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A world key to species of the genera *Topelia* and *Thelopsis* (*Stictidaceae*), with the description of three new species from Brazil and Argentina

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Abstract: The following new corticolous species are described. *Thelopsis cruciata* Aptroot & M. Cáceres, with an olive-green thallus, immersed red-brown perithecia and *c.* 50–100 cruciate ascospores per ascus, 7–10 × 4–7 µm, from Brazil. *Topelia argentinensis* Aptroot, L. I. Ferraro & M. Cáceres, with a verrucose, partly almost isidiate, greenish grey thallus, immersed pinkish perithecia and 8 uniseriate muriform ascospores per ascus, 12–17 × 7–11 µm, from Argentina. *Topelia tetraspora* Aptroot & M. Cáceres, with a *c.* 0·1–0·6 mm thick layer of coralloid to usually flattened, irregularly palmately branched isidia *c.* 0·05 mm diam., ascospores 15–19 × 2–6-septate, muriform, ellipsoid, 39–50 × 11–16 µm, only up to 4 per ascus maturing, from Brazil. *Thelopsis inordinata* is reported for the first time from South America, from Guyana. A key is given to all currently known species of *Topelia* and *Thelopsis*. The distinction between these genera has become arbitrary with the recent addition of more or less intermediate species.

Key words: Atlantic rainforest, Chaco, corticolous, Guyana, lichens, *Ostropales*, Sergipe

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Introduction

Thelopsis is a widespread but rarely abundant genus of the *Stictidaceae*. It occurs equally saxicolous and corticolous, both in tropical and temperate regions, in the latter often on soft bark of old trees. Species of this genus have globose, closed perithecioid apothecia, a hymenium with paraphyses and periphyses, and multispored asci.

So far ten species are known in the genus, only six of which were treated in the revision of the genus (Vězda 1968); the others were described in subsequent papers (Egea & Torrente 1996; Renobales *et al.* 1996; Aptroot *et al.* 1997; Moon & Aptroot 2009). Some species are known from one country only, but the known ranges of some species have expanded recently when additional reports were published (e.g. Harris 1979; McCarthy 1991; Aptroot & Seaward 1999; Elix *et al.* 2009).

Topelia (Jørgensen & Vězda 1984) is a closely related genus of rarely reported species, which differs from *Thelopsis* mainly by the ascospores that are only 8 per ascus. Four species were originally assigned to the genus *Topelia*, and they mostly have muriform, broadly ellipsoid ascospores, while the species included in the revision of *Thelopsis* (Vězda 1968) have at most submuriform ascospores that are ellipsoid, although one of the original *Topelia* species has submuriform ascospores. Four additional *Topelia* species have in the meantime been described or transferred into the genus (Mayrhofer 1987; Tretiach & Vězda 1992; Ryan & Lumbsch 2007; Kondratyuk *et al.* 2013). However,

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the delimitation between the two genera has become arbitrary with the recent description of the truly muriform *Thelopsis muriformis* Aptroot & K. H. Moon (Moon & Aptroot 2009). Below we describe another intermediate species.

During studies on lichen ecology and diversity by the authors in Atlantic rainforest reserves in the state of Sergipe in the north of Brazil, two undescribed species were encountered, one *Thelopsis* and one *Topelia*, and these are described below. The new species were both found in the Parque da Cidade, the only remnant of Atlantic rainforest in the city of Aracaju. From this area, two lichen species had already been described (Cáceres *et al.* 2013), both of which have been found subsequently in other Atlantic rainforest patches in the state. One of the species was also found in the larger Parque Nacional Serra de Itabaiana, from which few lichens have so far been reported (Cáceres 2007) but which is very species rich, with about 375 recorded. A further new *Topelia* species is described from the subtropical Chaco region in Argentina.

Because several new species have been recently described in these two genera, an artificial world key to all currently known species of *Thelopsis* and *Topelia* is given, with the currently known distribution ranges. The key is based on Breuss & Schultz (2007) which, however, only includes *Thelopsis* species. Although the delimitation between *Thelopsis* and *Topelia* has increasingly become arbitrary, the genera are not formally synonymized here pending further evidence.

