INTRODUCTION

_Hypoxylon_ Bull. is the largest and most complex genus of the family Hypoxylaceae (Wendt _et al._, 2018). The genus includes species with unipartite hemispherical to effused-pulvinate stromata with colored surface and homogeneous waxy to fibrous tissue bellow perithecial layer; and a nodulisporium-like anamorph, but with variations in the branching patterns of the conidiophores (Daranagama _et al._, 2018; Ju & Rogers, 1996; Wendt _et al._, 2018). Their stromata release diverse pigments in contact with KOH solution. These pigments are secondary metabolites deposited as colored granules below the stromatal surface and surrounding the perithecia, which frequently can possess species-specific chemical entities useful to discriminate _Hypoxylon_ species (Hellwig _et al._, 2005; Kuhnert _et al._, 2014ab; Stadler _et al._, 2008).

Members of the genus are recognized as saprobes or as facultative parasites when found on wood, but can also be isolated as part of the endophytic community in most of the forest trees (Kuhnert _et al._, 2014a). The majority of species has been reported from warmer climates especially the Tropics. This however could be the result of less extensive sampling in subtropical or temperate areas of the world (Fournier _et al._, 2015).

Since the beginning of the century, several surveys on the xylariaceous diversity have been carried out in the Argentine Yungas, the southernmost subtropical montane forest of the Neotropics (Hladki, 2007; Kuhnert _et al._, 2015, 2017; Sir _et al._, 2012abc, 2013, 2015, 2016ab, 2018; Sir & Hladki, 2014). These mycological trips showed that the genus _Hypoxylon_ is a remarkable, yet poorly documented component of the mycobiota of this ecosystem (Sir _et al._, 2012a). Hladki & Romero (2009ab) and Catania & Romero (2010) published the first reports of _Hypoxylon_ species from the Argentine northwest, recording less than ten species. In one of our previous studies, we already increased the knowledge about the diversity of the genus (Sir _et
In this context we proposed three new species: *H. calileguense* Sir, Kuhnert, Hladki & A.I. Romero, *H. lilloi* Sir, Lamb. & Kuhnert and *H. spegazzinianum* Sir, Kuhnert, Hladki & A.I. Romero; and recognized eight new records for Argentina: *H. carneum* Petch, *H. chionostomum* Speg, *H. flavoargillaceum* J. H. Mill., *H. griseobrunneum* (B.S. Mehrotra) J. Fourn., Kuhnert & M. Stadler, *H. haematostroma* Mont., *H. invesitens* (Schwein.) M.A. Curtis. *H. lividipigmentatum* F. San Martín, Y. M. Ju & J. D. Rogers, and *H. umbilicatum* Speg.

Here we report, three new species records of *Hypoxylon* for the Southern Cone of South America, collected in the Argentine Yungas. Also, we provide an emended taxonomic key for *Hypoxylon* species known from Argentina.

**MATERIALS AND METHODS**

Fungal collections were obtained between 2011 and 2015 at the Parque Nacional Calilegua and Reserva Provincial Las Lancitas from Jujuy province, Reserva provincial de Flora y Fauna Acambuco and Parque Nacional el Rey from Salta province, and Parque Sierra de San Javier from Tucumán province.

The materials were studied and isolated according to Sir et al. (2016). The color of stromata and extractable pigments are described following the color chart of Rayner (1970). The perispore was analysed under field-emission scanning electron microscope (SEM-Zeiss, Supra 55vp) in the Centro Integral de Microscopía Electrónica (CIME, CONICET-UNT). The reference collections were deposited in the LIL herbarium. Additional specimens examined were obtained from LIP and K herbaria (acronyms are from Index Herbariorum, http://sciweb.nybg.org/science2/IndexHerbariorum.asp). The author names of the fungal species were taken from Index Fungorum (http://www.indexfungorum.org/).

**RESULTS**

**Taxonomic part**

*Hypoxylon aeruginosum* J.H. Mill., var. *aeruginosum* Mycologia, 25 (4): 321(1933).

