . **D. talisense** (A.W. Archer) A.W. Archer  
 Constictic and cryptostictic acids present in addition to stictic acid, also sometimes  
 traces of norstictic acid; thallus saxicolous; ascospores  $88\text{--}147 \times 25\text{--}42 \mu\text{m}$  . . . . .  
 . . . . . **D. rupicola** B. O. Sharma & Makhija



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