Material and Methods

Identification and descriptive work was carried out in Itabaiana, Universidade Federal de Sergipe, using a Leica EZ4 stereomicroscope and a Leica DM500 compound microscope, and also in Soest using an Olympus SZX7 stereomicroscope and an Olympus BX50 compound microscope with interference contrast, connected to a Nikon Coolpix digital camera. Sections were mounted in tap water, in which all measurements were also taken. The specimens from this study are preserved in ISE or CTES, with duplicates in ABL. The chemistry of the type specimens was investigated by spot reactions with KOH, C and Pd, and by thin-layer chromatography (TLC) using solvent A (Orange *et al.* 2001).

The New Species

Thelopsis cruciata Aptroot & M. Cáceres sp. nov.

MycoBank No.: MB 809571

Corticolous *Thelopsis* with olive-green thallus, immersed red-brown perithecia and *c.* 100 cruciate ascospores per ascus, 7–10 × 4–7 µm.

Type: Brazil, Sergipe, Aracaju, Parque da Cidade Governador José Rollemberg Leite, 10°52′57″S, 37°03′10″W, on bark of tree, 75 m alt., 15 September 2013, *M. Cáceres & A. Aptroot* 18225 (ISE—holotype; ABL—isotype).

(Fig. 1A & B)

Thallus crustose, corticate, dull or slightly shiny, olive-green to olive-brown, smooth to somewhat granular, not surrounded by prothallus.

Perithecia numerous, dispersed, mostly immersed in the thallus or partly in the bark, globose, 0·25–0·35 mm diam., mostly covered by thallus, only a small area around the ostiole visible from above as a red-brown dot. *Ostiole* inconspicuous. *Wall* mostly hyaline, brownish around the ostiole, *c.* 50 µm thick. *Hymenium* not inspersed, IKI+ pale blue; *paraphyses* unbranched, sparse, apices not swollen; *periphyses* unbranched, numerous. *Asci* containing *c.* 50–100 ascospores, 80–95 × 19–25 µm. *Ascospores* hyaline, cruciate septate with generally 4 locules, globose to ellipsoid, 7–10 × 4–7 µm.

Pycnidia not observed.

Chemistry. No spot reactions. TLC: no substances.

Ecology and distribution. On rough bark of trees in Atlantic rainforest. Known only from Brazil.

Discussion. This new species is internally well characterized by the unique cruciate ascospores, which are otherwise unknown in the family, and occur in the order *Ostropales* or otherwise only in distoseptate ascospores. In most other characters it is close to *Thelopsis rubella* Nyl.

Additional material examined. **Brazil:** *Sergipe*: Aracaju, Parque Nacional Serra de Itabaiana, 250 m alt., 2013, *M. Cáceres & A. Aptroot* 18253 (ISE, ABL).