Figs. 1 and 4a

Stromata effused-pulvinate; 10–25 mm long × 5–15 mm broad × 0.4–6 mm thick; with inconspicuous perithecial mounds to plane; surface

Verdigris (74) to Cyan Blue (26) with Brick (59) margin, pruinose; black granules immediately beneath the surface and between perithecia, pale blue and pale green in water; with KOH-extractable pigments Umber (9) with Pale Vinaceous (85) tones; tissue bellow the perithecial layer inconspicuous, black. Perithecia obvoid to spherical 0.25–0.4 mm high × 0.1–0.2 mm diam., ostioles umbilicate. Asci cylindrical, 8-spored, 118–154 μm total length, the spore-bearing parts 68–75 × 6.8–8 μm and stipes 49–80 μm long, with amyloid apical apparatus, discoid, 0.5–0.7 μm high × 2–2.5 μm broad. Ascospores light brown to brown, unicellular, ellipsoid, nearly equilateral, with broadly to less frequently narrowly rounded ends, 8–11.3×4.4–6 μm (N= 60, Me= 10.1 × 5.5 μm), with straight germ slit less than to nearly spore-length; perispore indehiscent in 10% KOH; epispore smooth under LM and SEM. Conidiogenous structure with vorgariella-like branching patterns. Conidiophores hyaline, smooth. Conidiogenous cells hyaline, smooth, 15–27×3.85 × 2.3–2.9 μm. Conidia ellipsoid, hyaline, smooth, 4–6.4 × 2.9–3.8 μm.

**Culture:** not obtained.

**Secondary metabolites:** derivatives of lepraric acid (Læssøe et al., 2010).

**Specimens examined:** ARGENTINA. Tucumán, depto. Tafí Viejo, Parque Sierra de San Javier, la Cascada, 6/5/2013, Sir & Hladki 410 (LIL). FRENCH GUIANA: Sinnamary, Paracou, edge of parking area of CIRAD field station, on a corticated branch, possibly on old remnants of a Corticiaceae, 26/6/2012, leg. J. Fournier, GYJF 12236 (LIP, epitype).

**Discussion:** *Hypoxylon aeruginosum* is a species that was unknown from subtropical regions of the American continent, being previously recorded only from sites of the American tropical zone, i.e. Ecuador, French Guiana, Guadeloupe, Guyana, Martinique and Mexico (Fournier et al., 2015; Fournier & Lechat, 2015). This taxon is distinct from other *Hypoxylon* by its blue effused-pulvinate stromata and nearly equilateral ascospores which measure less than 11.5 μm (Ju & Rogers, 1996). The anamorph of this species is characterized and illustrated for first time herein.

In our collection a part of the specimen was found on top of another *Hypoxylon* sp. This phenomenon was also observed by Læssøe et al. (2010), who suggested a fungicolous life style.
Fig. 1. *Hypoxylon aeruginosum* (Sir & Hladki 410-LIL). A: stromata on substrate, B: detail of stroma on top of *Hypoxylon* sp. (arrows). C and D: details of stromatal surface showing ostioles. E: portion of anamorph showing conidiogenous cells (arrows). F: stroma in section showing the perithecia. G: KOH-extractable pigments, H: stromatal granules in water. I: ascal apical apparati in Melzer’s reagent. J: mature ascus. K: ascospores in KOH solution showing germ slit (arrows). L: ascospores in water. M: ascospores view under SEM showing smooth epispore. Scale bars. A, B: 5 mm. C: 1 mm. D, F: 0.3 mm. E, J, L: 10 µm. I, K: 5 µm. M: 2 µm.
Hypoxylon fendleri Berk. ex Cooke, Grevillea
11: 132. 1883. Figs. 2 and 4b.

