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Lophodermium (Rhytismataceae) on *Clusia*

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Three *Clusia*-inhabiting *Lophodermium* spp. are recognised: *L. clusiae* (LÉVEILLÉ) JOHNSTON stat. & comb. nov., *L. minus* (TEHON) JOHNSTON comb. nov., and *L. platyplacum* (BERKELEY & CURTIS) SACCARDO. Each species is described and illustrated.

The genus *Clusia* (Guttiferae) is widespread throughout tropical Central and South America. Most species have large, leathery leaves which, after falling, lie on the ground for several months before decomposing, providing an ideal substrate for Rhytismataceae. Among the species of Rhytismataceae reported from this host *Coccomyces clusiae* (LÉVEILLÉ) SACCARDO, *C. dentatus* (SCHMIDT & KUNZE : FRIES) SACCARDO, *C. limitatus* (BERKELEY & CURTIS) SACCARDO, and *Propolis quadrifida* (LÉVEILLÉ) MONTAGNE have modern descriptions and illustrations (SHERWOOD, 1977, 1980). Several *Lophodermium* species have been reported on *Clusia*, but in the only comprehensive treatment of nonconiferous *Lophodermium* species (TEHON, 1935), they were either not treated, or excluded from TEHON's concept of *Lophodermium* and its closely related segregate genera. Three *Clusia*-inhabiting *Lophodermium* species are recognised in the present study. One of these species, *Lophodermium minus* (TEHON) JOHNSTON, is found also on several other host genera (JOHNSTON, 1988, as *L. multimatricum* JOHNSTON), while the other two species appear to be specific to *Clusia*.

Material and Methods

Herbarium material was rehydrated in 3% KOH, and 8–10 µm thick sections of ascocarps were cut with a freezing microtome. Asci, ascospores, and paraphyses were examined from squash mounts made in 3% KOH and Melzer's solution. Herbarium references follow HOLMGREN et al. (1981).

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Taxonomic treatment

1. ***Lophodermium clusiae*** (LÉVEILLÉ) JOHNSTON stat. et comb. nov. – Figs. 1 & 4.

SYN.: *Hysterium foliicola* FR. var. *clusiae* LÉVEILLÉ. – Annales des Sciences Naturelles, Botanique. Sér. 4, 20: 291. 1863.

Ascocarps developing on fallen leaves, in discrete groups within pale, yellowish areas. Not associated with zone lines or anamorph pycnidia. In surface view ascocarps 0.8–1.5 × 0.5 mm, elliptic in outline, ends acute. Unopened ascocarps black with a well-developed pale zone along the future line of opening. Opened ascocarps with black walls, although often paler immediately inside edge of ascocarp. The single, longitudinal slit-like opening lined with a narrow, bright red zone. Ascocarps initially subepidermal, with epidermal cells becoming filled with fungal tissue as ascocarps mature. In vertical section upper wall of unopened ascocarp initially comprising mostly brown to dark brown, thick-walled, angular, 4–8 µm diam. cells, with a group of hyaline, thin-walled cells in the outer part of the wall in the area where the opening slit develops. As the ascocarp matures inside part of the wall becomes very dark and the cellular structure is obscured, and in some ascocarps the whole wall may comprise this very dark tissue. In opened ascocarps upper wall up to 60–70 µm wide, narrower towards the edge of ascocarp, comprising mostly angular, thick-walled, brown to dark brown cells, but with the inside part comprising dense, black tissue. Exposed face of broken upper wall lined with palisade-like layer of cylindric, hyaline, thin-walled cells. Lower wall 5–10 µm wide, of 1–3 layers of brown to pale brown, angular cells. – Paraphyses 1–2.5 µm diam., undifferentiated or slightly swollen near apex, extending 10–15 µm beyond asci. – Asci 120–140 × 7–8.5 µm, more or less cylindric, tapering to small, rounded apex, wall undifferentiated at apex, 8-spored. – Ascospores 75–95 × 1–2 µm, 0 septate, with gelatinous cap at both ends.

Specimens examined. – COLOMBIA: Nova Granata, on *Clusia* sp., LINDIG (2851) (K – type, as *Hysterium foliicolum*, part of collection only); Dpto. Cauca, between Popayan and El Tambo, on *Clusia* sp., DUMONT (CO 1243) et al., 14 Jul 1974 (NY, part of collection only). – PERU: Dpto. Cuzco, Cuzco-Pilocopata Rd, on *Clusia* sp., DUMONT (PE 1584, PE 1604) et al., 18 Jul 1976 (NY, part only of both collections). – VENEZUELA: Edo. Aragua, Parq. Nac. Henry Pettier, Rancho Grande, on *Clusia* sp., DUMONT (VE 1157) et al., 3 Jul 1971 (NY, part of collection only).