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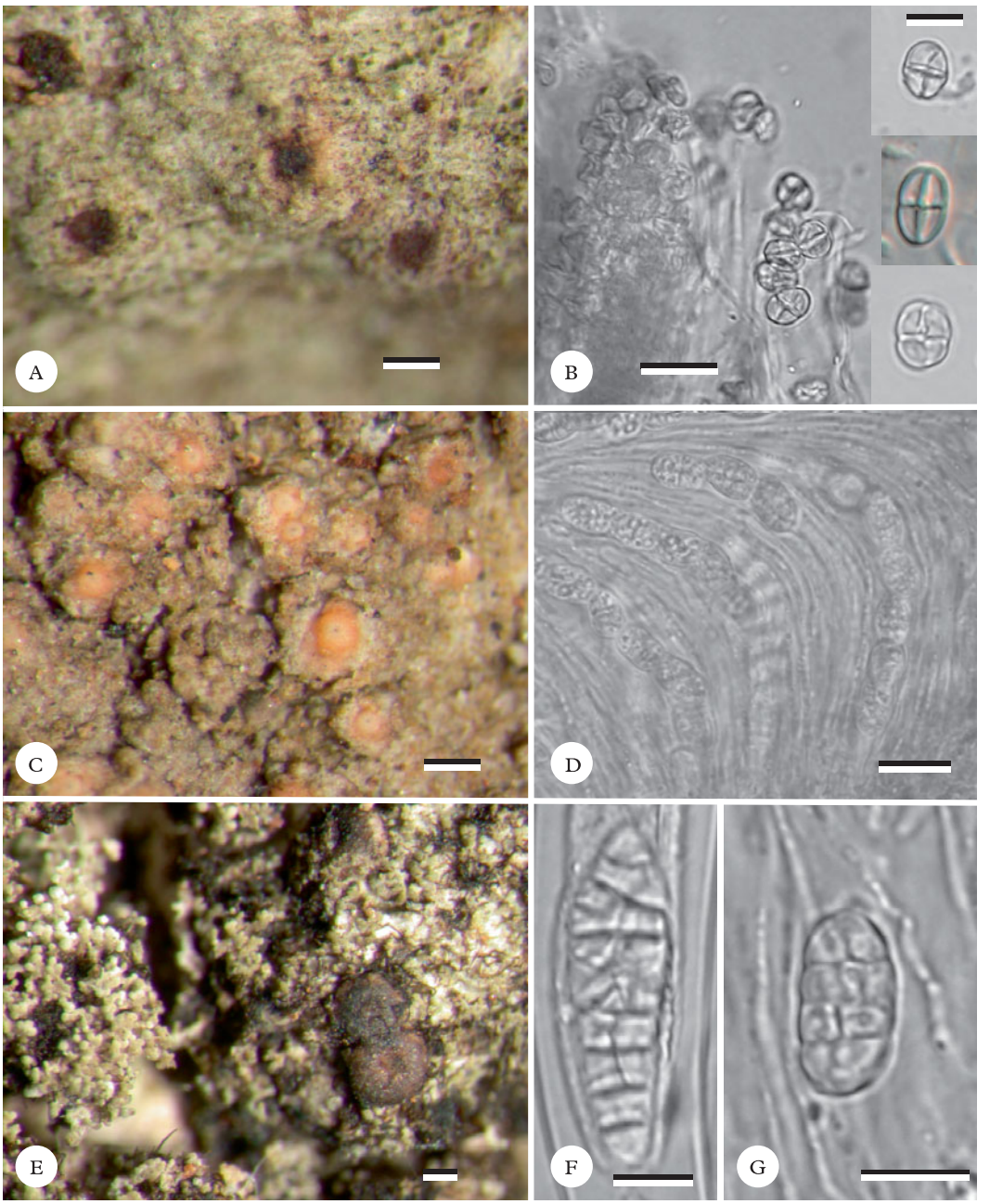

FIG. 1. A & B, *Thelopsis cruciata*, isotype. A, habitus; B, multispored asci (left), ascospores (right); C, D & G, *Topelia argentinensis*, isotype. C, habitus; D, asci with 8 ascospores; G, ascospore. E & F, *Topelia tetraspora*, isotype. E, habitus; F, ascospore. Scales: A, C & E = 0·1 mm; B (left) & D = 25 μm; B (right), F & G = 10 μm. In colour online.

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Topelia argentinensis Aptroot, L. I. Ferraro & M. Cáceres sp. nov.

MycoBank No.: MB 809572

Corticolous *Topelia* with a verrucose, partly almost isidiate, greenish grey thallus, immersed pinkish perithecia and 8 uniseriate muriform ascospores per ascus, 12–17 × 7–11 µm.

Type: Argentina, Chaco, 15 km W of Presidencia Roca, 26°06′28″S, 59°47′20″W, on bark of tree, 877 m alt., 27 February 2013, *L. I. Ferraro, A. Aptroot & M. E. S.Cáceres* 10889 (CTES—holotype; ABL—isotype).

(Fig. 1C, D & G)

Thallus crustose, corticate, dull or slightly shiny, greenish grey, uneven to verrucose, the verrucae partly so discrete that they are almost low isidia *c.* 0·05 mm diam., not surrounded by prothallus.

Perithecia numerous, dispersed, mostly immersed in the thallus, globose, 0·15–0·25 mm diam., mostly covered by thallus, pink in surface view although only a relatively small area around the ostiole is usually visible from above. *Ostiole* inconspicuous. *Wall* hyaline in section, *c.* 50 µm thick. *Hymenium* not inspersed, IKI+ blue; *paraphyses* unbranched, sparse, apices not swollen; *periphyses* unbranched, numerous. *Asci* containing 8 uniseriate ascospores, 90–115 × 10–13 µm. *Ascospores* hyaline, muriform, 4–6 × 1–2-septate, with 10–16 locules visible in surface view, broadly ellipsoid, 12–17 × 7–11 µm.