Stromata effused-pulvinate; 5–40 mm long × 3–20 mm broad × 0.7–1 mm thick; with conspicuous to inconspicuous perithecial mounds, in some case with wrinkled surface; surface Brown Vinaceous (84) with orange tones, pruinose; orange granules immediately beneath the surface and between perithecia, orange in water; with KOH-extractable pigments Orange (7); tissue bellow the perithecial layer inconspicuous, black. Perithecia obovoid 0.4–0.6 mm high × 0.3–0.5 mm diam., ostioles umbilicate. Ascii cylindrical, 8-spored, 85–160 µm total length, the spore-bearing parts 70–80 × 6–7.88 µm and stipes 45–80 µm long, with amyloid apical apparatus, discoid, 0.7–1.4 µm high × 2–2.7 µm broad. Ascospores brown to dark brown, ellipsoid-inequilateral, with narrow rounded ends, (8.4)9.3–11.7(12.4) × (4.6)4.8–5.9(6.6) µm (N= 60, Me= 10.7 × 5.4 µm), with sigmoid germ slit spore-length on the convex side; perispile dehiscent in 10% KOH, smooth to faintly striated under LM, striated under SEM; epispore smooth. Conidiogenous structure with virgariella-like and nodulisporium-like branching patterns. Conidiogenous cells hyaline, smooth to slightly roughened, 15–25 × 2.1–3.4 µm. Conidia ellipsoid, hyaline, smooth, 5.0–5.9 × 3.1–3.9 µm.

Culture: for description see Ju & Rogers (1996).

Secondary metabolites: mitorubrin, mitorubrinol, mitorubrinol acetate, orsellinic acid and BNT (Stadler et al., 2008).

Specimens examined: ARGENTINA, Jujuy, dpto. Santa Bárbara, Reserva Provincial Las Lancitas, 13/5/2012, Sir & Hladki 248 (LIL). Salta, La Candelaria, El Jardín, 3/5/2013, Sir & Hladki 387 (LIL). Dpto. Gral. José de San Martín, Reserva de Flora y Fauna Acabuco, 22/4/2014, Sir & Hladki 505 (LIL); road to Reserva de Flora y Fauna Acabuco, 23/4/2014, Sir & Hladki 574 (LIL); 21/5/2015, Sir & Hladki 950 (LIL). Dpto. Anta, Parque Nacional El Rey, 29/4/2014, Sir & Hladki 712, 720 (LIL); 28/5/2015, Sir & Hladki 887 (LIL). VENEZUELA: 261, corticated wood (K, holotype).

Discussion: Hypoxylon fendleri is a very common fungus in the tropical regions of the world (Fournier et al., 2015); this is the first record of the species for a subtropical area of South America. The taxon can be identified by its vinaceous stromatal surface, orange granules, orange extractable pigments, ascospores with sigmoid germ slit and nodulisporium-like anamorph (Ju & Rogers, 1996). The characteristics of the cultures obtained from Argentinean material were in accordance with previous descriptions for species (Ju & Rogers, 1996).

Hypoxylon undulatum Y.M. Ju, J.D. Rogers & Læssøe, Mycol. Mem. 20: 199 (1996).

Figs. 3 and 4c.