L. clusiae is distinguished from the other two *Lophodermium* species on *Clusia* by its large, elliptic, dark-walled ascocarps, and by the bright red zone of differentiated cells lining the ascocarp opening. The type specimen at K includes all three of the *Lophodermium* species discussed in this paper in adjacent spots on the same leaf.

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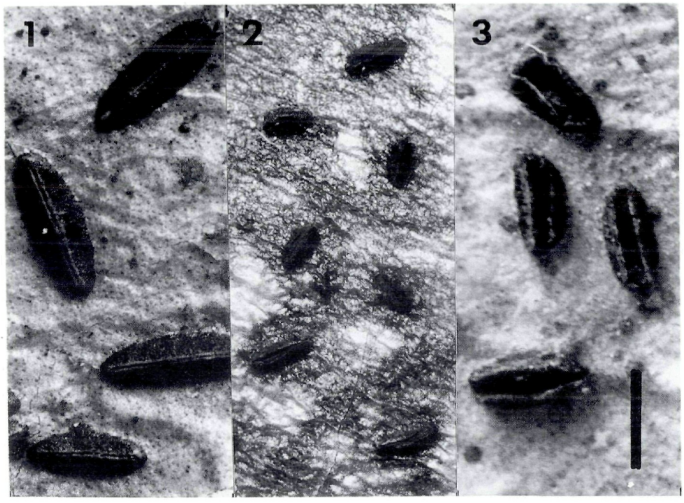

Figs. 1–3. Macroscopic appearance of ascocarps (bar scale = 1mm). – 1. *Lophodermium clusiae* (NY, Dumont-CO1243). – 2. *L. minus* (NY, Dumont-VE2051, neotype). – 3. *L. platyplacum* (NY, Dumont-CO6804).

From the brief description provided by LÉVEILLÉ (1863) it is not clear to which of these species he was referring. However, the three species differ in macroscopic appearance, and only one is similar to *Hysterium foliicola* var. *foliicola* (= *Lophodermium foliicola* (FR.) CANNON & MINTER). The latter species has black, elliptic ascocarps, with a prominent zone of differentiated, brightly coloured cells lining the edge of the ascocarp opening. It is assumed that LÉVEILLÉ's name applies to the species with this macroscopic appearance.

Lophodermium foliicola differs from *L. clusiae* in ascocarp structure and pattern of ascocarp development, in ascus and ascospore size, and in host preference. It is known only from Rosaceae, and may be confined to temperate Europe and North America.

L. clusiae is similar to *L. agathidis* MINTER & HETTIGE in many features, including the pattern of ascocarp development, the appearance of both immature and mature ascocarps in vertical section, and the microscopic appearance of asci, ascospores and paraphyses. *L. agathidis*, known from a wide range of host plants in New Zealand (JOHNSTON, 1989), is distinguished by the presence of pycnidia and by

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the row of cells lining the ascocarp opening being bright golden-yellow. These differences have been recognised taxonomically because of the correlation with geographic distribution. Although the two species are closely related, it is assumed that the New Zealand and South American populations now represent separately evolving groups.