Pycnidia not observed.

Chemistry. No spot reactions. TLC: no substances.

Ecology and distribution. On rough bark of trees in semi-deciduous subtropical forest. Known only from Argentina.

Discussion. This new species is in most characters close to *Topelia jasonhurii* L. Lökös *et al.* (Kondratyuk *et al.* 2013), which was recently described from Korea. That species mainly differs by the brown to black exciple in the ostiolar region.

Topelia tetraspora Aptroot & M. Cáceres sp. nov.

MycoBank No.: MB 809573

Corticolous *Topelia* with a *c.* 0·1–0·6 mm thick layer of coralloid to usually flattened, irregularly palmately branched isidia *c.* 0·05 mm diam., ascospores muriform, 15–19 × 2–6-septate, ellipsoid, 39–50 × 11–16 µm, only up to 4 per ascus maturing.

Type: Brazil, Sergipe, Aracaju, Parque da Cidade Governador José Rollemberg Leite, 10°52′57″S, 37°03′10″W, on bark of tree, 75 m alt., 15 September 2013, *M. Cáceres & A. Aptroot* 18228 (ISE—holotype; ABL—isotype).

(Fig. 1E & F)

Thallus crustose, corticate, dull or slightly shiny, mineral grey, mostly covered with a *c.* 0·1–0·6 mm thick layer of coralloid to usually flattened, irregularly palmately branched isidia *c.* 0·05 mm diam., not surrounded by prothallus.

Perithecia sparse, not equally dispersed, superficial on the thallus, mostly between but also emergent from the isidia, globose, 0·25–0·50 mm diam., not covered by thallus, dark brown to nearly black, often in various shades on one perithecium. *Ostiole* inconspicuous. *Wall* in section mostly brown on the outside, *c.* 50 µm thick. *Hymenium* not inspersed, IKI−; *paraphyses* unbranched, numerous, apices not swollen; *periphyses* unbranched, numerous. *Asci* initially containing 8 irregularly biseriate ascospores, but only up to 4 maturing (often only 2), 95–125 × 19–29 µm. *Ascospores* hyaline, muriform, 15–19 × 2–6-septate, ellipsoid, 39–50 × 11–16 µm.

Pycnidia not observed.

Chemistry. No spot reactions. TLC: no substances.

Ecology and distribution. On smooth bark of trees in Atlantic rainforest. Known only from Brazil.

Discussion. This is the only species known in the genus with real isidia. The previous species has tiny low warts that are nearly, but not really, isidia. It is therefore unmistakable and not likely to be confused with any other species.

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World key to the species of *Thelopsis* and *Topelia*

For all species, ascospore septation and measurements are given. This key also mentions the world distribution and the substratum if it is not tree bark.

1 Ascospores simple, minute, 4–6 × 3–4 µm; perithecia yellow; Europe, USA (Virginia) . . . . . **Thelopsis flaveola** Arnold
Ascospores transversely septate to muriform, larger; perithecia not yellow. 2

2(1) Ascospores transversely septate. 3
Ascospores cruciate, submuriform or muriform 10

3(2) Ascospores 1-septate 4
Ascospores 3-septate 8

4(3) Thallus byssoid; spores 9–13 × 4–5 µm; Australia, New Guinea, Thailand. . . . . **Thelopsis byssoidea** Diederich
Thallus not byssoid 5

5(4) Perithecia immersed in strongly convex to hemispherical thalline warts; spores 12–18 × 6–8 µm; on bark but occasionally on rock, Europe, North Africa, Asia (Hong Kong), Australia, North America . . . . . **Thelopsis isiaca** Stiz.
Perithecia not in thalline warts, entirely below the level of thallus surface, or protruding but not covered by a thalline layer 6

6(5) Ascospores 7–11 × 4–5 µm; endolithic, Spain . . . . . **Thelopsis foveolata** Renob. & Barreno
Ascospores mostly longer; thallus epilithic 7

7(6) Ascospores 14–19 × 4–5 µm; perithecia immersed in the thallus, pale; on rock, Socotra . . . . . **Thelopsis paucispora** Breuss & M. Schultz
Ascospores 10–14 × 5–6 µm; perithecia protruding, red-brown; on rock, South Africa . . . . . **Thelopsis obscura** Egea & Torrente