Stromata effused-pulvinate; 10–25 mm long × 5–15 mm broad, 0.4–1 mm thick; with conspicuous to very conspicuous perithecial mounds, in some case approaching to rossellinoid; surface Brown Vinaceous (84) to Fuscous (103), pruinose; dull rusty brown granules immediately beneath the surface and between perithecia, reddish brown in water; without apparent KOH-extractable pigments; tissue below the perithecial layer inconspicuous, black. Perithecia spherical to spherical compressed 0.2–0.3 mm diam, ostioles umbilicate, opening at the centre of a raised disc, 0.1–0.13 mm diam. Asci cylindrical, 8-spored, 89–117 µm total length, the spore-bearing parts 64–77 × 5–7.7 µm and stipes 20–40 × 0.7–1.4 µm long, with amyloid apical apparatus, discoid, 1 µm high × 1.5–1.8 µm broad. Ascospores brown to dark brown, ellipsoid-inequilateral, with narrow rounded ends, (9.1)9.6–11.0(11.6) × (3.5)3.9–4.8(5.1) µm (N= 60, Me= 10.3 × 4.2 µm), with straight germ slit spore-length on the convex side; perispore dehiscent in 10% KOH, smooth to faintly striated under LM, striated under SEM; epispore smooth. Conidiogenous structure with virgariella-like and nodulisporium-like branching patterns. Conidiophores hyaline, smooth to slightly roughened, at the centre of a raised disc, 0.1–0.13 mm diam. Asci cylindrical, 8-spored, 89–117 µm total length, the spore-bearing parts 64–77 × 5–7.7 µm and stipes 45–80 µm long, with amyloid apical apparatus, discoid, 1 µm high × 1.5–1.8 µm broad. Ascospores brown to dark brown, ellipsoid-inequilateral, with narrow rounded ends, (9.1)9.6–11.0(11.6) × (3.5)3.9–4.8(5.1) µm (N= 60, Me= 10.3 × 4.2 µm), with straight germ slit spore-length on the convex side; perispore dehiscent in 10% KOH, smooth to faintly striated under LM, faintly striated under SEM; epispore smooth. Conidiogenous structure with virgariella-like and nodulisporium-like branching patterns. Conidiophores hyaline, smooth to slightly roughened, Conidiogenous cells hyaline, smooth to slightly roughened, 10.4–23 × 2–2.8 µm. Conidia ellipsoid, hyaline, smooth, 3.5–5 (6.5) × 2.2–3.5 µm.

Culture: for description see Ju & Rogers (1996).

Secondary metabolites: unknown.

Specimens examined: Argentina. Jujuy, Ledesma, Parque Nacional Cailegua, 12/12/2015, Sir & Hladki 997 (LIL). Dpto. Gral. José de San Martín, road to Reserva de Flora y Fauna Acabuco, 21/5/2015, Sir & Hladki 849 (LIL).

Discussion: Hypoxylon undulatum was only known by its type material from Saint John (U.S. Virgins Island). This species is characterized by having effused-pulvinate stromata, fuscous surface with strongly exposed perithecial mounds, ostioles with a raised disc and by lacking apparent
Fig. 2. Hypoxylon fendleri (Sir & Hladki 574-LIL). A and B: stromatal habit. C: stromatal surface. D: stroma in section showing perithecia and granules (arrows). E: stromatal granules in water. F: extractable pigments. G: immature and mature asci. H: ascal apical apparati in Melzer’s reagent. I: immature and mature ascospores in water. J: branching of anamorph. K: ascospores in KOH solution showing dehiscent perispore. L: ascospores view under SEM showing striated perispore. M and N: ascospores in KOH solution showing germ slit (arrows). Scale bars. A, B: 5 mm. C, D: 1 mm. G: 20 µm. H, I, J, M: 10 µm. K, L, N: 5 µm.
Fig. 3. *Hypoxylon undulatum* (Sir & Hladki 997-LIL). A and B: stromata on bark. C and D: stromatal surface showing ostiolar discs (arrows). E: stromata in vertical section showing perithecia and ostiolar disc (arrows). F: stromatal granules in water. G: portion of stroma in 10% KOH. H: ascus, I: ascus in Melzer’s reagent (arrows). J: branching of anamorph. K: ascospores. L: ascospores in KOH solution showing dehiscent perispore. M: ascospores view under SEM showing faintly striated perispore. N: ascospores with germ slit (arrows). Scale bars. A: 5mm, B: 1 mm. C-E: 0.3 mm, H-K: 10 µm. L-N: 5 µm.
Fig. 4. Conidiophores and conidia. A: *H. aeruginosum var. aeruginosum* (from substrate, Sir & Hladki 410-LIL), B: *H. fendleri* (from substrate, Sir & Hladki 574-LIL), C: *H. undulatum* (from culture, EBS 849-LIL). Scale bar 10 μm.