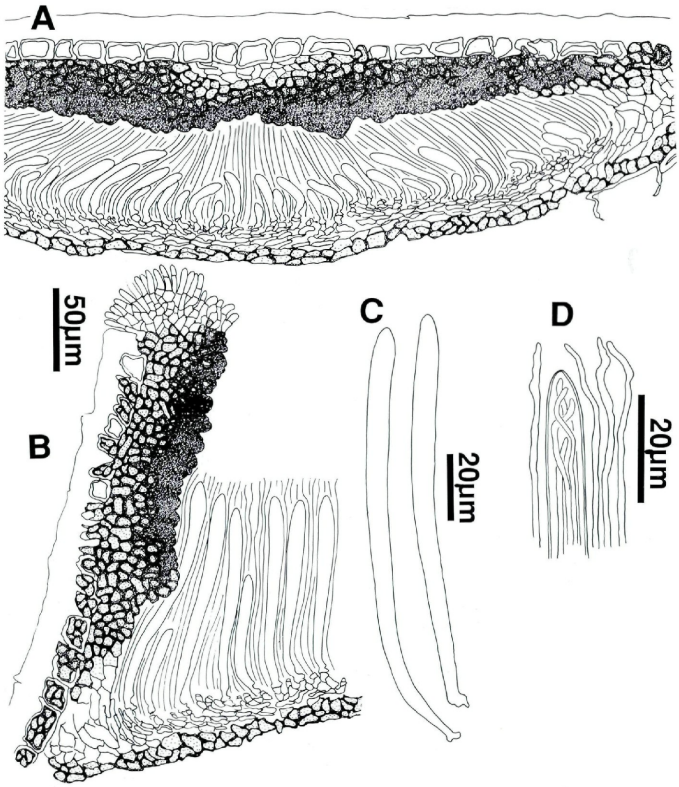

Fig. 4. *Lophodermium clusiae* (A, B: K, Lindig-2851, type. C, D: NY, Dumont-CO1243). – A. Immature, unopened ascocarp in vertical section showing group of hyaline, thin-walled cells near centre of ascocarp in outer part of upper wall. – B. One side of mature, opened ascocarp in vertical section. – C. Asci. – D. Apex of asci and paraphyses.

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2. ***Lophodermium minus*** (TEHON) JOHNSTON comb. nov. – Figs. 2 & 5.

BAS.: *Clithris minor* TEHON. – Botanical Gazette 65: 554. 1918.
SYN.: *Lophodermium multimatricum* JOHNSTON. – Mycotaxon 31: 384. 1988.

Neotype: VENEZUELA: Edo. Aragua, Parq. Nac. Henry Pettier, ca. 14 Km above Maracay, Maracay-Choroni Rd., on *Clusia* sp., DUMONT (VE-2051), HAINES & SAMUELS, 12 Jul 1971 (NY). (See notes below.)

Ascocarps developing on fallen leaves, in discrete groups, usually within pale, yellowish areas. Not associated with zone lines or anamorph pycnidia. In surface view ascocarps 0.4–0.8 × 0.2–0.3 mm, oblong to oblong-elliptic in outline, ends rounded. Unopened ascocarps with black walls, and with a faint or well-developed paler zone along the future line of opening. Opened ascocarps raising the host surface so that the wall becomes steeply angled to the surrounding leaf surface. A black, flattened area lines both sides of the single, longitudinal slit-like opening. Ascocarps initially subepidermal, with epidermal cells becoming filled with fungal tissue as ascocarp develops. In vertical section in unopened ascocarps the developing hymenium is surrounded by a layer of vertically oriented rows of cylindric cells, which is positioned beneath the epidermal cells of the host. Most cells in this layer are hyaline, but lowermost cells of each row become dark brown and thick walled. Most host epidermal cells packed with dark brown, thick walled, angular fungal cells, but a few cells remaining empty near midpoint of the ascocarp upper wall. In opened ascocarps the upper wall mostly of dark brown, angular cells, but along the edge of the ascocarp opening is a narrow extension to the upper wall which covers the hymenium, and which comprises very dark tissue with no obvious cellular structure. – Paraphyses 1–2(–4) µm diam., branching 2–3 times in upper 30–40 µm, sometimes irregularly swollen, extending 20–30 µm beyond asci. – Asci 100–130 × 6–7 µm, cylindric, tapering abruptly to small, rounded apex, wall undifferentiated at apex, 8-spored. – Ascospores 70–100 × 1.5–2 µm, tapering slightly to both ends, 0–1 septate, surrounded by narrow gelatinous sheath.

Specimens examined. – COLOMBIA: on *Clusia* sp., LINDIG (2851) (K, part of collection only); Dpto. Cauca, between El Tambo and Popayan, on *Clusia* sp., DUMONT (CO 1243) et al., 14 Jul 1974 (NY, part of collection only). – VENEZUELA: Edo. Aragua, Parq. Nac. Henry Pettier, on *Clusia* sp., DUMONT (VE 2051) et al., 12 Jul 1971 (NY - neotype); Dpto. Federal, Mt La Naiguata, on *Clusia* sp., DUMONT (VE 805) et al., 26 Jun 1971 (NY, part of collection only); Edo. Aragua, Parq. Nac. Henry Pettier, Rancho Grande, on *Clusia* sp., DUMONT (VE 1157) et al., 3 Jul 1971 (NY, part of collection only); Edo. Monagas, Caripe, on *Clusia* sp., DUMONT (VE 5359) et al., 18 Jul 1972 (NY); Dpto. Federal, Parq. Nac. El Avila, El Avila, on *Clusia* sp., DUMONT (VE 6156) et al., 27 Jul 1972 (NY). – NEW ZEALAND: Buller, vic. Murchison, Maruia Saddle, Warbeck Scenic Res., on *Rubus cissoides*, JOHNSTON (R161) et al., 16 Apr 1983 (PDD 461227 - holotype of *Lophodermium multimatricum*).