8(3) Perithecia reddish brown; spores 12–18 × 5–6 µm; on bark but occasionally on rock, Europe (e.g. Ukraine), Asia, North America . . . . . **Thelopsis rubella** Nyl.
Perithecia at least in the upper part brown-black or black. 9

9(8) Perithecia smooth, dark in upper part; ascospores 18–25 × 4–5 µm; on limestone, Central Europe . . . . . **Thelopsis lojkana** Nyl.
Perithecia warty, dark throughout; ascospores 11–20 × 4–7 µm; on mosses and plant debris, Europe, USA (Michigan) . . . . . **Thelopsis melathelia** Nyl.

10(2) Ascospores cruciate or submuriform, with less than 10 locules. 11
Ascospores muriform, with more than 10 locules 13

11(10) Ascospores cruciate, with generally 4 locules, 7–10 × 4–7 µm, *c.* 100 per ascus; Brazil . . . . . **Thelopsis cruciata** Aptroot & M. Cáceres
Ascospores submuriform, with more than 4 locules 12

12(11) Ascospores 40–80 per ascus, 9–14 × 5–7 µm; India, North America, here reported for the first time from South America: Guyana, Georgetown, University campus, February 1985, *A. Aptroot* 15702 (BR). . . . . **Thelopsis inordinata** Nyl.

Ascospores 8 per ascus, 9–14 × 5–7 µm; on limestone, Southern Europe . . . . . **Topelia heterospora** (Zahlbr.) P. M. Jørg. & Vězda

13(10) Ascospores *c.* 50 per ascus, 17–20 × 8–10 µm; Korea . . . . . **Thelopsis muriformis** Aptroot & K. H. Moon
Ascospores 8 (or less) per ascus 14

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14(13) Perithecia dark brown to nearly black; ascospores 39–50 × 11–16 µm, only up to 4 per ascus maturing; thallus with isidia; Brazil . . . . . **Topelia tetraspora** Aptroot & M. Cáceres
Perithecia pale brown to pink or colourless; thallus not isidioid 15

15(14) Perithecia opening with a wide pore 16
Perithecia remaining closed, only with a punctiform ostiole 18

16(15) Ascospores globose to broadly ellipsoid, 13–20 × 10–13 µm; southern USA (Arkansas, Louisiana, Missouri) . . . . . **Topelia aperiens** P. M. Jørg. & Vězda
Ascospores ellipsoid, over 20 µm long 17

17(16) Exciple 30–60 µm wide, brown to black outside, with dark granules; ascospores (20–)23–28(–32) × 9–12 µm; California . . . . **Topelia californica** P. M. Jørg. & Vězda
Exciple 70–80 µm wide, pale to yellowish brown outside, without dark granules; ascospores 20–26–(28) × 11–14 µm; on limestone, California . . . . . **Topelia gyalectodes** (Nyl.) B. D. Ryan & H. T. Lumbsch

18(15) Ascospores > 19 µm long 19
Ascospores < 18 µm long 21

19(18) Thallus grey; ascospores 25–33 × 14–19 µm; immersed in limestone, Cuba, Mexico . . . . . **Topelia brittonii** (Riddle) Mayrh.
Thallus green; in or on bark, on mosses or superficial on limestone 20

20(19) Perithecia not immersed in the substratum or the thallus; thallus pinkish; ascospores (20–)22–25(–28) × 12–14 µm; on bark, mosses or limestone, Mediterranean Europe, New Zealand, Lord Howe Island . . . . . **Topelia rosea** (Servít) P. M. Jørg. & Vězda
Perithecia immersed in the substratum or the thallus; thallus grey or green; ascospores 20–30 × 8–12 µm; immersed in bark, Italy . . . . . **Topelia nimisiana** Tretiach & Vězda

21(18) Exciple partly brown, at least near the ostiole and below the hymenium; ascospores (11–)12–15(–17) × 9–11 µm; Korea . . . . . **Topelia jasonhurii** L. Lökös *et al.*

Exciple pinkish, hyaline in section; ascospores 12–17 × 7–11 µm; Argentina . . . . . **Topelia argentinensis** Aptroot *et al.*

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