Key to species of *Hypoxylon* in Argentina

1. Ascospores averaging more than 25 μm in length ................................................................. 2
1’. Ascospores averaging less than 25 μm in length ......................................................... 4

2. Extractable pigments isabelline, ascospores subglobose, ellipsoid to pyriform, 28-41.5 × 17-22 μm ........................................................................................................*H. megalosporum*
2’. Without apparent pigments or with dilute vinaceous grey or brown vinaceous pigments, ascospores ellipsoid …………………………………………………………………………………………………… 3

3. Perithecia obovoid 0.5-0.7 mm diam.; ascospores 29.9-48.2 × 16-29 μm ……… *H. umbilicatum*
3’. Perithecia spherical, 1-1.4 mm diam.; ascospores 27.5-33 × 15.5-21 μm ……… *H. chionostomum*

4. Stromatal surface color blue ................................................................. *H. aeruginosum var. aeruginosum*
4'. Stromatal surface color other than above .................................................. 5
5. KOH-extractable pigments dark livid, vinaceous purple or without apparent pigments .......... 6
5'. KOH-extractable pigments with other than above colors ........................................ 8
6. Stromatal surface chestnut or sepia, KOH-extractable pigments dark livid, ascospores 7.9-14.5 × 5-7 µm .............................................................................................................. H. lividipigmentum
6'. Stromatal surface purplish gray or vinaceous gray, KOH-extractable pigments livid purple or absent, ascospores less than 11 µm long .................................................. 7
7. Ascospores with straight germ slit at the center of a dotted band, perispore dehiscent, smooth under SEM; conidiophores with nodulisporium-like branching patterns ................ H. carneum
7'. Ascospores with straight germ slit not at the center of a dotted band, perispore dehiscent with inconspicuous striated ornamentation under light microscope, very conspicuous striated under SEM, conidiophores with virgariella-like branching patterns .................................... H. tilloi
8. Ascospores nearly equilateral to slightly inequilateral, with germ slit on flattened side, perispore indehiscent in 10% KOH ................................................................. 9
8'. Ascospores conspicuously inequilateral, with germ slit on convex side, perispore indehiscent in 10% KOH ............................................................................. 11
9. Stromata pulvinate with inconspicuous to conspicuous perithecial mounds, surface sulfur yellow, KOH-extractable pigments red livid or vinaceous livid, ascospores 11-12 mm × 5-6 µm ........ H. kermesii
9'. Stromata effused-pulvinate, plane or with inconspicuous perithecial mounds, surface dark vinaceous to brown vinaceous, KOH-extractable pigments dull green or dark green ............. 10
10. Ascospores 9-11 × 4.5-5 µm .............................................................. H. investiens var. magnisporum
10'. Ascospores 7-10 × 3.3-4.5 µm ...................................................................... H. investiens var. investiens
11'. Stromata hemispherical, pulvinate, effused, effused pulvinate; plane or with inconspicuous to conspicuous perithecial mounds .......................................................... 12
11'. Stromata glomerate to effused-pulvinate with conspicuous to very conspicuous perithecial mounds, sometimes with the tendency to be perithecioid (approaching rosellinioid) ........ 24
12. Extractable pigments orange, scarlet or rust .................................................. 13
12'. Extractable pigments olivaceous, gray olivaceous, greenish olivaceous, dull green, dark green, amber, isabelline or fawn .......................................................... 20
13. Stromata with dull-colored granules, yellowish brown or brown ......................... 14
13'. Stromata with bright-colored granules, orange or orange red ............................... 15
14. Ascospores 8-12 × 4.5-5.5 µm .......................................................... H. rubiginosum var. rubiginosum
14'. Ascospores 7.5-9 × 3.5-5 µm ...................................................................... H. rubiginosum var. microsporum
15. Ascospores greater than 15 µm long .............................................................. 16
15'. Ascospores less than 15 µm long .................................................................. 17
16. Perithecia long tubular, more than 1.5 mm high, ascospores 15.1-23.5 × 6.0-8.9 µm, with smooth perispore, straight germ slit; conidiophores with periconiella-like branching patterns .......... H. haematostroma
16'. Perithecia spherical, ovoid, obvoid or tubular, less than 1.5 mm high, ascospores 14.5-17 × 6.5-7 µm with faintly striated to striated perispore, straight or slightly sigmoid germ slit; conidiophores with virgariella-like branching patterns........................................ H. crocopeplum
17. Ascospores less than 12 µm long and 5.5 µm wide ........................................... 18
17'. Ascospores greater than 12 µm long and 5.5 µm wide .................................... 19
18. Stromatal surface brown vinaceous, dark vinaceous, dark brick, or sepia, ascospores 8-12 × 4.5-5 µm, sigmoid germ slit, conidia 4-6 × 2.5-4 µm ...................................................... H. fendleri
18'. Stromatal surface umber, sepia, rust, sienna, dark brick, or bay; ascospores 7-11 × 3.5-5.5 µm, straight to slightly sigmoid germ slit, conidia 3.4-5 × 1.5-2 µm ...................................... H. subgilvum
20. Stromata pulvinate to effused-pulvinate (rare glomerate) with inconspicuous to conspicuous perithecial mounds, surface sepia, chestnut, perithecia spherical 0.2-0.5 mm diam. ................................................................. 21