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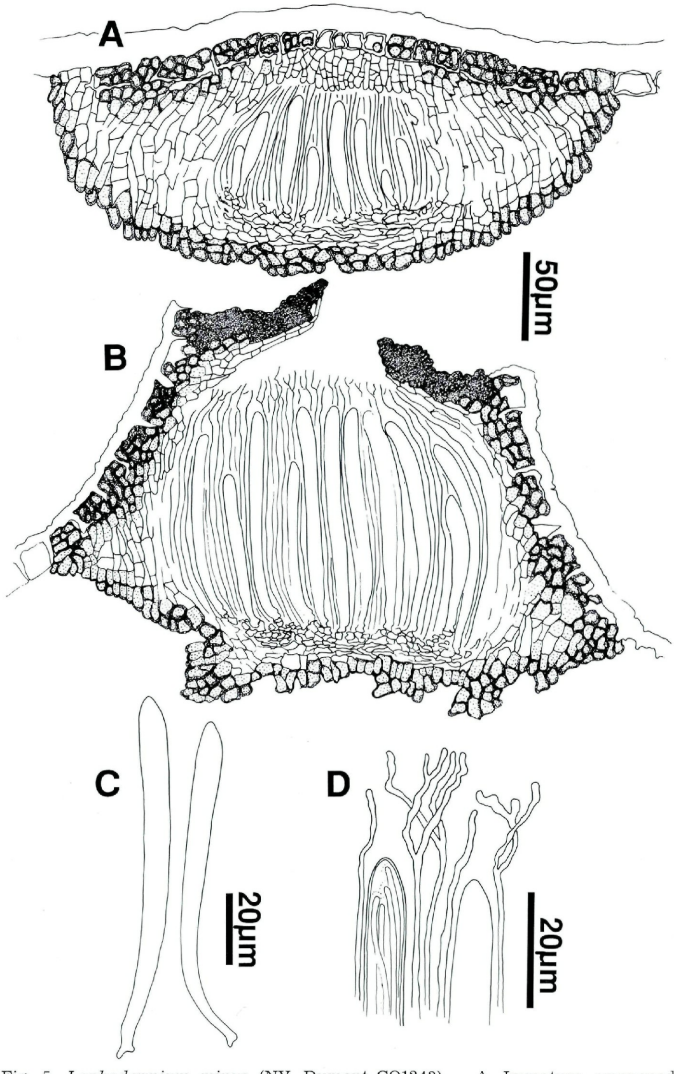

Fig. 5. *Lophodermium minus* (NY, Dumont-CO1243). – A. Immature, unopened ascocarp in vertical section showing layer comprising vertically oriented rows of hyaline, cylindric cells surrounding developing hymenium. – B. Mature, opened ascocarp in vertical section. – C. Asci. – D. Apex of asci and paraphyses.

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L. minus can be distinguished from the other two species on *Clusia* by its small, oblong, black-walled ascocarps, and by the distinctive, black, flattened area adjacent to both sides of the opening slit.

The type specimen of *Clithris minor* is missing. SYDOW (1930) speculated that *C. minor* may have been based on immature material of *Lophodermium platyplacum*. He could find no fungi matching TEHON'S description of *C. minor* in the material he had available, although he did not examine the type specimen. STEVENS-1595 was the only specimen cited under *C. minor* by TEHON (1918), and there are no other specimens at ILL identified as this species by TEHON. *C. minor* was originally described as occurring on the same leaves as *Clithris clusiae* TEHON (= *Lophodermium platyplacum* (BERKELEY & CURTIS) SACCARDO), and was distinguished by its smaller ascocarps, shorter asci, and tangled epithecium. The neotype chosen for *L. minus* has ascocarps smaller than those of *L. platyplacum*, with ascus and ascospore dimensions matching those given in the original description of *C. minor*. The epithecium of the neotype comprises tangled paraphysis tips. However the tips of the paraphyses are 2-3 times branched, rather than coiled as originally described for *C. minor*. Several other specimens which match the neotype in all the above features have been seen on *Clusia* leaves in association with *L. platyplacum*. Because the neotype fits closely the description of *C. minor* given by TEHON (1918), and as no other similar *Lophodermium* species have been seen on *Clusia*, it is assumed the neotype represents the species originally described by TEHON.

Lophodermium multimatricum JOHNSTON is placed in synonymy with *L. minus*, which it matches in all characters. *L. minus* can be distinguished from other species of *Lophodermium* with a similar ascocarp structure (JOHNSTON, 1988) by ascus and ascospore size, by shape of the ascus and paraphysis apices, and by the lack of anamorph pycnidia. It is found on many plants in New Zealand, as well as on hosts other than *Clusia* in South America (JOHNSTON, 1988).

3. *Lophodermium platyplacum* (BERKELEY & CURTIS) SACCARDO. - Sylloge Fungorum 2: 792. 1883. - Figs. 3 & 6.

BAS.: *Hysterium platyplacum* BERKELEY & CURTIS. – Botanical Journal Linnean Society 10: 372. 1869.

SYN.: *Clithris platyplacum* (BERKELEY & CURTIS) TEHON. – Illinois Biological Monographs 30: 115. 1935.
Clithris clusiae TEHON. – Botanical Gazette 65: 554. 1918.

Ascocarps developing on fallen leaves, in discrete groups within pale, yellowish areas, and in some collections associated with anamorph pycnidia. Not associated with zone lines. In surface view ascocarps 1.0–3.0 × 0.3–0.4 mm, oblong-elliptic to sublinear in out-

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line, straight or sometimes curved or bifurcate, ends rounded. Unopened ascocarps with walls pale brown, or more or less concolorous with surrounding host tissue, and with indistinct paler zone along the future line of opening. In opened ascocarps walls concolorous, or pale to dark brown, with a narrow dark line at outside edge of ascocarp. Hymenium yellowish to dark reddish brown, remaining exposed even when the ascocarp is dry. Pycnidia round in outline, 0.2 mm diam., concolorous with surrounding host tissue to pale brown. Ascocarps forming initially beneath the first row of hypodermal cells, as the ascocarps develop most of the hypodermal cells become partially broken down and filled with fungal tissue, and a few epidermal cells may also become invaded. In vertical section in unopened ascocarps the upper wall comprising mostly brown to dark brown, angular cells, but near the midpoint of the upper wall, in the area where the opening will develop, in the outer part of the wall, is a group of hyaline, thin-walled cells. In opened ascocarps the upper wall up to 30-50 µm wide, not increasing in width toward edge of the ascocarp opening, comprising mostly brown to dark brown, thin to thick-walled, angular cells. Extent to which the cells become darkened and thickened varies greatly between ascocarps. Along the edge of the ascocarp opening are a few paler, thinner-walled cells, but these not forming a well differentiated layer. Lower wall 15–30 µm wide, of several rows of angular, thick-walled cells, outer rows of cells brown to dark brown, inner rows pale brown to hyaline. – Paraphyses 1.5–2 µm diam., increasing in width to 3–5 µm at the clavate apex, embedded in thick yellowish gel, forming a regular palisade, extending 20–30 µm beyond asci. – Asci 120–150 × 6.5–8 µm, cylindric, apex broadly rounded, wall at apex sometimes slightly thickened with small central pore, 8-spored. – Ascospores 80–100 × 1–1.5 µm, tapering slightly to base, 0 septate, surrounded by gelatinous sheath. – Pycnidia in vertical section lenticular in shape, upper wall more or less absent. – Conidiogenous cells lining lower wall, solitary, more or less cylindric, tapering to apex, proliferating sympodially, often with two conidia held at apex. – Conidia 3.5–4.5 × 1.5 µm, cylindric with rounded ends, 0 septate, hyaline.

Specimens examined. – COLOMBIA: Dpto. Cauca, between Popayan and El Tambo, on *Clusia* sp., DUMONT (CO 1243) et al., 14 Jul 1974 (NY, part of collection only); Dpto. Antioquia, Valdivia Rd., ca. 8200', on *Clusia* sp., DUMONT (CO 6165) et al., 12 Aug 1976 (NY, part of collection only); Dpto. Norte de Santander, Cobaria Rd, on *Clusia* sp., DUMONT (CO 6804) et al., 20 Aug 1976 (NY, part of collection only). CUBA: on *Clusia* sp., WRIGHT (424) (Isotype – K). – PUERTO RICO: on *Clusia* sp., SEAVER (1844) & CHARDON, 1923 (NY); Mayaquez Mesa, on *Clusia rosea*, STEVENS (7482), 25 Jun 1915 (ILL 7421, as *Clithris clusiae*); Desecheo, on *Clusia rosea*, STEVENS (1577), 31 May 1913 (ILL 7425, as *Clithris clusiae*); on *Clusia rosea*, STEVENS (8014) (ILL 7422, as *Clithris clusiae*). – TRINIDAD: Gasparee Is., on *Clusia* sp., SEAVER (3431), 2 Apr 1921