21’. Stromata effused-pulvinate, plane or with inconspicuous perithecial mounds, surface brown vinaceous or dark vinaceous, perithecia obovoid to tubular 0.2-0.3 mm diam. ......................... 22

22. Stromatal granules dull olivaceous yellow; ascospores 9.7-13.0 × 4.0-5.7 µm, with straight germ slit spore-length ........................................................................................................ 23

22’. Stromatal granules dull reddish brown or blackish; ascospores with straight to slightly sigmoid germ slit spore-length ........................................................................................................ 23

23. Ascospores 10-12.5 × 4.2-5.6 µm, conidia 5-7 × 3-4 µm ...................................................... 23

23’. Ascospores 12.3-13.5 × 5-6 µm, conidia 3-4.5 × 1.5-2 µm ...................................................... 23

24. Ostioles slightly higher than the stromatal surface or with small papilla, ascospores 11.7-14.6 × 4.6-7.3 µm with sigmoid germ slit; conidiophores with nodulisporium-like branching patterns................................. 25

24’. Ostioles umbilicate most often opening at the centre of a raised disc, ascospores with straight or slightly sigmoid germ slit, conidiophores with virgariella-like or nodulisporium-like branching patterns................................................................. 25

25. Without apparent extractable pigments; ascospores shorter than 12 µm and narrower than 6 µm; conidiophores with nodulisporium-like and virgariella-like branching patterns ................................................................. 26

25’. Extractable pigments amber, orange or pure yellow; ascospores longer than 13 µm and wider than 6 µm; conidiophores with virgariella-like branching patterns ................................................................. 26

26. Apical apparatus bluing in Melzer’s iodine reagent, discoid, ascospores 13.9-21 × 6.8-10.2 µm, conidia 5-6.5(-7) × 2-3 µm ........................................................................................................ 26

26’. Apical apparatus highly reduced or lacking, not bluing in Melzer’s iodine reagent, ascospores 14.5-15.5 × 6.5-8 µm, conidia 4.5-5.5 × 3-3.5 µm ........................................................................................................ 26

KOH-extractable pigments (Ju & Rogers, 1996). The cultures obtained from Argentine material show the same features described for the ex-type culture of this species.

Medina et al. (2017) reported one specimen for Argentina found on Ocotea porphyria (Grisseb.) van der Werff (Lauraceae) as H. cf. undulatum. It differs principally from the specimens here described by having orange extractable pigments.

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