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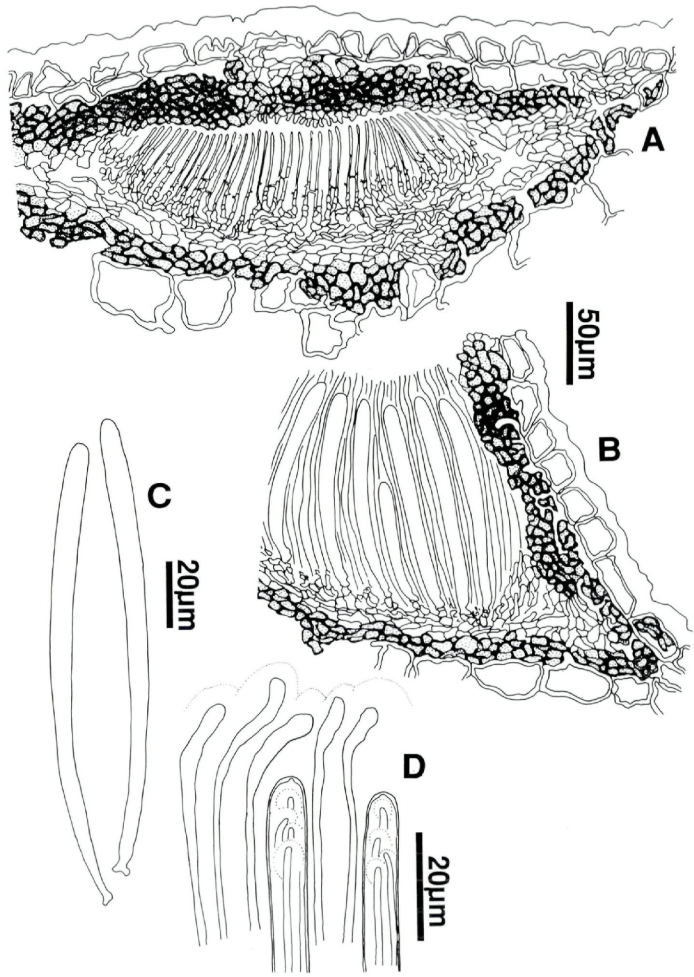

Fig. 6. *Lophodermium platyplacum* (A, B: NY, Seaver-3431. C, D: NY, Dumont-CO1243). – A. Immature, unopened ascocarp in vertical section. – B. One side of mature, opened ascocarp in vertical section. – C. Asci. – D. Apex of asci and paraphyses.

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(NY). – VENEZUELA: Catuche, Caracas, on *Clusia rosea*, SYDOW, 14 Sep 1927 (NY); Edo. Miranda, La Silla, on *Clusia* sp., DUMONT (VE 88) et al., 18 Jun 1971 (NY); Dpto. Federal, Parq. Nac. El Avila, Pico Avila, on *Clusia* sp., DUMONT (VE 561), 23 Jun 1971 (NY); Dpto. Federal, Mt. La Naiguata, above Las Delicias, on *Clusia* sp., DUMONT (VE 805) et al., 26 Jun 1971 (NY, part of collection only); Edo. Aragua, Parq. Nac. Henry Pettier, Rancho Grande, on *Clusia* sp., DUMONT (VE 1157) et al., 3 Jul 1971 (NY, part of collection only); Edo. Aragua, Parq. Nac. Henry Pettier, on *Clusia* sp., DUMONT (VE 2125) et al., 13 Jul 1971 (NY); Edo Sucre, Rio Aguas Calientes, on *Clusia* sp., DUMONT (VE 4238) et al., 8 Jul 1972 (NY).

L. platyplacum can be distinguished from the other two species on *Clusia* by its oblong-elliptic to linear, sometimes curved or bifurcate ascocarps, which have walls pale brown or concolorous with surrounding host tissue, and in which the often dark hymenium is widely exposed even when ascocarps dry.

The type specimen of *C. clusiae* is missing, but several other specimens identified as this species by TEHON have been examined from ILL. All match the type specimen of *H. platyplacum*.

Acknowledgments

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